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Working Paper

The Construction of Quantitative Indicators for International Comparisons

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Foreword

The fundamental concerns of the Economic Reform and Integration (ERI) Project focus on the transition from administrative management or command control systems to a pluralistic market system. Among the vast number of potentially interesting problems in “*emerging market economies (EMEs)*” such as the Soviet Union and other Eastern European countries, the following were named to be most suitable for this IIASA activity; *capital market and privatization, labor market and employment, opening of the economy, economic stabilization, and prices and competition.*

The ERI Project as part of the Technology Economy and Society (TES) Program is presently concerned with the intensive analysis of facts and theories relevant to each theme in order to produce practical policy alternatives for economic reform. The essential goal of this process is to coordinate collaborative research in specific areas of mutual East–West interest and to subsequently be able to present highest level policy-makers in EMEs with concrete, scientifically sound and sensible policy alternatives for actual use in their quest to successfully move towards a functional market economy.

An additional area of major focus has crystallized out of the work of the ERI Project. The main idea behind this additional research is to develop and apply an appropriate methodology for East–West socio-economic comparisons. The study area deals with the problem of whether conventional statistics and statistical, analytical methods still maintain significant meaning for economies that find themselves in a transitional phase from one economic system to another. Furthermore, the emphasis lies in demonstrating the feasibility of defining, compiling, and analyzing new indicators that can be derived from available statistics, measures and monitoring systems. A major task remains the analysis of a number of alternatives which can facilitate the collection of valuable statistics in transitory economies in order to make meaningful comparisons possible.

This essay is the first of a number of publications which will portray the results of research performed within the field of **Methodology for East–West Socio-Economic Comparisons** as part of the ERI Project. A scoping meeting for the further development of this research area at IIASA was jointly organized with the USSR Academy of Sciences under the title: *Economies in Transition: Statistical Measures Now and in the Future*. Some information and documentation regarding this international forum is being prepared.

Professor F. Schmidt–Bleek
Leader
Technology, Economy and Society Program

Abstract

The paper illuminates the necessity for developing internationally consistent statistical and methodological practices required to perform meaningful national and international, particularly East–West, comparative analyses. It addresses the susceptibility of inaccurate and delayed quantification and identification of phenomena in the social sciences as a result of the strict use of conventional indicators and methods of analysis. Throughout the paper, the theme alludes to the urgency to unify the previously divergent “*eastern*” and “*western*” economic thinking to facilitate the development of usable international economic comparisons. The lack of common measures and adequate data results in a deficiency of East–West quantitative comparative studies.

The content also encompasses a very concise review of the present methodologies available for using statistical data and developing traditional and, more or less, non–traditional indicators. In reference to this topic, special emphasis is given to the problems and dilemmas of interpreting change in transitional economies, which certainly cannot be solely described by conventional indicators used during an era of stability. Dissatisfaction among experts with the state of existing measurement and monitoring techniques of different aspects of socio–economic development has led to an on–going construction of new, non–traditional indicators. These attempts are themselves evidence for the heterogeneous manner of approaching essentially the common goal of developing more trustworthy and meaningful indicators.

The desire is to find a process of measurement that is applicable in transition phases as well as stabilized phases of socio–economic development. For precisely this reason, the author favors the *linguistic* methodology, which is presently the principal approach used in the IIASA Economic Reform and Integration Project for the construction of integral quantitative indicators oriented towards East–West comparative analysis. Finally, he addresses the substance and sequence of the research expected to be performed within the Project.

The Construction of Quantitative Indicators for International Comparisons

Peter O. Aven

1. THE QUANTIFICATION PROBLEM IN SOCIAL SCIENCES

Rather broad consensus among economists now exists, that socio-economic development is not a continuous process, an "even road". It can be better characterized as a successive emergence of new social and techno-economic paradigms replacing traditional ones. The evolutionary development "within" each paradigm prepares a soil for revolutionary changes, for paradigm shift - such a view on development was shared, in particular, by K. Marx and J. Schumpeter, though their ideas about periods in economic history were essentially different. Nowadays it is usually argued, that five techno-economic paradigms took place in the developed countries since the First Industrial Revolution - three of them date to our century (see Freeman, 1987).

