The role of quantitative methods in historical research

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The Role of Quantitative Methods in Historical Research

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Abstract: Theoretical problems of correlation between the peculiarities of cognition in humanitarian and natural sciences are discussed. Common features and differences between descriptive and quantitative methods used in historical science are analysed. Natural trends towards integration of different sciences, appearance of mass data, development of computers - these are the reasons for introducing mathematical methods in historical science in the USSR.

To properly define the role and place of quantitative methods in historical research we must first of all specify the notions »quantitative methods« and »mathematical methods«. More often than not, historical research, as well as other fields in the humanities, deal with them as identical concepts. They usually refer to any use of quantitative indices and mathematical methods applied while studying social phenomena and processes. But, strictly speaking, these methods are not identical. Quantitative methods in a broad meaning of the term are applied when dealing with research into processes and phenomena that are specified by a system of quantitative indices. Naturally, we may resort to definite techniques (as a rule, the simplest ones) of the mathematical processing of quantitative data (calculation of mean values, percentage, dispersion coefficients, etc.). These techniques are not intended for revealing the essence of phenomena by means of quantitative modelling. But any system of quantitative indices can serve as a foundation for constructing formal-quantitative models of various phenomena and processes under study with a need to be mathematically processed in a comprehensive way. Moreover, what is necessary is a preliminary construction of the essential-substantive model of these phenomena and processes.

Thus, strictly speaking, quantitative methods are in essence an analysis of processes and phenomena based upon the system of quantitative indices, while mathematical methods pressuppose the construction, on the ba-

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sis of the system of quantitative data, of formal-quantitative, mathematical models of these phenomena and processes.

In the epoche of the scientific and technological revolution science is marked by the ever growing mathematisation and computerisation to which advanced applied mathematics and computer technology contribute greatly. It would, however be, erroneous to ascribe the vigorous mathematisation of science, to successes in mathematics and computer technology as is often the case. Introduction of mathematical methods and computers in various sciences and fields of research is brought about by the inner development of these sciences and takes place only when they are »ready« to start this mathematisation and are keen on it.

Let us consider the objective prerequisites for the quantitative analysis of the phenomena of the real, both natural and social, world, i.e., whether the mathematisation of the cognition of the world is possible in the ontological sense. Such a possibility not only exists in reality, but it is also unlimited. This premise is true, since both in nature and in society the organic combination of quality and quantity occupies its proper place.

Quantity and quality express opposite sides of reality and are thus polar notions. But this opposition is combined, at the same time, with unity. And here measure is a synthesis of the opposition and unity of quantity and quality. Measure reveals and expresses their dialectical interrelationship, besides, it is measure that specifies the quantitative boundaries of quality and demonstrates the qualitative nature of quantity.

Consequently, the essence of any phenomenon, which is its qualitative definiteness, will be fully revealed only when the quantitative measure of the given quality will be specified. Thus, the characteristic feature of the objective nature of social phenomena is not only its accessibility to the application of quantitative and qualitative methods while studying these phenomena, but also the objective nature's deeper cognition is achieved only on their basis. So, the general prerequisite for applying quantitative methods in social and humanitarian sciences is a continuous deepening of research, which, at some stage, will engender the necessity in a quantitative analysis.

There always takes place the organic combination of differentiation and integration in the development of science. But at some stages of this development one or another side will come to the fore. Under the scientific and technological revolution, integration becomes more prominent. Simple accumulation of knowledge acquired as a result of intensive differentiation and specialisation of scientific research, without a proper integral, generalised approach, is unable to ensure the all-round, comprehensive and deep cognition of the objective reality, since this reality is an organic unity of the general, the particular and the single.

