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Descriptive–Explanatory Theoretical Models of the Socialist Economy: Review of a Research Direction

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Key Words—Economic systems; dynamic systems; control theory; mathematical economics; socialist economy; disequilibrium theory; chronic shortage; quantity adjustment; Hungary.

Abstract—The collection of works given in the Selected Bibliography forms *a research direction* in mathematical economics. The article is aimed at clarifying what is common in these works and what makes them different from other studies in related fields. The common main features are the following: the works (1) describe dynamic systems; (2) are modelling not only the real sphere but also the control sphere; (3) formalize behavioural regularities of the socialist economy; (4) suppose no optimizing behaviour, but only that the decision-maker possesses some response function; (5) focus on non-price signals; and (6) focus on non-Walrasian states of the economy. They wish to contribute to the elaboration of a *descriptive–explanatory* (positive) theory. They wish to explain *what is* in the socialist system and *why*, and not to tell what should be. These are researches made at the level of 'pure theory', therefore models are based on rather abstract assumptions. Finally, the article discusses research tasks.

1. INTRODUCTION

THE COLLECTION of works given in the Selected Bibliography at the end of the present article forms *a research direction.* [1]* It is the common feature of them all that they use mathematical models and a systems theory approach in analyzing economic problems. This is also done, however, by several other works. My article aims at clarifying what is common in the works included in the Selected Bibliography and what makes them different from other studies in related fields. The mainstream of contemporary mathematical economics reflects the theoretical influence of neoclassical economics. There are a few important 'currents' outside the mainstream, modern versions of Ricardian and Marxian theories, institutionalist approaches etc. The research direction surveyed in the present article shares a few characteristic features with these schools, but it is clearly different from them in many other attributes. The reader will get acquainted with these properties, successively, as we go along the more detailed description of our 'model family'.

The total length of the literature listed in the Selected Bibliography adds up to several thousand printed pages. The present survey cannot aim at completeness. It can provide only a few insights into some characteristic features of our research direction, leaving many important questions unanswered. For more detailed discussion the reader may consult the books and articles indicated in the Selected Bibliography.

The review will give grounds for dispute with some other trends. At the end of my article, I shall outline a few research tasks.

2. AN EXAMPLE: THE ORDER SIGNAL MODEL

Of the large number of models of the Selected Bibliography, we shall take one—not because it is considered to be the best or most complete one, but because the reference to a relatively simple example will make it easier to explain the propositions. The model of the economic system based on stock and order signal was constructed by the author with András Simonovits' collaboration. (See Selected Bibliography No. 11 and No. 12, Chapter 12.)

The economy has n sectors, connected by real input–output flows of the Leontief type, at the usual assumptions (linearity, no substitution, etc.). The functioning of the economy is described by a linear difference equation system. The model is summed up as follows [2]:

Identity of production and sales

$$\underset{\text{(production)}}{r(t)} = \underset{\text{(sales)}}{Y(t) \cdot 1} \qquad (1)$$

* Numbers in brackets refer to explanatory Notes which follow the Selected Bibliography.

Input stock balance

$$V(t+1) = V(t) - A\langle Y(t) \cdot 1 \rangle + Y(t) \qquad (2)$$

(input stock) (producer's consumption) (purchase)

in which A is the Leontief matrix of the current input coefficients.

Order stock

$$K(t+1) = K(t) + Z(t) - Y(t) \qquad (3)$$

(order stock) (order) (sales)

Regulation of sales

$$Y(t) = Y^*(t) - P \otimes [K^*(t) - K(t)] \qquad (4)$$

(sales) (normal sales) (normal order) (actual stock)

in which P is the matrix of the control parameters (rates of reaction).

Regulation of the order

$$Z(t) = Z^*(t) - Q \otimes [V(t) - V^*(t)], \qquad (5)$$

(order) (normal order) (actual input) (normal stock)

in which Q is the matrix of the control parameters (rates of reaction).

In an abstract and highly simplified form, the model features certain particularities of *the control of the shortage economy*. Within the scope of this model, the stock of unfilled orders $K(t)$ measures the intensity of shortage. The measure of shortage serves also as a signal. According to equation (4), sales (and production) exceed what is normal if the order stock exceeds what is normal. Because of chronic shortage, there are no output stocks. This is expressed by equation (1): what has been produced is immediately sold. On the other hand, producers wish to accumulate input stocks. Purchase must be preceded by order. According to equation (5), the order is larger than normal if the input stock has sunk below normal.

It is mathematically proven that—with certain further conditions, not to be discussed here—the system is viable; further, it is capable even of growing. The regulation mechanism resting on order signal on the output side, and on stock signal on the input side provides for the stability of the system [3].