Each paradigm shift is accompanied by the emergence of quite new products, markets, types of organization, etc. At the same time new problems arise, sometimes replacing and sometimes adding to the old ones.

New problems and new phenomena, that come into being, call for a re-evaluation of traditional priorities, of what is "important" and "desirable" for development. Thus, ecological and social effects of technological intensification, starting from a specific point in time, do not only acquire importance in their own right,

but also begin to affect opportunities for continued growth (of which they are as a rule the principal restrains). In order to ensure ever growing production under conditions of natural resource degradation and social transformation, accelerated growth is required in the areas of capital investment, energy consumption, use of mineral fertilizer, etc., which in turn can further aggravate the situation. As a result, a new important aspect of the development process arises: it's sustainability.

Another example of redefining the meaning of importance is connected with the comparative significance of economic growth factors. Traditionally, the presence of natural resources or access to them were considered as the main factors of growth. However, the experience of the last three or four decades demonstrates that at least in some cases abundant resources not only did not promote, but in fact hindered development (perhaps by hampering innovative activity). On the other hand, quality of labor force was not considered to be a highly important factor for growth and development. Anyhow, in the modern conditions cultural and social peculiarities of workers, reflected by educational and life style characteristics (including parameters of worker's time allocation and income distribution), are directly connected with the possibilities for future development, for efficient paradigm shift.

Changes in traditional priorities, emergence of new phenomena and problems demand new information which reflect and describe them. Generally speaking, any national economy (and society) is a large complex system which can be described in different languages, by different types of information. In practice, use in decision making process and in scientific analysis definite part of all available data mainly depends on:

- institutional structure of the economy and control mechanism
- peculiarities of a country's socio-political situation
- policy-makers' and academics' "mindset" and priorities.

Institutional and socio-political features of an economy are even less stable than techno-economic characteristics. (Mutual interdependence between different aspects of economic development

traditionally constitutes one of the most intriguing topics for scientific analysis). Therefore, the first two above mentioned points call for the permanent adjustment of data in use. This is especially the case for an economy in transition from a "plan" to a "market" system.

The latter point (especially for decision-makers) is strongly connected with the traditional techno-economic paradigm, with the objectives "natural" for it. A shift in information, used in decision-making, is usually late for paradigm shift - data in use characterize phenomena which were important at a previous stage of development, but not at present.

The use of traditional information redoubles inertia, hampers changes. Through statistics it has a reverse effect on priorities of policy-makers and decision-making. At some degree one may speak about a feedback loop: "priorities (goals) of development approved by the society - information in use - official statistics - priorities". Thus, irrational overproduction of specific products in the USSR is largely impacted by the predominance in soviet statistics of data which characterize the "industrialization level", reflected by the amount of steel, oil and machinery produced in the economy. Several decades ago such information said a lot and would have been used for an assessment of the national techno-economic level. This is no longer the case (Kiritchenko, 1990).

The adherence to traditional information not only hampers changes but impede efficient solutions if a paradigm shift takes place. Data reflecting successes or failures "within" a new paradigm is missing. Policy-makers can not respond to information they do not have, they can not correct mistakes they do not notice.

The relationship between traditional paradigm and national statistical systems we tried to show in (Aven, 1990). In reality, the poor quality of statistical systems also can be explained by an orientation towards data that can easily be collected and measured; by the aspiration to obtain (and publish) information which emphasize national achievements, etc. At any rate, reflection of

traditional ideas and priorities is the main reason for shortcomings in statistics. It mainly explains why:

- In national statistical systems an excess of data coincides with a lack of information. (First of all, non-economic indicators, which reflect long-term dynamics of development, are not represented adequately.)

- National data often becomes incomparable between countries. (It reflects differences in policy-makers' visions, especially between East and West, North and South).