On the whole, howener, in Soviet historical science at present, despite greater urge for integration, a differentiated, at times narrowly specialised,

approach gets the upper hand. So it is necessary to promote further strengthening of integration. But the matter is not just to move it to the forefront. It is also necessary to take into consideration a complex character of the correlation between integration and differentiation, as well as the specifics of this correlation in the modern epoch. Historians, unfortunately, do not pay due attention to this question. Thus, the main efforts aimed at overcoming the aftermath of excessive differentiation of research go along the line of the struggle with »petty subjects«, and the need for integration is realised through the publication of multi-authored voluminous generalising works. Meanwhile, as is the case with other, mainly natural, sciences, a distinctive feature of moving to the forefront of integrative tendencies is a synthesis of the generalised and special approaches to the study of reality. The very process of differentiation of research, while vigorously developing, now more actively goes along the path of integration. New directions of research, turning into independent branches of sciences or their disciplines, are now developing successfully at the junction of sciences or different aspects of separate sciences. Biophysics, biochemistry, physical chemistry, cybernetics, informatics, bionics, astrobiology, space medicine - all these and many other scientific disciplines and directions of sciences present, on the one hand, the process of differentiation of scientific cognition, and, on the other, its integration. Comprehensive interdisciplinary research, a feature of modern science, is a synthesis of the differentiating and integrative sides in scientific cognition.

Integration of scientific cognition, in all its manifestations, follows its own path of development, i.e., has a mechanism of its own: first, the transfer of ideas and premises of scientific cognition from one field of science to another, secondly, the use of the conceptual-categorial apparatus belonging to one field of scientific knowledge in other sciences. In other words, more profound research is a product of mutual exchange and synthesis of different sciences. But integration may call forth new ideas, approaches and techniques, so it has brougth about the general scientific approaches and methods.

However, to make the mechanism of integration function smoothly it is necessary that synthesised ideas, approaches, methods and conceptual-categorial apparatus be reducible. Meanwhile, even within the framework of one science, due to the multiformity of cognised reality and variability of tasks of research and scientific methods, such reducibility is hardly possible. To overcome this problem it is necessary, first, to make universal the language of science, and, secondly, to elaborate general scientific and inter-problem (or regional, as they are ofter called) approaches and methods of cognition and the conceptual-categorial apparatus corresponding to them. The solution of these problems must go along the path of abstraction and formalisation, the supreme manifestation of the latter is, as is known, the mathematisation of scientific research.

Modem science has achieved outstanding successes in moulding new general scientific approaches and methods and the conceptyal-categorial apparatus corresponding to them. In this sense, the most important among them is the systems approach, structural and functional analysis, proability approach, mathematical-statistical analysis, model approach, and mathematical modelling, multi-dimensional approach and multi-dimensional mathematical analysis, informational approach and enthropy analysis. I should like to stress the particular importance of the systems approach since the above-mentioned and some general scientific approaches and methods are mostly based on it and manifest themselves as concrete methods of the structural and functional analysis through which principles of the systems approach are realised.

The inherent gravitation of the systems analysis methods towards formalisation could be explained by the fact that any system, here we have in mind social systems, can be presented by more or less aggregate totality of its components. These components, as well as their features and connections, could become objects of calculation. Consequently, there is a real possibility to apply quantitative and mathematical methods and to make analysis more profound by means of introducing into it such a notion as measure. This will allow to systematise and more comprehensively express the correlation between phenomenon and its essence, content and form, quality and quantity in the system under study.

These are the main factors determining the more distinct outline of tendencies towards mathematisation of modern scientific research and their application in historical studirs. Experts in the theory and methodology of scientific cognition note the greater theoretisation and dialectisation of scientific quest and on this basis the emergence of a new style of scientific thinking; all this being an integral expression of the above-mentioned tendencies. This new style has a wider, deeper, more complex and rigorous view of the objective reality and the approaches to study it. But this has not yet found its clear expression in the historical sciences, unlike other sciences, and has not been comprehended in full measure. But the development of historical science goes along the same path as other sciences. So, the more actively historians apply new tendencies in scientific cognition, the greater successes will be scored in the development of historical sciences.

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From its very inception and up till now mathematisation in historical sciences has always been accompanied by disputes over the expediency of such an approach, its possibilities and limits.

