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METHODOLOGICAL PROBLEMS IN THE DESIGN OF INDICATORS IN SOCIAL SCIENCES WITH THE FOCUS ON SOCIO-ECONOMIC GEOGRAPHY

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Abstract: The paper presents the indicator method as an important tool of research in social sciences with the focus on socio-economic geography. It introduces the notion of indicator in the methodological meaning and concentrates on its basic type, i.e. the inferential indicator. The concept of an indicator is explained using a realistic approach, which assumes that unobservable conceptual properties can be represented by observable real properties. In this approach, an indicator is characterised as an observable variable assumed to point to, or estimate, some other unobservable variable. The indicator method is then a way of the realistic conceptualization and a cognitive operation as well. The paper contains the systematization of cognitive indicators in socio-economic geography. It also shows the examples of the construction and interpretation of applied indicators.

Keywords: observable and unobservable properties; realistic conceptualization; systematization of cognitive indicators; examples of indicators; socio-economic geography

JEL codes: C10, C18

1. Introduction

The basic components of socio-economic reality which is the subject of social sciences are real objects. Every real object has a number of real properties. This list of its known individual properties represent the state of object. The states of real objects or the changes of these states are empirical facts (events) discovered and established based on observation.

However, apart from real objects, conceptual objects are also distinguished, that is constructs, such as concepts, propositions and theories which are creations of the human mind (Bunge 1977, 1996). They are not parts of the real world (i.e. entities) as it is with real objects, but they can represent them. Constructs are conceptual representatives of real-world components, i.e. real objects and their properties (Bunge 2006).

The empirical-scientific model of contemporary socio-economic geography assumes that empirical facts are of fundamental importance in building up knowledge (Chojnicki 2010). However, the subject of research in socio-economic geography next to observable objects is often objects inaccessible to direct observation, i.e. conceptual objects and their properties. In order to preserve the empirical character of socio-economic geography, we try to detect such properties which would be subject to observation and which could make it possible to determine unobservable properties of conceptual objects.

Examples of unobservable properties, called latent, are social concepts, economic concepts, properties of spatial and regional systems, such as suburbanization, human capital, a level of socio-economic development, prosperity, the standard of life, social cohesion, sustainable development, competitiveness, a knowledge-based economy, spatial accessibility, spatial coherence.

An approach distinguishing real objects and conceptual objects (constructs) is the basis for the application of indicators as a method for the description of the properties of those objects.

The indicator method, or indicator inference, is a way of a realistic conceptualization of reality, which consists in expressing unobservable conceptual properties by means of observable real properties (Bunge 1996).

This article aims at presenting the indicator method as an important tool for the cognitive research conducted in the field of social sciences with the focus on socio-economic geography and shows some of the methodological problems involved in the design of indicators.

2. Index and indicator

In scientific terminology it is important to distinguish between an index and an indicator. These are two separate terms with different meanings but related to each other. An index is a statistical term and an indicator a methodological one. An index is linked to statistics. It results from the assignment of certain real numbers to the properties of specific objects as their measures. It is a descriptive parameter of an object's property in the numerical form. In statistics we distinguish indices of structure, intensity, and the dynamics of phenomena (Banasiński & Lange 1968). An index is treated as a synonym for statistical data.

An example of an index in statistics can be a readership index, which is the number of books read during a year per inhabitant. However, when we interpret this index as meaning that the growth in reading rates proves the growth in the cultural level of a society, then we use the term in a methodological sense of a cognitive

value, i.e. an indicator (Tabin 1983). The terms: indicator and index are compatible but cannot be considered interchangeably.

An indicator is a term mainly applied in sociological research. Typical indicators are income inequality indices. In economics, demography and socio-economic geography the term index is used, which still can be wildly understood. Some indices (so-called by their authors) are essentially indicators. An example can be Florence's statistical index of localization (1948). It is worth noticing that in recent years in regional studies, among others in the research on regional competitiveness, a clear distinction between indicators and indices is introduced (Aiginger & Firgo 2017).