Imperfections of national statistical systems are rather evident. However, orientation towards traditional objectives and priorities has an adverse effect not only on official statistics, but on information used in social sciences. It manifests distinctly in measurable information (information based on measurable indicators), directly connected with statistics.

As a matter of fact, quantification (appearance of measurable indicators) always occur late in the realization process of a new problem. This is especially true in the case of complicated phenomena where researchers often disagree on appropriate quantitative as well as qualitative measures. Such divergence of opinion can be connected not only with new notions but with conventional ones as well. Thus, the understanding of economic efficiency, varies among environmentalists, sociologists and businessmen. Even among specialists of one field ideas about indicators, which should be used to measure efficiency of the national economy, differ substantially (and are changing continually). The same is also true for such "popular" notions as, for example, sustainability or potential output (see Uno, 1988). The wide use of these notions does not correspond with the unity of views concerning their measurement.

Dissatisfaction with existing measures of different aspects of socio-economic development leads to a permanent construction of new, non-traditional indicators. Some examples of such construction can be found below. The majority of well-known attempts is connected with general measures of socio-economic development,

capable, for example, to substitute GNP (see e.g. Nordhaus and Tobin, 1972; Chenery et al., 1986). Its own tradition has the construction of social indicators, reflecting level and quality of life, living and labor conditions, etc. Attempts to quantify more narrow, special features of growth and development have also taken place.

Even without going into details of different attempts one can be sure that the problem of determining quantitative indicators which comprehensively characterize techno-economic and socio-economic development seems to be scientifically valid. Moreover, this problem will also be timely - each paradigm shift, technological and social transformation presupposes changes in quantitative measures used in the analysis of existing processes.

The problem of indicators is one of comparisons. On the one hand, one cannot make any comparisons without appropriate measures capable to catch differences between elements under investigation. On the other hand, the practical use of newly constructed indicators in comparative analysis, identification of relevant figures allow testing the validity of the proposed measures.

The elaboration of "adequate" measures has special significance for international comparisons, especially for East-West. For decades economic thinking was divided into "eastern" and "western". Each was developing within its own scientific tradition, using its own notions. As a result, measures which are used in economic analysis in "capitalist" and "socialist" (recently) countries are still essentially different. The difference between the System of National Accounts (SNA) and the Material Product System (MPS) is the most evident example. (The construction of the MPS clearly reflects not only the Marxist economic theory, but also derivative theories and dogmas produced on its base in Eastern Europe). However, "pure statistical" measures are not the only ones used in scientific studies. Various derivative indicators also differ. The absence of a coordinated set of socio-economic indicators used for the description of a national economy aggravates the problem of East-West comparisons, born, for example,

by inconvertible currencies or fluctuations in exchange rates. The lack of common measures and adequate data results in a deficiency of East-West quantitative comparative studies. Their number is essentially inferior to the number of relevant studies done not only for developed, but also for developing countries.

2. STATISTICAL APPROACH TO THE CONSTRUCTION OF NON-TRADITIONAL INDICATORS

Three main approaches to selecting and constructing indicators (which reflect certain phenomena) exist:

- Expert constructing, including the use of various experts. In this case, each expert presents his own list of indicators. All the lists are compared and analyzed sometimes with special mathematical methods, for example with the methods of the so-called "orientation theory" (Muller-Reissmann and Shaffner, 1988), which helps to discover whether the experts have concentrated too much on one orient (such as adaptability, perhaps, or efficiency) while ignoring another (such as security).

-Simulation modeling: assessment of relevance of information content of each indicator through simulation.

- Statistical approach: indicators are constructed according to the results of a statistical analysis of empirical data.

Within the statistical approach itself two large groups of methods can be identified. The first is econometric modelling based on regression analysis. Its main goal is to determine interdependence between various already known indicators. However, this determination allows not only to assess influence of some "input" characteristics on an "output" one, but also to construct (on the base of analysis and interpretation of "residuals" of a production function) new indicators. The most known tradition of such construction is connected with the elaboration of various productivity indices (labor, capital, joint factor productivity) and with the assessment of different factors' contribution to economic growth. First attempts of such analysis, connected with

the exploration of economic development of one single country, date back to late fifties (see e.g. Abramovitz, 1956; Solow, 1957; Kendrick, 1961). International comparisons based on an analogous approach began with the pioneer work of E. Denison (1967), which initiated a series of relevant publications - their survey can be found in (Maddison, 1987).