In their attitude towards descriptive and quantitative methods, Soviet historians, on the whole, proceed from the aknowledgement of expediency and necessity of applying both methods, their rational combination with due account given to the character of objects under study, to the data of historical research and the tasks of research. But a general view does not rule out controversy over the place and role of descriptive and quantitative methods in historical research. Here discrepancies mean neither the acceptance of some nor the expulsion of others, on the contrary, they just differently assess the role of quantitative methods and the expediency of their wide application in historical research. The controversy stems from the erroneous interpretation of one of the concrete-methodological aspects of cognition of social phenomena, that is, the widerspread opposition of the quantitative and qualitative analysis. The reason for such an opposition lies in a rather vague terminology. The term »qualitative« (analysis, method, approach) can also be used while disclosing the essence-substantive, qualitative nature of phenomena, as well as in the sense of a descriptive form of their characteristics. This term, undoubtedly, must be applied in the first sense.

Some of the champions of the quantitative methods (mostly from laymen in history), that are proponents of the opposition of the qualitative and quantitative analyses, refer the latter to the descriptive methods. Stressing the imperfection of these methods, they, on the one hand, absolutise the quantitative methods, and, on the other, underestimate the determining role of the substantive historical analysis, which not only diminishes quickly the efficiency of the quantitative methods application, but also leads to grave errors.

The opposition of the quantitative (essence-substantive) to the qualitative analysis, however, is inexpedient. It is clear that the qualitative analysis, oriented towards revealing the inner essence of phenomena and processes under study, is the leading one in any research and in any methods. But the quantitative one (essence-substantive), relying on definite theory and methodology of historical cognition, could be realised given some information, as well as data, on phenomena and processes under study. This information may be provided and processed in two forms-descriptive. (2) Thus, every historical analysis could be either substantive-descriptive or substantive-quantitative. Consequently, it is inexpedient to contrast the quantitative analyses, as is often the case. What can be compared are the descriptive and quantitative methods of expression, processing and analysis of concrete-historical data.

Let us consider the question of the correlation of descriptive and quantitative methods with due account of an ontological and an epistemological-methodological aspect of scientific cognition.

Every historical reality could be presented as a totality of a phenomenon and its essence, form and content, quality and quantity. All this should be taken into account and revealed in the course of scientific cognition which is aimed at bringing to light the essence-substantive, qualitative definiteness of the object of cognition. This definiteness could be revealed as a result of the theoretical essence-substantive analysis, that is, quantitative analysis. The supreme level of this analysis finds its expression in constructing the theoretical essence-substantive model of the object.

The essence-substantive analysis is carried out in a natural language, descriptive form. For instance, the fact that the feudal mode of production presupposed the personal dependence of the peasant from his lord, and that under capitalism worker is a free seller of his work force, as well as the consequences stipulating these differences, may be expressed only in a descriptive way. The essence-substantive analysis can be based on the descriptive, as well as quantitative methods of expression, precessing and analysis of concrete data, i.e., these methods are equally possible.

But the inner essence, content and qualitative definiteness do not, as a rule, lie on the surface and do not reveal themselves in a direct way... Directly tangible are their form and phenomenon. These two can, quite lawfully, be presented in a descriptive way. Moreover, their descriptive characteristic could be, more often than not, more expressive and comprehensive than a quantitative one.

But the process of object cognition is culminated, as is well known, in defining the correlation between quantity and quality, that is, in defining a measure which may reveal their unity. Here the descriptive methods turn out to be futile, so the task could be solved by means of the quantitative methods, this, of course, only holds it their application is possible. As you see, descriptive and quantitative methods always comprise a unity and only one of them can play a leading role.

Descriptive methods are a major form of historical analysis. And this is not due to the fact that many phenomena of social life cannot be measured at present, and not because almost all sources are narrative, as the proponents of these methods stress. Possibilities of measuring, including that based on descriptive characteristics of historical objects, will expand along with the progress of science. But even if the time will come when everything in historical development could be measured, even then the essence analysis of this development will remain descriptive and will be based, as before, on concepts and categories expressed in a natural-language form. These categories, despite the seeming all-mightiness of mathematics and its intensive progress, could not be replased by its concepts and language.