3. THE COMMON MAIN FEATURES OF THE MODELS

And now let us leave the illustrative example. We shall lay down the six main characteristics which are shared by the models treated in the works of the Selected Bibliography.

(a) *Dynamic systems*

Our models describe dynamic systems. Their mathematical form is either a differential or a difference equation system. Some of the works—not all—make use of the apparatus of control theory. This was the case with our example: the stock and order signal model given under Section 2.

This is a feature separating our works from a large part of mathematical economics in which static models are used.

(b) *Real sphere and control sphere* [4]

Many works of mathematical economics confine themselves to analyzing the real sphere, or perhaps take into account the control of real processes exogenously. This is done, for example, by most of the analyses applying the apparatus of Leontief models or of mathematical programming. The same thing can be said of the classic studies discussing the two outstanding achievements of mathematical economics: the dynamic Leontief model and Neumann's growth model. For example, the Neumann model computes the optimum prices and discount rates belonging to the optimum path at a given criterion, but does not feed them back into the system.

On the contrary, it is a particularity of our research trend that signals are generated endogeneously in the models and, relying on these signals, control takes place endogeneously as well. Or, if that is not the case generally, at least that part of the control sphere is endogeneous upon which the examination in question is centred. The model builder pays equal attention to represent both the real sphere and the control sphere. In our example, equations (1) and (2) describe the functioning of the real sphere, and equations (3)–(5) that of the control sphere. There, as well as in all models of this research direction, the centre of the analysis is exactly the connection between the two spheres.

(c) *Behavioural regularities of the socialist economy*

In describing the real sphere, our models usually apply standard assumptions. No attempt is made at stressing any system-specific features; these elements of our models might refer to the real sphere of any system. Our example is concerned with a production function of the Leontief type: this is obviously a simplification, but a rather general one, which might be applied in the modelling of real input–output relations of any socioeconomic system.

On the other hand, in modelling the control sphere, it is our intention to represent system-specific features. The researchers of this trend are concerned with the problems of the *socialist* economy. Either such behavioural regularities are formalized which are present exclusively in the socialist economy or in one of its existing versions, or such regularities which are present in different economic systems, yet play a

particularly important role in the socialist economy.

This is the situation, for example, with the stock and order signal mechanism presented in Section 2. This regularity is also to be found with each firm, or even with whole sectors, in the capitalist economy. Yet it is much more characteristic of economic formations in which shortage is widespread and chronic. It is true that the control of real socialist systems differs from the extremely simplified, abstract schemes of equations (4) and (5). Yet we believe that those two equations represent something—on a high level of abstraction—that is very characteristic of the control processes of our economic system.

For another example, I refer to the macrodynamic model described in the study listed in Selected Bibliography No. 8. In this model, the equation describing the control of investments formalizes —making use of the results of Bauer's, Soós's, Lackó's and other research work—the behavioural regularities which have been demonstrated by the historical–empirical observation of the Eastern-European socialist economies. In describing other relations as well, this model tries to reflect, in mathematical form, the behavioural regularities found in the socialist economy. On the one hand the intensification of shortage leads to pressure exerted by customers on the producer who tries to react by increasing supply through 'rush work'. On the other hand the intensification of shortage keeps back some of the buyers from purchase: they would rather leave their money unspent than be forced to purchase less acceptable substitutes.

This feature of our model rests on the epistemological and socio-philosophical conviction that the socialist economy—and within it, the control of socialist economy—has got certain *regularities, rules and norms.* Although the centre has an important role, what takes place in the economy is not simply what is decided by the centre. Social conditions, ownership and the institutional framework develop certain regularities which will prevail as long as those conditions prevail. These regularities can be observed, and described in words. And, if that is so, they can also be mathematically formulated, at appropriate simplifying assumptions, for models that serve for the theoretical analysis of qualitative interactions.

(d) *Response functions*

We hold it to be too strong and unnecessarily restrictive an assumption that every decision-maker active in the economy has a utility function of which he wants to reach the maximum. It is not our intention to 'disprove' this assumption which is no more in itself than an empty frame of theory. We should rather say that it is felt as an uncomfortable straitjacket which binds, unnecessarily, the hands of the model builder.

Instead, a much more general and less restrictive assumption will be sufficient: on specific impulses, the decision-maker reacts in specific manners. In other words: his behaviour can be described by *response functions.* In our example, equations (4) and (5) give the response functions. In the former, reaction on the order stock is sales, i.e. production, in the latter, reaction on the input stock is purchase.

