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SYSTEM OF WEIGHTS IN ANALYSIS OF INFLATION

Summary: Indexes are an instrument of choice for analyzing changes of many economic quantities. Some of them, such as stock market indexes or indexes employed for inflation measurement, may take on fairly complex forms. Index value depends on two coefficients: price and quantity. Quantity, in a sense, is a system of weights used to describe the price vector. This paper addresses the problem of changes in the system of weights for the purpose of calculating consumer price index.

Key words: price, inflation, index, weights system.

1. Introduction

The past decades are characterised by the strive for formalisation of social sciences, including above all economics. Attempts have been made to express rules and correlations governing those spheres of human life in the specific mathematical language. The list of persons honoured in the field of economic sciences with the prestigious Noble prize confirms this outlook on science. The greatest recognition has been given to papers on the verge of mathematics and economics, and more specifically – mathematical solutions to problems of the area of economics or, more widely, social sciences. The authors of such theories have determined directions of future research and the original approaches to them have been the inspiration to those who currently tackle similar problems.

Mathematics is the knowledge of the world, processes occurring in it in the abstract approach. Creating models is nothing else than identifying natural structures with their abstract ideal counterparts. Due to them pluralism and diversity, by emphasising the essence, are reflected in simple and accurate theories and these are proven within their confines. This idea is perfectly captured by von Neumann's words: "Science does not attempt to explain, and it does not even almost attempt to interpret, it is mainly concerned with constructing models. A model is understood as a mathematical creation which, upon the addition of verbal interpretation, describes the observed phenomena. The only and proper justification of this mathematical creation is the expectation that it will work in practice".

One may risk the statement that the development of a particular scientific discipline depends on how much can be measured within its scope. To measure obviously means to make a measurement, that is to bestow objects with a specific form. It is not a coincidence that the most dynamically developing branches of science are technical disciplines. The possibility to properly define given notions, that is using the same language, facilitates and accelerates the development of a particular discipline. If there is no single definition of a given object or it allows multiple interpretations, the analysis of such a phenomenon causes much trouble and may lead to the common lack of approval of the conclusions drawn therefrom. The basis and starting point of any research should be determining what and how ought to be measured. The consistency of the variable in terms of theory and measurement should be assured[1].

2. Measurement

A measurement, to simplify, is a reflection of a real structure in a model structure. In other words, it is the cognition of the reality by means of analogy, thanks to the retention of relations occurring therein in a known and researched relation system. A relation system is understood as an ordered pair (A, R), where A is any set and R is a function mapping a set of indices I in a set of polyadic relations specified in the A set. Therefore, for every $i \in I$, $R(i)$ or in other words R_i, is a certain subset of the n_i-fold Cartesian product $A \times ... \times A$. The notation $R_i(a_1, ..., a_{n_i})$ means that the array $(a_1, ..., a_{n_i}) \in R_i$. A type of a relation system (A, R) is called a τ function transforming the set of indices I into a set of natural numbers in such a way that n_i number, that is the multiplication factor of the relation R_i is assigned to the i index[2].

Relation systems (A, R) and (A', R') are of the common type if and only if functions τ and τ', being the respective types of those relation systems, are similar, that is there occurs a bijection φ of set of indices I into set of indices I' such that $\tau = \tau' \circ \varphi$. In other words, relation systems are of the common type when there exists one-to-one correspondence of the relations of the first and second system. Correspondence in the sense that the corresponding relations have the same multiplication factor, that is R_i multiplication factor is the same as $R'_{\varphi(i)}$ for every $i \in I$. Therefore, the sets of indices of the common type of relation systems may for the sake of simplification be identified.

The common type of relation systems is the first element ensuring the analogies of the real structure and model structure. It is not certain, though, whether relations represented by the function R are transferred between real objects and their abstract equivalents described by R'. In order to emphasise those correlations, certain classes

[1] F. Neal, R. Shone, *Proces budowy modeli ekonomicznych*, PWN, Warszawa 1976.

[2] A. Smoluk, *Metoda homomorfizmów w teorii zbiorów uporządkowanych*, "Ekonomia Matematyczna"1998, No. 2.

of mapping of the common type of relation systems, called morphisms, are considered.