Complexity of societal phenomena dictates the necessity to be expressed in the system of concepts and categories adequately only in a natural-language form.

This adequacy had been elaborated by the whole history of human kind and no artificial language (mathematical for one) can replace it no matter how perfect it could be. The strong points of these languages are their logical austerity, undeviational notions. So this is the reason why they are unable to reflect multiformity of societal phenomena. The natural language, with all its diversity of notions and dynamics, can more adequately reflect these phenomena. On the strength of this alone we cannot expect the emergence of some new science-mathematical history, as some champions of quantitative methods believe.

Finally, one more argument in favour of descriptive methods. Despite the fact that quantitative methods will of necessity find ever broader application in historical studies, there will never be a need for everything in historical development to be measured and expressed in quantitative terms. Among the varied special functions of historical science are those which can be more efficiently performed by precise descriptive methods. One of these functions is the enlightening-educative function.

The strong aspects of descriptive methods are their universality and accessibility, concreteness and vividness. But dialectics is such that in their strength can also be their weakness. Since by descriptive methods it is difficult to form a system of representational factors, especially when the objects of study are mass historical phenomena and processes, these methods can lead to illustrative or factual accounts. In the first case this may generate unsubstantiated observations and conclusions; in the second, confusion of the primary and the secondary, the typical and the accidental.

Furthermore, while making it possible to establish certain characteristics and properties of the objects under examination, a descriptive analysis fails to show their absolute and relative measures. And while allowing the possibility of bringing out the relationships of certain phenomena and of the characteristics of particular objects, it does not measure the strength of the impact of some factors on others.

This limitedness of descriptive methods inevitably engenders a corresponding type of historical thinking. Its distinguishing features are vagueness and more or less indetermimate conclusions, which make the obtaining of conclusive knowledge from them less likely.

Finally, the universality and seeming accessibility of descriptive methods constitute one of the reasons why historians fail to pay due attention to improving the methods of their science, to mastering the methods of other sciences, and to the cognitive arsenal of science as a whole. Such is the place of discriptive methods in historical studies and their correlation with quantitative methods.

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Let us examine more concretely the question of what place quantitative methods occupy in historical studies.

First of all let us recall once again that the essence of quantitative analysis is not merely to use certain quantitative data in a study. Quantitative analysis involves the identification or formation of a system of numerical characteristics of the objects, phenomena or processes under study, which, being subjected to a particular mathematical treatment, provide new information for the analysis of essence. As has been noted, the practical application of these methods become necessary and feasible only at a particular stage in the investigation of the phenomena and processes of historical development. What stage is it? What shows in concrete terms that it is time to move over to quantitative analysis?

In general, the answer is that the switchover to quantitative and mathematical methods can occur at the moment when it becomes possible to measure the characteristics of the phenomena and processes, and when we thus manage to obtain a system of the necessary quantitative indices. But the trouble is that measuring becomes practically possible and admissible only when knowledge of the phenomena and processes under study is of a theoretical nature. In concrete terms this is manifested in the fact that analysis of essence reveals the qualitative definiteness of these phenomena and processes. For this purpose the mathematicized science or its domain must »be sufficiently mature, possesing a well established conceptual apparatus; i.e., there must be established in it on a qualitative level the more important concepts, hypotheses, generalizations and laws.« (3)

In this connection, there is no approving the nihilistic attitude sometimes expressed by Cliometrists, especially beginners, towards studies of certain historical phenomena and processes made by their predecessors, who relied on descriptive methods or used quantitative data without their having undergone special mathematical treatment and analysis. Had the predecessors of the Cliometrists failed to bring research to the level that permits a switchover to mathematical methods, the application of these methods would have been impossible.