Maddison's paper, representing the last word in the relevant field, clearly demonstrates advantages and shortcomings of the econometric approach to indicator construction. As it is put by the author himself: "Transparency is in fact this technique's major charm, ... although on significant points there are large judgmental elements... There are no iron laws". The desire to minimize the judgmental component while constructing new measures (but not while interpreting them) was among the main incentives for using in such construction various methods of the multidimensional statistical analysis.

Among these methods (or groups of methods) are: factor analysis, principal component analysis, cluster analysis, multidimensional scaling, discriminant analysis, functional scaling, principal plane analysis. Except cluster analysis, all these methods are directly oriented towards the construction of new (usually integral) indicators.

The application of statistical methods (from the "indicators" viewpoint) makes it possible:

- to assess the information content of individual characteristics

- to single out "closely interrelated" parameters and through this to avoid unwanted duplication in the desired system of indicators

- to construct new aggregated characteristics, which possess some optimum qualities.

Different requirements for the "optimality" of a new indicator, i. e. different goals of its construction, lay in the foundation of the distinction between various methods. Thus, one possible interpretation of the principal component analysis is

determined by the fact that the sum of correlation coefficients between the first principal component and the initial set of indicators is maximum compared to all other measures. Therefore, the first principal component optimally "represents" the whole group of initial parameters (Rao, 1964). Such a quality should naturally be used for the compact description of original information.

In functional scaling, a sought indicator (also produced as a linear combination of initial parameters) has to "explain" (better than any other measure) interconnections between objects under research (Aven et al, 1988). In factor analysis the goal is to explain correlations between initial parameters (Harman, 1960), etc.

The use of various statistical methods is justified especially in the analysis of "unfamiliar" objects and phenomena, when de facto the mode of description itself, the "language" has not been formed yet. In some sense, this is the case with the description of national economies during the phase of a paradigm shift or in the period of intensive institutional reforms. As has already been mentioned, each techno-economic paradigm calls for specific measures unknown at a previous stage. The same is true for the transitional economies which cannot be solely described by conventional indicators used during the era of stability. (Thus, rapid development of non-monetary, i. e. barter, economic relations in the modern practice of the USSR gives a special significance to various physical measures). The construction of new adequate characteristics is necessary for any valuable international comparisons, which would also be much more effective with the use of multidimensional statistical analysis.

The specifics of international comparisons, especially East-West, is connected with the lack of some part of information and its incomparability - to obtain all the desired data is practically impossible. At the same time, the use of statistical methods is based on a processing of large arrays of empirical information. Therefore, methods which should be used in international

comparisons must be able to deal with incomplete arrays.

One such method is the so-called the "linguistic approach to data analysis" (Braverman and Muchnik, 1983). Its essence is in the combination of three different tasks in one procedure. The first is "extremum grouping of parameters". Its main idea is connected with the usual presence of some groups of strongly interrelated (correlated) parameters in every relatively large set of socio-economic indicators. Parameters of each group correlate strongly one with another and relatively weakly with other parameters. Therefore, it is not necessary to know magnitudes of all indicators. Magnitude of one or at most several characteristics reflect rather adequately magnitudes of all others.

Moreover, it seems reasonable to substitute all the parameters of the group by a new indicator, which represents them in the best way. The first principal component is very natural, but not the only choice.

The extremum grouping and the construction of representative indicators constitute an important part of the "linguistic" methodology. However, the quality of new characteristics can be assessed only by the analysis of a distribution of objects in the constructed space. The simultaneous construction of objects' classifications on each indicator's axe and the overlapping of these classifications (i. e. the construction of a multidimensional typology) is also a significant aspect of the "linguistic" approach.