If the relation systems (A, R) and (A', R') are of the common type, the function $f: A \rightarrow A'$ is called:

a) a homomorphism of systems (A, R) and (A', R') if and only if

$$R_i(a_1,...,a_{n_i}) \Rightarrow R_i^{'}(f(a_1),...,f(a_{n_i}));$$

b) a comorphism of systems (A, R) and (A', R') if and only if

$$R_i^{'}(f(a_1),...,f(a_{n_i})) \Rightarrow R_i(a_1,...,a_{n_i});$$

c) a bimorphism of systems (A, R) and (A', R') if and only if

$$R_i(a_1,...,a_{n_i}) \Leftrightarrow R_i^{'}(f(a_1),...,f(a_{n_i})).$$

A bimorphism which is a bijection is called an isomorphism, while the isomorphism between the same structures – automorphism[3].

Any morphism f of relation systems (A, R) and (A', R') is called the measurement of structure (A, R) with structure (A', R'). The former system is designated in such situations as the natural structure, while the latter as the model structure or the primary scale of measurement. The f mapping transfers correlations occurring in the examined relation system into the model system. Relations between the objects – elements of the A set – their features, intensity of occurrence, described by R function thanks to the relevant morphism are transferred to the model structure in which an accurate description can be made.

That definition embraces the most important classes of mapping considered within the theory of measurement. The classic monographs dedicated to those issues[4] draw the most attention to bimorphisms called homomorphisms of relation systems there. The others are only mentioned and a wider description can be found in the works by other authors[5]. The location of bimorphisms in the centre of interest of the theory of measurement can be simply and naturally justified. In such situations, correlations being the subject of a measurement are identical to those observed in the model structure. The most relevant measurements will be obviously obtained by means of isomorphisms. The application of any of the remaining mappings always results in impoverishing of one of the structures.

If the determined relation systems of the common type (A, R) and (A', R') are provided, the function ϕ transforming the set A' into itself is called admissible map

[3] J. Magiera, *Ogólna teoria pomiaru*, [in:] *Elementy metrologii ekonomicznej*, ed. A. Smoluk, Wyd. Akademii Ekonomicznej, Wrocław 2000.

[4] J. Pfanzagl, *Theory of Measurement*, Physica-Verlag, Wurzburg-Wien 1971; F.S. Roberts, *Measurement Theory*, Addison-Wesley Publishing Company, London-Amsterdam-Ontario-Sydney-Tokyo 1979.

[5] E.W. Adams, *Elements of a Theory of Inexact Measurement*, "Philosophy of Science" 1965, Vol. 32, No. 3; J.A. Schreider, *Equality, Resemblance and Order*, Mir Publishers, Moscow 1975.

if and only if for every morphism f of those structures, the mapping $\phi \circ f$ is also a morphism. It is convenient to assume in practical applications that both mentioned morphisms are of the same type, which means they are at the same time homomorphisms, comorphisms or bimorphisms. The admissibility of transformations will be understood in such sense in the further part of this discussion. However, that notion may be generalised, acknowledging the change of the type of morphism upon superposition with mapping ϕ[6]. The essence of that notion is that both f and $\varphi \circ f$ are the measurement of (A, R) structure with (A', R') structure.

An ordered pair $((A', R'), \Phi')$ noted simpler in the form (A', Φ'), where Φ' is any subset of the set of all admissible maps Φ is called the measurement scale. The issue of equivalence, similarity or measurements (for every $a,b \in A$ $(f(a) = f(b)) \Leftrightarrow (g(a) = g(b))$) is connected with the selection of scale. Intuitively, it corresponds with the reality. If the scale is very general there are many equivalent measurements in terms of that scale. A ruler without the scale may serve as an analogy here. By making the scale more precise, plotting certain marks on the ruler, the range becomes narrower. There are more and more relevant factors and hence smaller and smaller abstraction classes of the similarity relation. In an extreme case, a Φ' set may comprise only one item – identity transformation. Then the abstraction classes are composed of one item. All measurements on such a scale are significantly different.