In this study the following terms are applied: indicator and index and their modified names in the form: the cognitive indicator and statistical index.

3. Types of indicators

The notion of indicator in a methodological sense developed in social sciences, mainly in sociology, and became an important tool for cognitive research. For the first time we encounter this term in Dodd's work (1942). Contemporary research achievements in the field of methodology is rich and it would be hard to outline it here. Pawłowski (1969) and S. Nowak (1970, 1985) investigated the indicator method in Polish sociology. Of great importance in the world achievements are Bunge's works (1975, 1981, 1985, 1996) who developed the conception of indicators in the theoretical-methodological aspect in scientific philosophy.

According to S. Nowak (1977), an indicator is a property from whose occurrence we conclude either with certainty or with certain probability the occurrence of another property called an indicatum. In terms of the relation between an indicator and an indicatum, he distinguishes definitional indices and empirical indices. Definitional indicators are based on identity relations. "The indicator itself is the very phenomenon that we want to study and its characteristic features form the definition of the corresponding concept" (S. Nowak 1977, p. 132). When we say that the number of annually committed crimes is a crime indicator, we assume that "crime" is "the number of crimes committed". An indicator is a definition of an indicatum. The concept of definitional indicators was justified and interpreted on the basis of the opinion that those notions should be defined in observational-measuring terms. Thus, those indicators can be occasionally assumed as operational definitions. Empirical indicators are the ones in which the relation between the indicator and the indicatum (property indicated by it) is not based on terminology, but is a factual relation. On the assumption that the indicator and the indicatum are different in terms of the notion and definition, it can be assumed that there is a dependence which is directly or indirectly subject to empirical verification. There are two types of empirical indicators: (1) an observational indicator when both an indicator and an indicatum have the character of observable properties; an indicatum can be observed empirically and thus the existence and the strength of relation between them can be empirically stated. An example of this indicator is the number of bank accounts as an indicator of people's incomes; (2) an inferential indicator when from

that an indicator occurs we deduce the existence of certain property (latent property) inferred from its various symptoms, but not directly observable.

An inferential indicator is a certain property (variable) which determines and gives an empirical sense to a certain unobservable property. This involves conceptual objects and their properties which are unavailable for observation and which are attempted to be determined by the properties which relate to them and which are subject to observation and measurement. Hence, the indicator of the attractiveness of a city is the number of tourists, hotels or historical buildings. Other examples of inferential indicators are density of cities as an indicator of urbanization, net balance of journeys to work as an indicator of a city closure, the number of non-profit organizations as an indicator of social capital, employment in the high technology industry as an indicator of regional competitiveness. In the case of inferential indicators, the existence or the occurrence of an indicatum cannot be confirmed by direct observation. An indicator is characterized as an observable property assumed to point to, or estimate some other unobservable property (Bunge 1975). Inferential indicators are based on the relation which occurs between an indicator and an indicatum, that is between an observable and an unobservable property. This relationship is discussed in various categories: of cause and effect, statistical, and probabilistic (Pawłowski 1969). If, e.g. the "high level of consumption" is analysed and the "possession of a luxury car" is assumed as an indicator, the relation between them can be interpreted in different ways. Analysing it in the categories of cause and effect, one can reflect on whether an indicator is a necessary and a sufficient condition of an indicatum. It is worth noting that this relation is hypothetical in character.

The major importance of inferential indicators is that they help to verify theoretical, i.e. unobservable terms, and theoretical statements occurring as part of pre-theoretical knowledge (Chojnicki 2008).