Several studies centre their attention on a particular form of control: *control according to norm.* Social experience, habit and tradition develop certain norms which function as 'adjustment signals'. Deviation from the norm triggers off certain reactions, which drive the system back to its normal path. Our example in Section 2 uses this form: the control reacts on the negative feedback of the deviation from the norm of the order stock, respectively from that of the input stock.

The control according to norm is a formalism easy to treat mathematically. It fits in well with the apparatus of control theory. It is recalled that one of the main sources of inspiration of mathematical control theory is engineering, where control frequently applies this form. What is more, it would carry a lot of advantage in case of quantification, that is to say, in the econometric application of a model originally constructed for theoretical purposes. The norms, that is, the normal values of different economic indicators are usually easily measurable.

At the same time, however, it is not at all our intention to create a kind of exclusive dominance for the model of control according to norm. It is *one* of the 'frames' or 'schemes' in which the decision and control process can be described. In some cases it is the best one to apply, because it accentuates an essential motive of the process empirically observable in reality. In other cases, its use would be arbitrary or uncomfortable [5]. The Selected Bibliography includes a few models which do not apply this type. For example, the study cited in Selected Bibliography No. 13 describing the functioning of the market of a shortage economy applies simple response functions. The buyer makes it dependent on the expected queuing time, whether he will join the queue or effectuate forced substitution (i.e. buy something different from his original demand)—without assuming, in this model, that a 'normal queuing time' exists.

(e) *Non-price signals*

In our models many kinds of information flows are present. The majority are non-price (or, as they are called in Western literature, not quite correctly, 'quantity') signals. I shall quote a few examples.

—The case presented in Section 2 (Kornai–Simonovits, Selected Bibliography No. 11): *deviation of the order stock and of the input stock from the norms.*
—The model of a market with chronic shortage (Kornai–Weibull, Selected Bibliography No. 13): *expected queuing time.*
—Macrodynamic model (Kornai, Selected Bibliography No. 8): *the synthetic indicator of shortage* as a synthetic representation of shortage indicators effective on the micro-level; further, *the deviation of consumption, investment commitment and stocks from normal.*
—Model of the investment cycle (Lackó, Selected Bibliography No. 17): indicators of the *foreign trade balance* and of *investment tension.*

We do not assert that non-price signals are exclusively effective. Prices play an extremely important role in every economic system. Of course, it depends on the particularities of any given system, to what extent prices or non-price signals are effective in one or another sector. The latter are of importance in the capitalist economy, even though the main influence there is that of prices. In the socialist economy, prices largely affect the purchase decisions of households at all times. On the other hand, central planners, non-profit institutions and firms are less sensitive to prices and react mainly on non-price or 'quantitative' signals. It is hoped that the reforms of the economic mechanism in Eastern Europe will bring some change in this respect.

To assume that the economic decision-maker reacts 'purely' on non-price signals is to simplify reality. And it is an even stronger abstraction to model a system in which there are no prices at all, but exclusively non-price signals. It will be easier to understand this aspect of our research course if it is viewed as integrated in the history of theory of this question. For a long time, mathematical economists standing on the grounds of neoclassical theory had ruled the field. Their models used oversimplified and one-sided forms to describe the information flowing in the economy: they assigned an *exclusive* role to prices. If the Walras–Arrow–Debreau models represent, in their classic and crystallized form, the 'thesis', our school represent the 'antithesis' [6]. Exactly because it comes out as an antithesis, it stresses one-sidedly the role of non-price signals. Obviously, in a complete theory both prices and non-price signals must have their place, in the proportions as they are found in real economic systems. So far, we have made only one or two modest steps from the antithesis towards synthesis. (For example, the study by Martos, Selected Bibliography No. 19, draws a comparison between the mechanisms reacting on prices and those reacting on non-price signals. The model by Kornai–Weibull, Selected Bibliography No. 13, represents a sequential decision process: the buyer reacts first on the price, then on the non-price signal.) We are far from satisfactory synthesis yet.

(f) *Non-Walrasian state*

Economic systems may be permanently in a state deviating from the Walrasian perfect equilibrium, which is free of excess demand and excess supply on all markets. In reality, chronic shortage or chronic slack shows in the production and on the market, or shortage and slack are present simultaneously.

Let us consider the example introduced in Section 2. In this system, excess demand may be permanently large (the normal value of unfilled orders is high), simultaneously with a very large input stock as a consequence of the hoarding tendency (the normal value of the input stocks is high). The system may move on a normal path (that is, on the non-Walrasian 'equilibrium' path specific of the system), while permanently and consequently away from the perfect market equilibrium.