The most important in terms of practical applications are obviously those scales where the A' set is the set of real numbers. They are called numerical scales. Their role is huge, particularly in the case of technical sciences. By means of them numerical measurements are obtained, which play the key role in measuring phenomena, or objects on which those fields focus. They are a manifestation of the strive to describe the state of nature numerically and of the formalisation of the processes occurring therein. It is easy to note that they have constituted the prototype of the notions generalised later. Such scales can be encountered in everyday life, while measuring, e.g. weight, length or temperature.

Two types are generally distinguished among numerical scales in terms of the admissibility of a specified class of transformations. The first one is linear, indicator scales, for which admissible transformations are functions in the form $\phi(x) = \alpha x$, $\alpha > 0$. They may play a significant role in economic sciences. The measurement results obtained by means of such scales differ from one another in terms of the unit, whereas the ratios of relevant values remain the same. It is nothing but e.g. denominating prices of certain goods or services in another currency or different units of the same currency. Such applications may be frequently encountered while considering, let us say, export settlements.

Another type of numerical scale is the interval scale. It is defined by a class of admissible transformations generalised in relation to the previous one. This time these are functions preset by the formula $\phi(x) = \alpha x + \beta$, where $\alpha > 0$ and β is any real

[6] J. Magiera, op. cit.

number. There is no point distinguished on the scale and translations of measurement results are permissible. In everyday practice, temperature or time is measured in that manner. Economic applications are possible with measurements of prices encumbered with a fixed, not expressed as a percentage, margin. Then a simpler version of the interval scale may be used, though, which is the differential scale defined by means of admissible transformations in the form $\phi(x) = x + \beta$.

The above presented discussion is within the confines of the part of the theory of measurement called basic measurements. Essential classifications and distinctions are made here. Within the scope of the measurement of inflation, those issues are related to the analysis of prices of individual goods and services. The topic has not been widely covered in the literature. The majority of authors concentrate in this respect only on the secondary element, which is the transformation of specified results of measurement of prices into price indicators being the final stage of the inflation measurement. This is an issue related to another section of the theory of measurement, concerning derivative measurements.

3. Definition of inflation

When analysing the published definitions of inflation one may notice that, except a certain common core, they differ in subsequent elements. In the economic dictionary[7] the following definition may be found under the entry *inflation*: “A general increase in prices of the majority of goods and services on the market caused by the fall in purchasing power of money present on the market”. It is further explained there that “the process of increasing the amount of money in a faster pace than total number of goods increases, which leads to the growth of prices, is called inflation”. The comparison of the two statements placed on the same page of one work may give rise to doubts as to the essence of inflation. Is it the increase of prices or the increase of the amount of money? The answer to this question is of great significance in the context of inflation measurement since, from the point of view of the two definitions, two different values should be measured. Furthermore, the statement concerning the change of prices of the majority of goods is not particularly accurate. It lacks criteria allowing to distinguish this “majority”. Depending on what will be accepted as clarification of the term, diverse results of analyses may be achieved.

A portion of the doubts is dispersed after analysing definitions provided in other publications. Kołodko[8] understands inflation as “a process of general price level growth or pressure on the growth as a result of the growing manufacturing costs and excessive stream of demand in relation to supply[...]”. In this case the author clearly transfers the weight of the definition of inflation onto the growth of prices but he adds the pressure on the growth as a significant element of the notion. It does not

[7] *Słownik ekonomiczny*, Znicz, Szczecin 1994.

[8] G. Kołodko, *Polska w świecie inflacji*, Książka i Wiedza, Warszawa 1987.

facilitate constructing relevant measures. Classic indicators do not allow for this aspect and only the research of inflation expectations includes elements of pressure on price growth.

The definition according to which inflation is “a process of continuous price growth or – in other words – continuous fall of money value”[9] gives rise to certain doubts from the point of view of measurement. Price growth is supposed to be a continuous process. Based on the examples presented in the quoted paper, it may be concluded that the authors understand the continuity as changes which are not of one time, leap-based nature. Thus, the growth of goods and services prices is not treated as inflation-related as long as it is not a result of a cycle of multiple changes. Such a statement may lead to a large number of diverging interpretations of the described phenomenon. Therefore, the authors transfer the weight of differentiating continuous changes from one time changes onto the analysis of their results. The former cause permanent changes, while the latter – temporary changes. In its concept the so understood definition begins to get closer to the definition of core inflation[10]. According to the discussed definition, the fall of money value is supposed to be an alternative to the growth of prices. From the point of view of determining the subject of measurement these are two different categories.