Bunge (1996), considering indicators in their narrowest sense, i.e. in the form of inferential indicators, analyse the links of conceptualization, which specifies and improves concepts, with operationalization. "The 'operationalization' of construct consists in relating it to data via one or more indicator hypothesis" (Bunge 1996, p. 170). The indicator hypothesis is the relationship between an unobservable variable UO and an observable variable O and takes the form of the functional dependence UO=f(O). This hypothesis has the character of a theoretical or empirical one, which has to be justified and verified in logical and cognitive terms.

In this article, without going into an extensive analysis of compound methodological problems connected with the construction and use of indicators already presented in Bunge's works, attention is paid to the following premises, important for the indicator inference: (1) "Although all indicators are variables, not all variables are indicators. Likewise, while all indicators are observable, not all observable variables are indicators" (Bunge 1975, p. 68); (2) "The indicator should follow directly from the theory determining their significance" (Bunge 1981, p. 379). However, most indicators in social sciences are proposed on the basis of intuition without theoretical justification; (3) "Some indicators are unreliable for being ambiguous" (Bunge 1996, p. 170). The relation between a single indicator and an indicatum can

be imprecise and hence unreliable. Thus, large outlays on education can indicate either an advanced and modern education system or a backward one subject to modernization. In turn, per capita income is not reliable indicator of the quality of life. According to Bunge (1985), there are two ways of decreasing the ambiguity of indicators. The first one consists in building a large set of indicators having each control the others. Such proceeding is applied, e.g. in the research of the quality of life (Bunge 1975; Chojnicki & Czyż 1987). The second way is embedding indicators in theories which are capable of explaining why an observable variable is a good indicator of an unobservable variable.

4. Systematization of indicators in socio-economic geography

In socio-economic geography statistical indices and cognitive indicators are used. Indices include statistical data which inform about the state of socio-economic phenomena and are published in statistical yearbooks or included in data bases. For the research proceedings in the field of socio-economic geography, however, cognitive indicators are of particular importance.

Cognitive indicators, applied in the indicator method in socio-economic geography are divided into kinds according to the characteristics of variables formulated as indicators. The following kinds of indicators are distinguished:

1. Empirical and theoretical indicators. Empirical indicators concern variables observational-measuring in character. Theoretical indicators are determined based on theoretical variables. These variables are derived from the mathematical model of a phenomenon. They do not have their empirical counterparts. Yet, they are the variables which are a transformation of empirical variables and which acquire a new interpretation (descriptive or theoretical). The empirical indicator of the population distribution is the population density and the theoretical indicator – a mathematical population potential (Chojnicki 1966).
2. Qualitative indicators (e.g. intentions underlying social actions) and quantitative (e.g. the number of years of education as an indicator of human capital). The values of these indicators due to the character of variables may represent various measurement scales: nominal, ordinal, interval and ratio scale.
3. Attribute and relational indicators. Attribute indicators represent intrinsic properties that an object possesses regardless of other objects. Relational indicators represent the properties of pairs of objects, they identify the relationships between those objects in the form of an interaction (meaning that a change of one object is accompanied by a change of the other one). An example of the first one is the quality of soil as an indicator of the value of agricultural land and the second – migrations as in indicator of interregional linkages.
4. Significant and nonsignificant indicators. They are distinguished in the procedure of the reduction of the initial set of properties, which results in the derivation of statistically significant properties being the basis for significant indicators, and the rejection of properties nonsignificant in character (L. Nowak 1977). Principal component analysis belongs to one of the reduction methods. A com-

ponent is built on the dependencies between empirical variables and is a theoretical variable statistically significant when it explains an important part of the total variance of input variables (Chojnicki, Czyż 1987, 2003; Rodrigues-Pose, Crescenzi 2008).