The wide variety of models listed in the Selected Bibliography serve for studying these chronic shortages and slacks, permanent asymmetries, and non-Walrasian 'equilibrium' paths [7].

While the preceding six features are shared by all the works of our research trend, they differ as to how far they cover the national economy, or, what extent

Table 1. Survey of models according to scope and aggregation

	Aggregate (macro-) model on the national economy level	Disaggregate (micro-) model
Covering the whole economy	Macrodynamic models: 3, 8	*n*-sector models: 1, 2, 4, 5, 9, 10, 11, 12, 15, 19, 20, 23, 24, 25
Covering a delimited field of economy: partial models	Models of investment cycles: 14, 17, 18, 22	Partial market with queue: 13
	Models of households' consumption: 16, 21	

of aggregation or disaggregation they apply. Table 1 sums up the works from this aspect.

4. DESCRIPTIVE–EXPLANATORY (POSITIVE) THEORY

Thus far the characteristic features of the *models*, that is, of the *apparatus* of the studies have been used to describe the research direction. Now we shall go on to throw a light on the typical *questions* which these models are to answer [8]. The question asked by a research trend is often more characteristic even than the answer, since the latter may be immature, deficient or inexact—particularly if it is a fresh course.

This research trend wishes to contribute to the elaboration of the *descriptive–explanatory* (positive) theory of the socialist economy. Let us reduce the notion to its components and consider first the attribute: this is a *descriptive–explanatory* (positive) theory and not a normative one. We wish to answer the question, *what is there* in the socialist system (description) and *why* it is there (explanation), and not: *what ought to be there.*

The two kinds of question-asking in a research work are not mutually exclusive. Sticking to the mathematical models: in many cases, the same model may answer the question: what is there? as well as the question: what ought to be there? For example, an input–output balance is used to analyze the real input–output relations of the present, as well as to draw up a plan for the future input–output relations. Or, a simulation model is applied for an *ex post* economic history analysis up to present times, and then the same model can be used to make alternative prognoses and help to find out, which of the alternatives is worth realization.

While I hold it to be possible to connect the two different questions, I venture the following remark: most of the works of mathematical economics in socialist countries have not paid enough attention to the first question so far. They have often failed to give a description and even more often to provide an explanation. Energies are largely spent on building decision, planning and operation research models, which are clearly and one-sidedly normative. Only a few models are constructed from the outset so as to produce a descriptive–explanatory theory on systematically recurrent economic phenomena. The decision models would also be more successful if they were supported by an adequate descriptive–explanatory (positive) theory. It would happen then less frequently that the decision model suggests something, and in practice something else is done. And not always because external conditions have developed otherwise than what was foreseen in formalizing the model. Something else is done because there have been some internal forces, behavioural regularities effective in the depths of the economic system, interests, decision-making attitudes and 'conditioned reflexes' which drive the economy to another direction than where the recommendations of the decision model would like to drive it.

This problem is closely connected to what was already mentioned in presenting the main features 2, 3 and 6 of the research trend. In most cases, the decision models cover only the real sphere and, perhaps, also a part of the control sphere: the flow of incomes, and the changes in costs and prices. As a rule, they do not contain *behavioral equations* to describe regularities in the actions of the actors of the economic system, and their typical reactions on the impulses that affect them. Economic policy is just an exogenous factor which decides what to do, listening to the recommendations of the planners and even of the model builders. And yet economic policy is an endogenous part of the system and its behaviour, or at least some of its components are determined by certain regularities. A descriptive–explanatory model, or a model of double aim—positive *and* normative—has to contain by all means behavioural equations.

With the aid of an input–output balance, or of a mathematical programming model, the computer easily satisfies every balance equation. A planning model may help to find out the perfect Walrasian equilibrium of the economic system and after it has been found, the planner will observe regretfully, that the system has again deviated from this perfect equilibrium-plan. An appropriate descriptive–explanatory theory of the socialist economy is to make it clear that, due to certain behavioural regularities, the system will not and cannot be in a Walrasian equilibrium, but *must* deviate from it permanently.

We shall now discuss the other component of the term 'descriptive–explanatory theory', that is, *theory*. A considerable part of the works listed in the Selected Bibliography is in the category that is called 'pure theory'. We work with strong abstractions. The majority of the works do not aspire after numerical results but carry out only a qualitative analysis. They advance exactly formulated propositions and provide mathematical proofs. (In a few cases, for example in the studies Selected Bibliography Nos. 4 and 5 by Zsuzsa Kapitány, conjectures are set forth instead of rigorously proven propositions, and their validity is supported by computer simulation.)