It is also worth paying attention to the definition according to which inflation is “a permanent growth of the average or general price level not corresponding to the equivalent growth of the average quality of the consumed goods and services”[11]. The authors of the statement equal the average and general growth of price level. However, it seems that the terms are not identical and therefore it might lead to divergence in assessing inflation-related phenomena. General price level should be understood as the level specified after analysing prices of all goods and services available on the market. The term *average* indicates either a narrower scope of goods prices which are taken into consideration in discussions – these will be exclusively those goods which are most frequently purchased by a large number of consumers – or a certain average of all prices. The latter case does not clarify what type of average should be taken into account.

A simple definition of inflation is provided in handbooks by Samuelson and Nordhaus and by Begg[12]. In the former one, inflation is understood as “general growth of price level”, while in the latter as “growth of average price level of goods within a given period”. Except the above mentioned difference consisting in using other adjectives specifying price changes, the essence of the term remains the same.

[9] J. Bauc, M. Belka, A. Czyżewski, A. Wojtyna, *Inflacja w Polsce 1990-1995*, Wyd. Prywatnej Szkoły Bussinesu i Administracji, Warszawa 1996.

[10] P. Woźniak, *Inflacja bazowa*, CASE, Warszawa 2002.

[11] D. Kamerschen, R. McKenzie, C. Nardinelli, *Ekonomia*, Fundacja Gospodarcza NSZZ „Solidarność”, Gdańsk 1991.

[12] P.A. Samuelson, W.D. Nordhaus, *Economics*, McGraw-Hill Inc., New York 1992; D. Begg, *Makroekonomia*, PWE, Warszawa 2000.

Moreover, Begg additionally introduces the notion of pure inflation as a special instance of inflation "which occurs when all prices of goods and production factors increase at the same pace." Thus, pure inflation is the type of phenomenon which does not influence the mutual relation of prices of individual goods and services. The price structure is preserved and only their absolute value is changed. However, such a construction of the definition does not allow to leave out changes of an indexation nature encountered in the case of e.g. denomination or money exchange, which are not related to inflation processes. That practically corresponds to the change of a measurement scale, that is expressing certain values in new units, which should not be considered an inflation manifestation.

On the basis of the presented definitions it is apparent that there is no unanimity in the literature as far as the definition of inflation is concerned. One may only talk about some common elements. Those elements allow to assume that inflation is a disproportionate change of the general price level. In the face of this problem, the specification of what is understood as the general price level becomes crucial.

4. General price level

The function L: $(\boldsymbol{R}_+ \cup \{0\})^n \to \boldsymbol{R}_+ \cup \{0\}$ is called the price level if and only if it is:

(1) monotone (strictly increasing) i.e. for every two elements $C^1, C^2 \in (\boldsymbol{R}_+ \cup \{0\})^n$ such that $C^1 \geq C^2$ i $C^1 \neq C^2$,

$$L(C^1) > L(C^2)$$

and

(2) homogeneous, i.e. for every $C \in (\boldsymbol{R}_+ \cup \{0\})^n$ and every $\lambda \in \boldsymbol{R}_+ \cup \{0\}$,

$$L(\lambda C) = \lambda L(C).$$

Relation of order in the set $(\boldsymbol{R}_+ \cup \{0\})^n$ used in the definition is a relation of product order defined by the formula $(c_1, \dots, c_n) \geq (c_1', \dots, c_n') \Leftrightarrow c_1 \geq c_1' \wedge \dots \wedge c_n \geq c_n'$ [13].

The axioms of monotoneity and homogeneity included in that definition are natural from the point of view of the content described by the function L. Monotoneity means that the price level increases in line with the increase in the price of any of the analysed goods. Homogeneity, on the other hand, may be interpreted as the change of the unit of the currency used for the calculations. The equal scale of changes of each coordinate leads to the same change in the value of the function.