5. Indicators in denomination and normalized indicators. The first ones are identified in the categories of the properties expressed in physical units (involving economic, social and ecological events) and are conventionally called "natural indicators" (e.g. infant deaths per 1,000 live birth as an indicator of health condition) or are expressed in money values (e.g. Gross Domestic Product (in zlotys) per employee as an indicator of productivity). The second ones are constructed on the basis of normalized variables (including standardized ones) which are comparable and allow performing further mathematical operations (E. Nowak 1990).
6. Partial and synthetic indicators. This division corresponds to the division into simple and composite indicators (Babbie 2001). A partial indicator is constructed based on a single property of a phenomenon (e.g. population growth as an indicator of a demographic situation, the number of students as an indicator of human capital). A synthetic indicator concerns a multivariate description of a phenomenon and can be the average of partial indicators. An example of a synthetic indicator constructed in such a way is Perkal's index[1]. The application of a synthetic indicator requires previous normalization and transformation of variables (Grabiński et al. 1989). In turn, Aiginger and Firgo (2017) compile composite indicators based on principal component analysis and factor analysis. Synthetic indicators include: an indicator of socio-economic development level, an indicator of a knowledge-based economy, an urbanization indicator, a regional competitiveness indicator.
7. Positive indicators (stimulants), negative indicators (destimulants). We deal with stimulants when we assess positively the growth in the value of an indicator and with destimulants when we assess it negatively. For example, a stimulant is the number of patents as an indicator of innovativeness in the economy and a destimulant – the number of road accidents per 10,000 inhabitants as an indicator of public safety. Destimulants are indicators of adverse events from the economic, social and ecological point of view, which are the symptoms of irregularities in the development process. All the values of these indicators that are greater than zero indicate an absolutely unfavourable situation. Even the lowest dust emission per km^2 is unwelcome. Whereas indicators-stimulants, unlike destimulants, require that the limit between the favourable and unfavourable value be arbitrarily established. For example, an indicator of 10 doctors per 1,000 population may be the evidence of the low standard of life. There are also indicators for which a certain range of values exists, assessed positively from the point of view of a given phenomenon, and every deviation (both up and down)

[1] Perkal's index was introduced to Polish socio-economic geography and interpreted by a mathematician – Kostrubiec (1965). In Anglo-Saxon geography this indicator appears as the z-score method (Smith 1972).

is assessed negatively. An example of this is food consumption as an indicator of the standard of life (Appenzeler 2011).

8. Indicators in subject order. These are indicators of socio-economic phenomena which are part of a specified research problem. For example, in the research of regional development the following can be distinguished: urbanization indicators, indicators of a knowledge-based economy, business environment indicators, population development indicators, social capital indicators.
9. Descriptive and normative indicators (Bunge 1981). A descriptive indicator of social participation is the share of the population taking part in making social decisions. The corresponding normative indicator is the optimum share which ensures an effective organization of social activities. A normative indicator of the level of life in the form of per capita income, e.g. in the Mazowsze region, can adopt the value of a descriptive indicator, which is the value of the per capita income already gained in the Stockholm region. The most common are the normative indicators of sustainable development.
10. Spatial indicators. In geographical research spatial indicators belong to a specific and important category. They concern the properties considered in a spatial aspect and are determined in different spatial scales: local, regional, national, global. These are indicators of spatial distribution, location, spatial concentration, neighbourhood, spatial differentiation, location rent, spatial accessibility of phenomena, spatial order. Spatial indicators are divided into: indicators concerning the properties of a territorial unit (territorial indicators), e.g. an indicator of the density of a road network in a region and indicators consisting of an implicit or explicit element of distance constituting a basic geographical property (an indicator of interregional linkages, an indicator of spatial accessibility of a city).

It is worth noting that a given indicator represents, as a rule, some of the indicator kinds defined above. For example, an indicator for spatial distribution of phenomena can be at the same time an empirical, quantitative, partial, significant, etc.

5. Examples of cognitive indicators used in socio-economic geography

Classic cognitive indicators, used in socio-economic geography include among others: indicators of regional specialization, indicators of a spatial concentration of socio-economic phenomena, indicators of changes in the structure of regional economy, indicators of socio-economic interactions in territorial systems.