The "linguistic" methodology lies at the base of the IIASA "Economic Reform and Integration" Project approach to the construction of integral quantitative indicators oriented towards East-West comparative analysis. Relevant algorithms have been realized within the computer package "Typolog-terry", which has been produced specifically for interregional and international comparisons.

3. SUBSTANCE AND SEQUENCE OF RESEARCH

Construction of new indicators with the help of statistical

methods require the presence of corresponding information. At first sight, a vicious circle emerges. For information collection a system of indicators is required, although the construction of adequate characteristics is the main goal of the study. Actually, the use of statistical methods presupposes consistent creation of some preliminary hypotheses which are examined by statistical analysis. The choice of an initial set of indicators is determined by one of such hypotheses. It settles the assortment of parameters, each of which reflects some essential feature of the phenomena under investigation and does not duplicate any other parameter. As a result of statistical processing of the information obtained (together with content analysis) some indicators are added and some excluded from the initial list.

Moreover, the construction of non-traditional integral indicators with the use of the "linguistic" methodology calls for the formulation of a preliminary hypothesis which reflects an initial impression of a researcher on "orthogonal" aspects of the phenomena under study. These aspects correspond to the groups of "strongly interrelated" parameters. The "extremum grouping" helps to confirm correctness of the initial hypothesis or, on the contrary (and much more frequently) to disprove it. However, the search for parameters' grouping without the formulation of some initial hypothesis, i. e. just a "statistical search", may lead to the examination of many obviously false variants and therefore to a waste of computer time.

Hence, one may speak about the construction of a basic structure of a system's description, which is corrected and fulfilled with content (i. e. some set of quantitative parameters is put in accordance with each aspect of the proposed structure) by the use of statistical methods. The IIASA "Economic Reform and Integration" Project is concentrated specifically on the problems of institutional and structural reforms in Eastern Europe at this time. East-West comparative analysis is mainly treated as a tool for the elaboration of policy proposals for countries in transition from centrally planned to market economies. So, it was decided to

use the analogy with medicine in constructing the basic structure of countries' descriptions. Such analogies are rather popular in the "reform economics" (see e. g. Kornai, 1986).

Similar to medicine three separate levels of a national economy's description have been chosen. They are:

- * Symptoms - "socio-economic self-feeling" of a country
- * Diseases - "socio-economic health"
- * Receptivity - the ability to withstand diseases.

Each level ought to be described later by a minimal number of integral quantitative indicators - their construction is the main goal of the methodological part of the ERI Project. In the ideal case each aspect of a phenomena under investigation would be described by one single characteristic. However, each of the levels chosen seems to be "multiaspect" itself. Therefore, it can be adequately described only with some set of relatively independent indicators. Hence, similar to the initial step, the formulation of a preliminary hypothesis in order to avoid needless calculations is necessary. For the level of symptoms the preliminary structure for the characteristic of a country's "socio-economic self-feeling" consists of the five following "blocks":

- Individual welfare (income, consumption, leisure)
- Demography and health (life expectancy, family "quality", causes of death, etc,)
- Criminality
- "Social peace" (employment, strikes, income and consumption distribution)
- Environment.

In the process of statistical analysis the proposed structure might be changed. Besides, each block will be described by a separate set of integral indicators whose interconnections will also be clarified. At any rate, in the first step a list of primary parameters has to be put in accordance with each of the blocks - the important goal of the preliminary hypothesis is to provide a "proper" choice of initial parameters. Thus, thirty one parameters have been chosen for the block "Welfare". They include personal

consumption and social expenditures in GNP per capita; number of telephones, TV sets and cars in private use per capita; annual consumption of major food stuffs; dwelling space and number of rooms per capita; hours of work to purchase a car and a TV set; etc.