The studies apply the following procedure in a great part. They describe a real sphere and leave its control to a certain well defined control mechanism. (Of such kind is the slack and order signal

mechanism described in Section 2.) And then they ask such questions as:

—Is the system viable?
—Has it a normal path (that is, an 'equilibrium' path, in the mathematical sense, that may be deviating from the Walrasian state?)
—Is it able to grow? On what does the growth rate depend?
—Is it capable of 'self-regulation'? Is the system stable? What constraints may lead to its destabilization? If the system is driven off its normal path, how fast is its convergence toward the normal path?
—Is there any cyclical movement within the system?
—How does uncertainty affect the system?

The first modest steps have been made in comparing different economic systems. The differences consist in what signals they react on; which degrees and combinations of centralization and decentralization are present in them; whether they are affected by exogenous constraints, and so on.

At this point, I shall mention only two of the results of these analyses.

One important theoretical result is this: non-Walrasian systems may have such characteristics which have previously been proved by mathematical economic theory to be present only in Walrasian systems. Such characteristics are: the existence of a normal path, viability, stability. Thus, for example, there are models of a chronic shortage economy—which is our main interest—in which *shortage is constantly reproduced, while the system survives, is functioning, and its control is stable.*

Another important theoretical result; there exists *a control mechanism which, though functioning without price signals, is still decentralized.* Economic theory used to be prone to contrast two extreme and one-sided types: the perfectly centralized system in which there are 'quantitative' signals, and the perfectly decentralized system in which prices exclusively serve for signals, It has been proved that a third type exists (more exactly, a whole family of systems), in which there is no price signal and yet it is able to function relying on a decentralized flow of information and decentralized decisions. (The system presented as an example in Section 2 is a member of this family: every producer decides independently on production, purchase and sales, relying on the observation of their own stocks and unfilled orders.)

5. RELATED TRENDS

We have come to the end of the description of our research direction. In the Selected Bibliography, those mathematical models are listed which share the six main features discussed in Section 3 and which try to answer the questions outlined in Section 4, that is, which claim to be a descriptive–explanatory (positive) theory.

I have included in the Selected Bibliography a few works the authors of which do not expressly declare to belong to this trend. I did not make it dependent on the authors' agreement, but on the properties of their studies, whether to consider them to belong here.

On the other hand, I did not include certain works which, though showing affinity to our research course in a few important features, are different in some other essential respects.

First of all it has to be made clear that the present article is concerned only with works using a *mathematical* apparatus. Simultaneously with them, and in a close intellectual interaction (what is more, in a few cases of the same author), a number of analyses were made which agree with or are close to those discussed here, as for their way of asking questions, their approach and initial assumptions, as well as conceptual system—only they do not use mathematical models for their analysis. These 'verbal' models are also characterized by the six features specified in Section 2 of the present article: (1) dynamic approach; (2) examination of the connection between the real sphere and the control sphere; (3) an attempt to reveal the behavioural regularities of the socialist economy; (4) no optimizing behaviour of the actors of the economic system is assumed; (5) a particular attention paid to non-price signals; (6) a particular attention paid to the non-Walrasian states. As a matter of fact, a *wide research trend* is under discussion, which strives for elaboration of a descriptive–explanatory theory of the socialist economy, and in which the mathematical and non-mathematical 'sub-trend' live parallel and intertwined [9].

The most important international research current that shows several similarities with the research trend of mathematical economics treated in this article is the so-called 'disequilibrium theory'. This made its appearance in the Western literature under the influence of Keynesian macroeconomics, as a partial revision of Walrasian microeconomics. Clower, Barro and Grossman are its pioneers; Benassy, Grandmont and Malinvaud followed them [10]. Most members of the 'disequilibrium school' study the capitalist economy, though a few remarkable works on the socialist economy have also been published [11]. At this point we cannot explain in detail in which points their position and methodology agree with ours and in which points they do not. In any case, we may consider the adherents of the 'disequilibrium theory' as our 'allies' in our efforts.

Our research direction addresses similar issues as some scholars who could be classified as 'institutional economists'. Here is a short list of such issues: adjustment, homeostatic and accommodating control processes, bargaining and negotiating, information flow between human actors etc. [11]. Our results may perhaps contribute to the mathematical formalization of some instutionalist theories.

There are other tendencies and schools as well with which we have similar views in one, two or more important theoretical and methodological questions. Thus we do not feel isolated in our experiments.

6. RESEARCH TASKS

The total volume of the works listed in the Selected Bibliography is huge. Yet we must say: this is still only the beginning. For the time being, the models applied are rather simple and the results modest. I shall select just three of the multitude of tasks.