Given such a generally formulated definition of price level, there are many functions fulfilling the preset conditions. What remains is the question whether monotoneity and homogeneity are the only postulates which are to be intuitively required from such a type of mappings. The widening of the scope of axioms will

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[13] W. Eichhorn, *Functional Equations in Economics*, Addison-Wesley Publishing Company, London-Amsterdam-Ontario-Sydney-Tokyo 1978.

lead to the increased specification of the considered transformations. The additional conditions most frequently mentioned in the literature are additivity and multiplicativity of the price level.

The function L is called an additive function if for any $C^1, C^2 \in (\boldsymbol{R}_+ \cup \{0\})^n$,

$$L(C^1 + C^2) = L(C^1) + L(C^2)\,.$$

Multiplicativity means, in turn, that for any $C \in (\boldsymbol{R}_+ \cup \{0\})^n$ and every $\lambda_1, ..., \lambda_n \in \boldsymbol{R}_+ \cup \{0\}$ there exists a non-negative function η dependant on the parameters $\lambda_1, ..., \lambda_n$, such that

$$L(\lambda_1 c_1, ..., \lambda_n c_n) = \eta(\lambda_1, ..., \lambda_n) L(c_1, ..., c_n)$$

and $\eta(1, ..., 1) = 1$. The first of the conditions is natural from the point of view of the notion of price itself. It is but a linear functional specified on the economic space of goods, and therefore the preservation of additivity as an additional postulate with the definition of the price level seems to be comprehensible. Multiplicativity proves, in turn, a very useful axiom from the point of view of the theory of measurement. Functions fulfilling that condition ensure the compliance of derivative measurements – which is the inflation measurement in end effect – with the primary ones, thanks to which the prices of individual goods or instruments are obtained. The compliance is obviously understood with the accuracy of the relevant, given the subject of the measurement, class of admissible transformations. Upon such narrowing of the discussion, it turns out that additive and multiplicative price levels have very simple representations.

The function L is an additive price level if and only if $L(C) = \alpha_1 c_1 + ... + \alpha_n c_n$, whereas a multiplicative one if and only if $L(C) = \gamma c_1^{\alpha_1} ... c_n^{\alpha_n}$ for certain positive $\gamma, \alpha_1, ..., \alpha_n$, with additionally $\alpha_1 + \alpha_2 + ... + \alpha_n = 1$ in the second case[14].

While looking for the appropriate form of indicators describing the inflation, it is easy to notice that according to that notion the functions of price levels fulfil the criteria postulated by the authors of the majority of definitions. Inflation is a change in the general price level. Therefore, from the point of view of that value it should be crucial to accurately define and subsequently measure the price level. Inflation would be expressed by that level in that case as a function analysing the changes thereof. Price indices serving for the inflation measurement should be thus in a way connected with that previous element of structure, which aim is to describe the prices of goods and services in general.

5. Price indices

Similarly to the price level, the notion of price index can be defined axiomatically. Such an index is a function of two variables, each of which is a vector of prices of two compared periods. It may be assumed, for technical grounds arising from the

[14] Ibidem.

necessity to take quotients into account, that prices of each good are positive, that is the considered vectors have positive coordinates[15].

The function Π: $\boldsymbol{R}_+^{2n} \to \boldsymbol{R}_+$ is called a price index if and only if it is:

(1) decreasing in terms of the first and increasing in terms of the second variable – for every $C^1, C^{1,1}, C^{1,2}, C^2, C^{2,1}, C^{2,2} \in \boldsymbol{R}_+^n$ if $C^{1,1} \leq C^{1,2}$ and $C^{1,1} \neq C^{1,2}$ and $C^{2,1} \leq C^{2,2}$ and $C^{2,1} \neq C^{2,2}$, then

$$\Pi(C^{1,1}, C^2) > \Pi(C^{1,2}, C^2) \text{ and } \Pi(C^1, C^{2,1}) < \Pi(C^1, C^{2,2});$$