These indicators are represented by Florence's location quotient (1929), Florence's localization index (1948), Blakely and Bradshaw's prosperity index (2002), and the potential ratio (Czyż 2002). It is emphasized that the indicators analyzed are often called indices or coefficients by their authors.

A choice of exemplary indicators is justified in the following way: the first two are in the original version the indicators with a simple construction, often modified, with great interpretative possibilities, recognized as a basic tool for economic

development analysis, also widely applied in regional analysis (see: Miller et al. 1991; Woźniak 2015; Isard 1960); the remaining two are new indicators provoking a discussion.

Florence's location quotient (LQ_i), in other words an index of regional specialization is the ratio value of a determined economic or social activity M in region i to this value in the higher-level spatial unit A (a country):

$$LQ_i = \frac{M_i}{M_A}$$

LQ_i determines in which regions the "overrepresentation" of a given activity ($LQ > 1$) occurs and in which there is a relative "scarcity" ($LQ < 1$). "Overrepresentation" can be interpreted as a regional specialization.

Location quotient (LQ) enables also the comparisons for different periods of time, which would not be possible applying such indicators as, e.g. the value of the production sold per inhabitant (in zlotys) due to inflation. Thus, the location quotient fulfils the function similar to the standardization of features (Stryjakiewicz 2000).

The location quotient was also used for determining the economic base of a city (Jerczyński 1973) as an indicator of an exogenic activity E_{ex}:

$$E_{ex} = \frac{\frac{E_{iC}}{E_C}}{\frac{E_{iN}}{E_N}}$$

where:
E_{iC} – employment in activity i in city C,
E_C – total employment in city C,
E_{iN} – employment in activity i in the country,
E_N – total employment in the country.

The quotient is a comparison of the structure of employment in city C with the structure treated as the reference pattern. $E_{ex} > 1$ means the surplus in a given activity, i.e. an exogenic activity of a city.

Florence's statistical localization index (IL) is an indicator of the concentration of an economic activity in a regional system[2]. "It is essentially a comparison of the percentage distribution by region of employment in the given industry with the regional percentage distribution of the base magnitude, for example total national manufacturing employment" (Isard 1960, p. 252).

The localization index (IL) for the given i industry is computed according to the formula:

$$IL_i = \frac{\sum_{j=1}^{n}(y_{ij} - x_j)}{100} \qquad \text{for } y_{ij} > x_j,$$
$$n = \text{number of regions},$$

[2] This indicator was called the coefficient of localization by Isard (1960, p. 252).

where:
y_{ij} – percentage share of region j in national employment in industry i
x_j – percentage share of region j in the national scale of a phenomenon which is the basis for the comparison.

The limits to the value of the index are 0 (total dispersion) and 1 (an entire industry is concentrated in one region).

Florence's localization index has also a new interpretation as an index of the location orientation (Stryjakiewicz 2003). "The location analysis of the food industry is based on a combination of two location quotients calculated in the relation to the population number and the acreage of agricultural land. This index can be termed as the index of the location orientation of the sectors of the industry in question." (Stryjakiewicz 2003, p. 141). In turn, Luchter and Wacławowicz (1963) modifying Florence's index constructed the statistical demographic index as the measure of territorial dispersion of services.

Blakely and Bradshaw's prosperity index (*IP*) (2002) is an index of changes in the structure of an economy. This index is a ratio of the growth in wages to the growth in jobs, e.g. in the industry in a given region or a country:

$$IP_i = \frac{K}{Z}$$

where:
K – wage growth (in %) in region i in a any period,
Z – job growth (in %) in region i in the same period.

There are many possible interpretations of the prosperity index because it can be referred to different stages of economic development and different economic systems. The interpretation of this index adopted in the regional knowledge-based economy is the following: if the index is over 1.0, wages will increase faster than jobs and this industry activity represent a modern economy with high-technology firms offering higher wages for highly qualified employees.