(1) With some of the ready models the ordinary further steps ought to be taken: *to try to lift or weaken the assumptions which are the most restrictive and most simplifying on reality*. A great number of our models use linear forms to describe such interrelations which ought to be given in a non-linear form; in several of our models constraints, should be included, and so on.

(2) It would be useful to extend our research to subjects that have not been treated before. Thus for example it would be important to model *price formation*, and the *reactions on prices*, in the spirit of the theoretical and methodological ideas which I outlined in the present article.

Let us first take the examination of price *formation*. Some so-called 'price models' are well known. They have been constructed with great care and they have an important role in the preparation of decisions concerning prices in Eastern Europe. They describe internal relationships of costs and prices, in most cases with the aid of Leontief models. They are apt to give a conditional forecast: in which way the prices would change, *if* the price of one or another product or of production factor changed, or if other cost factors or calculation principles were modified. On the other hand, they do not answer the question (they have no intention of answering it), which *behavioural regularities* are present in the *actual* formation of prices, including the behaviour of those who exert an influence on price determination.

In order to examine the *effect* of prices, economy is to be divided into two parts. The effect of consumer prices on *households* has been sufficiently treated in Hungarian literature, however, less attention has been paid—with a few exceptions—to the analysis of those specific circumstances (shortages, administrative regulation), which damp the effect of consumer prices in the socialist economy. The sporadic exceptions have been included in the Selected Bibliography (Nos. 16 and 21).

The effect of prices *in the sphere of enterprises and non-profit institutions* has been hardly discussed in the Hungarian (or other Eastern-European) literature of mathematical economics.

The research tasks indicated here are intertwined with another highly important subject: the descriptive–explanatory theory and mathematical models of *the inflation trend prevailing under the socialist economic conditions* ought to be worked out. Only the initial steps have been taken in this direction.

(3) With a few exceptions, models of 'pure theory' are included in the Selected Bibliography. The following step is *econometric* analysis [12]: transformation and development of the theoretical models in a way that the model can be quantified. The regularities revealed by theory are to be considered as hypotheses which must be tested by econometric methods: supported, improved or be rejected. (The following works of the Selected Bibliography are in the econometric field: Lackó, Nos. 16 and 17; Simon, Nos. 21 and 22; Kyn *et al.*, No. 14; Maresse, No. 18.) The work is enormous which waits to be accomplished.

At this point, I wish to make a few remarks on the situation of econometrics in Hungary. In the last 10–15 years it has made good progress; there are quite a number of economists well versed in it; one or two strong research groups have been formed. The main difficulty is, in my opinion, that a considerable part of econometric research works lack a theoretical foundation. Ever since econometrics has been present in economic science of the world, the question has been recurring: is it possible to measure without theory? The question is being asked in Hungary, too. In my opinion, in the majority of cases the following order of succession is inevitable: *first* economic interrelations must be theoretically clarified and upon this basis hypotheses set up, and it is only *after* that measuring and the econometric testing of the hypotheses can take place.

A number of econometric researchers went straight to measuring, bypassing theoretical clarification. They have relied on good luck, waiting for some interpretable result to emerge in the course of their computations. If I wished to caricature the situation, I might add: they have always imported the latest Western model, without considering whether the theory underlying the model fits the specific conditions of the socialist economy. Meanwhile, they have neglected the Hungarian theoretical researches centred on the understanding of the specific features of the socialist economy.

I have no intention of blaming econometricians alone for the present situation. Certainly, theoretical economists are also guilty of negligence: they have failed to initiate cooperation, to suggest the econometric examination of their theories. In any case, I do hope that the situation will change and the number of econometricians will be growing who adopt the research tasks outlined in this article and are prepared to contribute to the elaboration and empirical analysis of the descriptive–explanatory theory of the socialist economy.

7. A SHORT CLOSING REMARK

The research direction set forth in this article is not intended to be a scientific monopoly. On the one hand, it is *complementary* with other research activities. It aims at elaborating a descriptive–explanatory positive theory, therefore it has to be complemented by normative researches. It is of theoretical character, and has, therefore, to be complemented with more practical investigations.

On the other hand, *competition* is necessary. Several competing trends together may come to better understand the function of the economic systems and to work out useful proposals for their improvement.