The second level ("Diseases" or "Health") characterize the "status" of a national economy. We include here characteristics which influence "Symptoms" indicators and cannot be changed rather quickly. This mainly concerns characteristics of output, production factors and productivity. The preliminary "blocks" for this level are:

- Output (aggregate and by sectors)
- Capital (composition by sectors, vintages, etc.)
- Labor (age distribution, education and skills, etc.)
- Natural resources
- Technology and other production factors
- Participation in the international division of labor (shares of import in the consumption of various products, etc.)
- Productivity and efficiency (intensity of resources' utilization, productivity of various factors, energy and material efficiency, etc.)

The level "Receptivity" corresponds with those input characteristics whose values can be changed relatively quickly by a government. These characteristics are directly connected with the problematic of economic reform. Possible "blocks" for this level would be:

- Institutional structure of an economy (structure of ownership, monopolization level in various sectors, etc.)
- Money and finance (fiscal variables, credit system, debt, inflation, etc.)
- Management system (number of hierarchical levels, expenditures on government bureaucracy, number of concordances in decision making, etc.).

The "level" and the "block" structures mentioned above are doubtlessly controversial. However, we would like to stress once

again the preliminary character of hypotheses formulated at the initial phase of the use of statistical methods. The real structure of the sought for description can be elaborated only as a result of empirical data processing.

Within the framework of the IIASA "Economic Reform and Integration" Project the data to be collected will cover OECD and East European countries, Western Soviet republics and Russia, and also some newly industrialized countries. Initially four years (1970, 1975, 1980, 1985) will be selected. Direct comparative analysis based on these data is (as we mentioned above) hampered by different methodology used at the construction of statistical systems in various countries. Anyhow, relevant data collection and their adjustment (in order to provide comparability) has already began. Certain part of information on the two above mentioned levels ("Symptoms" and "Health") has become the object of the "linguistic" analysis. However, results obtained until now appear too premature to be presented.

REFERENCES

- Abramovitz, M. (1956), Resource and Output Trends in the United States since 1870. American Economic Review 46 (May).
- Aven, P. O. (1990), Proposed Reforms to the System of Agricultural Statistics in the USSR. Paper presented at the OECD Conference on Statistical Systems of Central and Eastern Europe, September 10-12, Paris, France.
- Aven, P. O., Oslon, A. A. and Muchnik, I. B. (1988), Funktzionalnoie shcalirovanie (Functional Scaling). Moscow, Nauka.
- Braverman, E. M. and Muchnik I. B. (1983), Strukturnie metodi obrabotki empiricheskikh dannih (Structural Methods for Empirical Data Processing). Moscow, Nauka.
- Chenery, H. B. et al. (1986), Industrialization and Growth. Oxford Univ. Press.
- Denison, E. (1967), Why Growth Rates Differ. Washington, DC, Brookings Inst.

- Freeman, C. (1987), Technology Policy and Economic Performance: Lessons from Japan. London, Pinter.
- Harman, H. (1960), Modern Factor Analysis. Chicago Univ. Press.
- Kendrick, J. W. (1961), Productivity Trends in the United States. Princeton Univ. Press.
- Kirichenko, V. N. (1990), Vernut doverie statistike (To Render Credibility to Statistics). Kommunist, No. 3.
- Kornai, J. (1986), Contradictions and Dilemmas: Studies on the Socialist Economy and Society. Cambridge, M. I. T. Press.
- Maddison, A. (1987), Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment. Journal of Economic Literature, vol. XXV (June).
- Muller-Reissmann, K. F. and Schaffner, J. (1988), Criteria Systems for Agriculture. Hannover, ISP.
- Nordhaus, W. and Tobin, J. (1972), Economic Growth. Fiftieth Anniversary Colloquium. New York, N. B. E. R.
- Rao, C. R. (1964), The Use and Interpretation of Principal Component Analysis in Applied Research. Sankhya, ser. A, vol. 26.
- Solow, R. M. (1957), Technical Change and the Aggregate Production Function. Review of Economics and Statistics, 39 (August).
- Uno, K. (1989), Potential Output: Conceptual Problems and Empirical Measurement. Paper prepared for the 21st General Conference of the International Association for Research in Income and Welth, August 20-25, Lahnstein, West Germany.