The potential ratio P_i is a systemic indicator of the level of socio-economic development of a region determined by a mathematical potential model (Chojnicki 1966). It is expressed in the formula:

$$P_i = \frac{U_i}{V_i}$$

It is composed of the two versions of the potential model:
(1) income potential U_i in region i

$$U_i = \frac{z_i}{d_{ii}} + \sum_{j=1}^{n} \frac{z_j}{d_{ij}}$$

where:
z_j – income in region j
d_{ij} – distance of region i from region j
$\frac{z_i}{d_{ii}}$ – self-potential of region i

(2) population potential V_i in region i

$$V_i = \frac{l_i}{d_{ii}} + \sum_{j=1}^{n} \frac{l_j}{d_{ij}}$$

where:
l_j – population in region j.

The income potential is a function of the income generated in region i as well as incomes in other regions and of the distances separating them. Thus, the income potential allows one to consider the effect of interregional flows of income on the spatial variability thereof. In turn, the population potential defines the accessibility of region i to the inhabitants of all the other regions of the system. In relation to region i it measures the contribution of the population of all the other regions as augmented by the influence of the region on itself. The ratio of potential income to the population potential is then a systemic indicator of a regional level of socio-economic development (Czyż 2002).

6. Comment and discussion

The indicator method belongs to traditional description methods in socio-economic geography (Chojnicki 1977; Czyż 1980). Most applied indicators are classified as so-called "old" indicators, which originated in social sciences, regional analysis and were transferred to geographical research. The interpretative possibilities of many indicators are still far from being exhausted.

However, in the discussion about the cognitive value of indicators, attention is paid to the inadequacy of some indicators and hence there are suggestions that new, alternative ones should be constructed and used. The criticism concerns mainly the application of income as an indicator of socio-economic development. In sociology the use of income as an indicator of the quality of life is questioned. In the Polish economy and statistics an opinion prevails that the Gross Domestic Product (GDP), estimated in accordance with the principles determined by the European System of National Accounts, is only the measure of volume and changes in the level of production, (more precise – of a value added). This index can be treated as an indicator of economic growth (Czerwiński 1992; Wyżnikiewicz 2017). It is also emphasized that a certain reservation in regard to GDP as an indicator of the economic growth of a given country is connected to globalization which manifests itself in multinational enterprises and caused difficulties in establishing the places where the domestic product is created (Malaga 2009; Wyżnikiewicz 2017).

In the world economy the usefulness of the GDP as an indicator of social development is questioned and the construction of many indicators of social progress is recommended including the ones of sustainable development and the state of the natural environment (Stiglitz et al. 2009). The assessment of a development level is proposed not in reference to GDP but under the new perspective of more socially

inclusive and ecologically sustainable growth path and used a wide set of "beyond GDP" indicators.

Attempts have also been made to develop a new indicator of the development level in the form of a "green" income. This indicator is constructed on the assumption that environmental well-being should be treated on equal terms with the importance of positive aspects of a market economy. Yet, the construction of the "green" income index itself creates problems as to what crucial elements of the ecosystem should be included in it (Malaga 2009).

Difficulties in the construction of alternative indicators and their concretization resulting from the lack of data still make the GDP remain a commonly applied indicator of the development level, also in socio-economic geography,

In geographical regional studies the criticism of a regional income (GDP per capita) as an indicator of the level of socio-economic development can be included in the following statement: a regional income is the measure of the volume of an economic activity, situated in a given region, but it does not include the influence of spatial and socio-economic relations occurring in the entire regional system on the development level of each region. Therefore, the modification of this indicator is presented, made with the use of a mathematical potential model and the proposition of a new systemic indicator in the form of the ratio of potential income to the population potential is suggested (Czyż 2002).

It is worth noting that in socio-economic geography most indicators applied are limited to certain socio-economic systems. Hence, there is a need to order them and determine what sets of alternative indicators should be used in various spatial patterns.

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