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8. J. Kornai, *Növekedés, hiány és hatékonyság. A szocialista gazdaság egy makrodinamikai modellje*. Közgazdasági és Jogi Könyvkiadó, Budapest (1982). *Growth, Shortage and Efficiency. A Macrodynamic Model of the Socialist Economy*. Blackwell, Oxford (1982). A dynamic mathematical macromodel of socialist systems. Mostly theoretical, some numerical illustrations.
9. J. Kornai and B. Martos, Gazdasági rendszerek vegetativ müködése. *Szigma* **4** (1971), 35–50. Autonomous control of the economic system. *Econometrica* **41** (1973), 509–528. See annotation to No. 12.
10. J. Kornai and A. Simonovits, Neumann-gazdaságok szabályozási problémái. *Szigma* **8** (1975), 81–100. Decentralized control problems in Neumann economies. *J. Econ. Theor.* **14** (1977), 44–67. See annotation to No. 12.
11. J. Kornai and A. Simonovits, Rendelésjelzésen alapuló szabályozás egy Neumann-gazdaságban (Order signal control in a Neumann economy). *Szigma* **8** (1975), 281–290. See annotation to No. 12.
12. A. Bródy, I. Dancs, L. Hunyadi, Zs. Kapitány, J. Kornai, B. Martos, A. Simonovits and J. Sivák, *Szabályozás árjelzések nélkül*, ed. J. Kornai and B. Martos. Akadémiai Kiadó, Budapest (1981). *Non-Price Control*. North-Holland, Amsterdam (1981). Collection of papers, which compare the properties of various control mechanisms, regulating the same real processes: a dynamic economic system composed of many sectors and operating with Leontief-technologies. The models differ from each other in the content of signals, in the degree of centralization or decentralization, in handling time (continuous versus discrete time) and so on. Numbers 1, 2, 4, 5, 9–11, 15, 19, 20, 23–25 are either original publications, revised and included in the collective volume, No. 12, or more elaborated versions, published at a later date. As for mathematical apparatus: difference or differential equation systems, control theory.
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15. I. Ligeti and J. Sivák, *Növekedés, szabályozás és stabilitás a gazdasági folyamatokban* (Growth, control and stability in the economic processes). Közgazdasági és Jogi Könyvkiadó, Budapest (1978). See annotation to No. 12.
16. M. Lackó, Lakossági megtakaritás és ellátási helyzet. *Közgazdasági Szemle* **23** (1976), 535–551. Consumer savings and the supply situation. *Acta Oeconomica* **15** (1975), 365–384. Econometric study of consumer saving in a shortage economy.
17. M. Lackó, Feszültségek felhalmozása és leépitése. *Közgazdasági Szemle* **27** (1980), 923–940. Cumulating and easing of tensions. *Acta Oeconomica* **24** (1980), 357–377. See annotation to No. 14.
18. M. Maresse, The bureaucratic response to economic fluctuation: an econometric investigation of Hungarian investment policies. *J. Policy Modelling* **3** (1981), 221–243. See annotation to No. 14.
19. B. Martos, Öt mechanizmus (Five mechanisms). *Szigma* **9** (1976), 213–226. See annotation to No. 12.
20. B. Martos, Comparison of economic control systems. In J. M. L. Janssen, L. F. Pau and A. Straszak (eds.), *Models and Decision Making in National Economies*. North-Holland, Amsterdam (1979). See annotation to No. 12.
21. A. Simon, A lakossági fogyasztás és megtakaritás vizsgálata ökonometriai módszerrel (Examination of the households' consumption and savings by econometric method). *Szigma* **10** (1977), 249–264. See annotation to No. 16.
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23. A. Simonovits, A decentralizált szabályozás maximális konvergenciasebessége. *Szigma* **11** (1978), 49–68. Maximal convergence speed of decentralized control. *J. Dynam. Control* **3** (1981), 51–64. See annotation to No. 12.
24. A. Simonovits, A teljesen decentralizált szabályozás (The totally decentralized control). Manuscript, Institute of Economics, Hungarian Academy of Sciences, Budapest (1981). See annotation to No. 12.
25. I. Virág, Gazdasági rendszerek vegetativ müködése sztohaszitikus külsö fogyasztással (The vegetative functioning of economic systems with stochastic external consumption). *Szigma* **6** (1971), 261–268. See annotation to No. 12.

[1] Important contemporary contributors to neoclassical mathematical economics are Hicks, Samuelson, Arrow, Debreu and Koopmans, to mention only Nobel Prize winners. For a concise summary see K. J. Arrow and F. N. Hahn, *General Equilibrium Analysis*. Holden Day, San Francisco (1971). Major contributions to Ricardian and Marxian mathematical economics: P. Sraffa, *Production of Commodities by Means of Commodities*. Cambridge University Press, Cambridge (1960); M. Morishima, *Equilibrium, Stability and Growth*. Oxford University Press, Oxford (1964); and A. Bródy, *Proportions, Prices and Planning*. North-Holland, Amsterdam (1970). For a summary survey of the institutionalist approach, see A. G. Gruchy, *Contemporary Economic Thought: The Contribution of Neo-Institutional Economics*. Kelley, Clifton (1972).