From what has been indicated it is also clear why many historians do not understand the necessity and do not feel a practical need to apply quantitative methods. This is the result of the fact that the field of historical studies within the range of their interests is not »old enough« for mathematization. The fact that there are too many such fields is the inevitable result of widespread empiricism in historical studies. The first thing to do is to overcome this empiricism instead of seeking to introduce mathematical methods as broadly and as fast as possible.

Quantitative and mathematical methods can be used in scientific research to resolve various tasks. The first task is to express the object of study in terms of quantity in order to specify the quantitative measure and boundaries of the respective qualities. The second task, being resolved by mathematical methods, is to build formal-quantitative, mathematical models of the phenomena and processes under investigation. This is the fundamental way or form of mathematizing scientific cognition. The third task involves the use of mathematical methods to devise new scientific theories, and to express and analyse the existing ones; i.e. it is connected with the formalization of the main results of scientific knowledge itself.

In historical science so far only the first two tasks are resolved by mathematical methods. There is a wide range of phenomena and processes the study of which, at the present stage of development of historical science, can be effective only on the basis of quantitative and mathematical methods. These are primarily all kind of mass phenomena and processes. Here the use of mathematical methods is necessary for revealing the law-governed nature of historical development. The objective laws concerned have a variety of expressions and they are studied by various mathematical methods. Mass historical phenomena and objects represent various social systems with complex inner structures; they also form definite types marked by inner unity. This makes it possible for historians to make wide use of the systems approach, of structural-functional analysis, of multidimensional typology and other mathematical principles and methods.

As will be seen, in all aspects of historical development, whenever it is manifested as a mass phenomenon, there is a need to use quantitative and mathematical methods. But these methods may also be needed when studying individual phenomena, by which we mean the results of the activities of individuals. The individual can also appear in mass phenomena and processes, but here it is merely one of the numerous intersecting forces, one of the small particles of the resultant force which expresses the outcome. Whereas in individual phenomena the role of a single person is of decisive importance. To be sure, in these cases too the individual experiences the impact of other individuals. But this impact, if any, is transmitted only inderectly, through the conceptions, aspirations, aims and will of the person creating a given event. Individual events abound in the political and especially in the spiritual spheres of human activity.

In the main, descriptive methods are used when studying individual events. But in a number of cases they happen to be inadequate. These are above all cases when it is necessary to bring out the essence of contradictory views, propositions and requirements, and also their inconspicuous evolution; and especially when the positions of different personalities have to be compared. Mathematical methods in the form of modelling can be

more effective compared with descriptive methods also when evaluating the decisions taken and the current policy in cases where real possibilities existed (and not alternative ones introduced by the historian).

Such are the main tasks the solution of which requires the application of quantitative and mathematical methods, if we take an onthological approach to these tasks, i.e., proceeding from historical reality. Another group of problems that need to be solved by mathematical methods includes investigative, or epistemological, problems proper. The group of such problemns is also large. Let us note the more important ones among them.

To begin with, the application of mathematical methods can be effective when checking the authenticity of information from historical sources, both mass and individual and expressed in qualitative as well as descriptive form. These methods are also essential for raising the information pay-off of the sources. The checking of the authenticity of data from historical sources and the increasing of their information pay-off are central to the study of sources.

Another important problem concerns the formation of a representational system of facts. This problem is particularly complicated when the historian addressed himself to a multitude of data embracing the whole vast aggregate (in statistics it is called general aggregate) of objects under investigation. The all-round treatment of these data presents difficulty and is more often than not inexpedient. Whereas for the formation of the representational selection of data it is necessary to turn to the selective method, which is well elaborated in mathematical statistics. Mathematical methods can also help the historian in specifying the representability of what are called natural selections, i.e. the totality of data whose volume is unalterable.

There is another problem in connection with the fact that many sources contain data on a very large number of attributes characterizing the phenomena and processes under study. Mathematical methods can help to identify the more substantial from among these attributes for the purpose of resolving the investigative task set. When identifying the more essential characteristics happens to be difficult, or when the selection of a section of the characteristics leads to considerable losses of information, there is a need for »laconic« information, i.e., for a switchover to a lesser number of integral characteristics derived on the basis of the whole of their initial aggregate. Such a task can be resolved only by mathematical methods.