[2] I am the author or co-author of some of the works listed in the Selected Bibliography, in others I had no part. I lay particular emphasis on the contribution of Mária *Lackó*, Béla *Martos*, András *Simonovits* and Jörgen W. *Weibull* to the trend.

[3] Notation. Small letter: vector of n components; capital letter: matrix nXn; capital letter in parentheses $\langle\ \rangle$: diagonal matrix nXn; $\otimes$: the logical (element by element) product of matrices.

[4] The works cited give the sufficient conditions of asymptomatic stability, respectively of the relative asymptotic stability.

[5] The distinction was introduced in my book *Anti-Equilibrium* [Közgazdasági és Jogi Könyvkiadó, Budapest (1971)]. The real sphere includes the physical processes of the economic system (production, investment, consumption, trade), and the control sphere the information and decision processes that regulate the real processes.

[6] In the socialist economy, such control processes are found in a great number which react by sharp turns on the reaching or exceeding of *critical values*, and on the hitting of physical, behavioural or tolerance limits. (For example, the drastic freeze of investments, if the deficit of the balance of payments or the mass of debts have surpassed a critical value.) Our works have so far failed to formalize this important type of control. It is true, though, that this is much more difficult to handle mathematically than the control according to norm.

[7] Keynes called attention to the importance of non-price signals asserting themselves in capitalist conditions. After that, with a delay of several decades, the first mathematical models appeared in Western literature to analyse 'quantity adjustment'. Such are the works of Clower, Barro, Grossman, Benassy, Malinvaud and of others, which show a closeness to our school, among other things, in this respect (in stressing the role of non-price signals).

[8] The main feature 4 and, even more so, 5 and 6, are closely connected to some of the ideas presented in my book *Economics of Shortage*, Selected Bibliography No. 7. Those who know this book will better understand the economic contents of the models of the Selected Bibliography.

Economics of Shortage introduced theoretical propositions and methodological conceptions in most part verbally. Some of the works in the Selected Bibliography are attempts at formalizing these theoretical and methodological conceptions. At the same time, I believe that a full and comprehensive formalization of 'economics of shortage' has not yet been done.

[9] The separation is to some extent arbitrary. As a matter of fact, we touched upon the economic contents of the models in presenting the main features 5 and 6.

[10] Of my own works, I put *Economics of Shortage*, Selected Bibliography No. 7, in the latter category, which is mostly verbal, except for one or two chapters and the appendices. Further works of this category are, in my opinion, the studies about the investment cycles by Tamás Bauer and K. Attila Soós, the article on the planners' behaviour by János Gács and Mária Lackó, works by Gács on building material shortage and import restrictions, the study on uneven production by Mihály Laki, works concerned with inventories by Katalin Farkas, Attila Chikán, Márta Nagy and Ervin Fábri, etc. Of course, there are differences besides the similarities, in the approach and scientific apparatus of the authors mentioned.

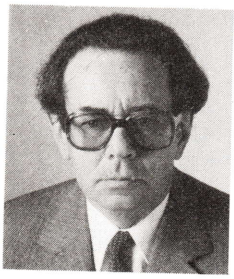
[11] A comprehensive review and bibliography are supplied in A. Drazen, Recent developments in macroeconomic disequilibrium theory. *Econometrica* **48** (1980), 283–306.

[12] See first of all R. Portes and D. Winter, The demand for money and for consumption goods in centrally planned economies. *Rev. Econ. Statist.* **60** (1978), 8–19; and by the same authors, Disequilibrium estimates for consumption goods markets in centrally planned economies. *Rev. Econ Studies* **47** (1980), 137–159.

[13] See, for example, S. T. Lowry, Bargain and contract theory in law and economics. *J. Econ. Issues* **10** (1976), 1–22; and R. M. Troub, General adjustment theory and institutional adjustment processes. *J. Econ. Issues* **17** (1983), 315–324.

[14] Here as well as all through this article, I use the word 'econometrics' in a narrow sense: I understand thereby the application of mathematical–statistical methods in the quantification of economic models and in the testing of theoretical hypotheses.

[15] As indicated in the introduction of the paper, the Selected Bibliography contains only the works which belong to the research direction surveyed in the paper. Other references are given in the Notes Section. To assist the orientation of the reader, there are short annotations.



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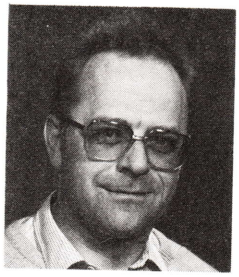

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