Finally, mathematical methods help to clarify the conceptual apparatus of historical science and make it possible to a certain degree to standardize its language, and this facilitates the incorporation of historical studies into the general process of integration of scientific knowledge.

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Yet the efficiency and power of mathematical methods do not make them universal means for carrying out historical studies. There are limits to their efficient applications set by the specifics of the object of historical cognition and by the present level of historical and mathematical knowledge.

The application of mathematical methods in historical or any other research becomes possible after the characteristics and properties of historical phenomena and processes have been measured, i.e., expressed in numerical values. But the measuring of very many historical phenomena entails great difficulties. Moreover, for all the universality of mathematical methods, most of them are designed for analysis of natural phenomena, and therefore not all of them can adequately reflect social phenomena. Mathematical methods specially meant for analysing social phenomena have only lately begun to be elaborated.

The scope and depth of mathematization of the social sciences and the humanities are also restricted by the very specifics of mathematical knowledge. These specifics consist in its axiomatic nature. Its essence is that underlying knowledge is a system of propositions accepted without proof, from which all the basic affirmations are logically deduced. It is impossible to build up our knowledge of society by this principle, i.e., to reduce the totality of this knowledge to a system of axioms from which all basic conclusions are drawn. The main obstacle to this is the complexity of the object of cognition. That is precisely why the mathematization of the social sciences and the humanities, as has been pointed out, has not reached the level of formalized mathematical expression of its results, i.e., the level of theories, hypothesis, concepts and categories.

Thus, mathematical methods in historical studies (not only historical for that matter) have their own sphere of effective application, and there are limits to this application set by the aim of the studies, as well as by the potentialities and specifics of mathematical knowledge.

Our account of the essence and place of quantitative and mathematical methods in historical science clearly shows that the application of these methods can be successful provided close attention is paid to theoretical and particularly to methodological and logical problems of historical studies. The elaboration of these problems presents interest not only, and not so much on the epistemological level proper, as on the practical level. Only a high level of theoretical-methodological training and broad professional-historical grounding will enable Cliometrists to make in-depth historical studies and to avoid any likely mistakes.

As to the methodological-technical aspect of the application of mathematical methods, the historian has to master it to the extent to which he

can independently perform mathematical procedures connected with data treatment. Characteristic of the present stage of the application of mathematical methods in historical studies, as in other fields of science, is joint work of historians and mathematicians in the same scientific collectivity. This is a tangible manifestation of the development of integration in historical studies. As available experience shows, this form of cooperation ensures more effective application of mathematical methods in historical science and the future belonges to it. Its stands to reason that if joint work is to be successful, it is not only the historian who has to have a degree of mathematical training; the mathematician, too, has to be versed in history. The main difficulty is that the historian must possess a definite amount of knowledge in mathematics, and the matematician - in history. Both normally prove to be capable of this.

But apart from this, each of them, while remaining a specialist in his own field, must have mastered a new style of scientific thinking: the historian mathematical and the mathematician historical thinking. Herein lies the main difficulty. Consequently, the in terpen etration or synthesis of the concrete substance of the approaches of the humanities and formal logic, and of mathematics - this constitutes the combination which, other things being equal, ensures success in the application of mathematical methods in historical studies. To master the art of this combinaton is a key task for both historian and mathematician.

Notes

1. As is known, Hegel was the first to draw attention to the triad »quality-quantity-measure«. He looked at it, however, from the idealistic point of view, as a correlation and movement of concepts, and not as a property of objective reality reflected by these concepts.
2. For their historical analysis, data from material and representational (natural-representational, artistic-representational and graphic-representational) sources must be translated into a descriptive or quantitative form.
3. G.I.Ruzavin, Mathematization of Scientific Knowledge, M., 1984, p.191.