(2) homogeneous in relation to the second variable – for every $C^1, C^2 \in \boldsymbol{R}_+^n$ and any $\lambda \in \boldsymbol{R}_+$,

$$\Pi(C^1, \lambda C^2) = \lambda \Pi(C^1, C^2);$$

(3) equal to one on the diagonal – for every $C \in \boldsymbol{R}_+^n$,

$$\Pi(C, C) = 1;$$

(4) invariant in terms of multiplication by a scalar – for every $C^1, C^2 \in \boldsymbol{R}_+^n$ and any $\lambda \in \boldsymbol{R}_+$,

$$\Pi(\lambda C^1, \lambda C^2) = \Pi(C^1, C^2).$$

All the axioms mentioned in that definition are naturally justified in the context of price change analysis. If the first variable is interpreted as the vector of prices of the previous period, whereas the second one as the vector of prices of the same goods in the later period, then monotoneity condition of individual coordinates means respective inequalities between the index values. Adopting a base period, in relation to which comparisons are made, as one with higher prices, results in decreasing the value of the function of the index, and comparisons in relation to the same vector of two different ordered yields the same relation between the function values.

The second axiom ensures that the proportional change of prices of all goods be identically reflected in the analysed index. This issue is important particularly in the time of changing currency units. Homogeneity in relation to the second variable ensures the same change of price index in such cases.

The third one sets the principle of comparisons of the same vectors of prices. If prices in the considered periods are identical, the index assumes the value of one. The fourth one means, in turn, that if the difference between periods compared twice amounts only to differences arising from a different determination of the currency unit, such a change should not affect the value of price index.

Examples can be provided that constitute proof that the system of axioms located in the definition of price index is independent in that there exist functions fulfilling each of the three but not the fourth[16]. Therefore, while accepting such an axiomatic structure of that function, one may not deplete the scope of the provided conditions.

[15] Ibidem.

[16] Ibidem.

They all shape the form of the price index in a certain way. The only matter to be thought on is whether all four indeed play the key role in the analysis of price changes. The earlier provided examples of interpretation of all of them justified that the answer is yes.

Examples of price indices may by the following functions:

$$\Pi_1(C^1, C^2) = \frac{\alpha_1 c_1^2 + \ldots + \alpha_n c_n^2}{\alpha_1 c_1^1 + \ldots + \alpha_n c_1^n},$$

where $\alpha_1, \ldots, \alpha_n$ are any positive real numbers;

$$\Pi_2(C^1, C^2) = \left(\frac{c_1^2}{c_1^1}\right)^{\alpha_1} \ldots \left(\frac{c_n^2}{c_n^1}\right)^{\alpha_n},$$

for positive and summing up to one $\alpha_1, \ldots, \alpha_n$ and

$$\Pi_3(C^1, C^2) = \sqrt{\frac{\alpha_1 c_1^2 + \ldots + \alpha_n c_n^2}{\alpha_1 c_1^1 + \ldots + \alpha_n c_n^1} \cdot \frac{\beta_1 c_1^2 + \ldots + \beta_n c_n^2}{\beta_1 c_1^1 + \ldots + \beta_n c_n^1}}$$

assuming that $\alpha_1, \ldots, \alpha_n$ and $\beta_1, \ldots, \beta_n$ are positive.

It can be easily noted that a special case of the Π_1 index is the Laspeyres index[17]. Assuming that $\alpha_1, \ldots, \alpha_n$ is a constant system of weights designated in the specified base period corresponding to the price vector C^1, and while considering the function Π_1 as a function of the second variable, a classic formula serving for the calculation of the inflation value is obtained. Similarly to the Paasche index[18], with the difference, however, that the first of them is to be assumed as the variable, and the scalars are to be treated in terms of a system of weights corresponding to the current moment. The function Π_2 after a similar modification may be interpreted as the above-mentioned index, where the arithmetic mean is replaced with geometric mean, and Π_3 as the Fisher index[19]. Difficulties in interpretation, in particular departure from considering the index function as the function of two variables, are obviously caused by the fact that constant weights are assigned to a specific period. Weights cannot be made variable, that is made dependent on each price vector separately, since it would require considering a function of four variables. Two of them would be prices, while the second two – weights. Such structures may be found in the literature[20].

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[17] E. Laspeyres, *Die Berechnung einer mittleren Warenpreissteigerung*, "Jahrbücher für Nationalökonomie und Statistik" 1871, Nr 16.

[18] H. Paasche, *Über die Preisentwicklung der letzten Jahre, nach den Hamburger Börsennotierungen*, "Jahrbücher für Nationalökonomie and Statistik" 1874, Nr 23.

[19] J.F. Pickering, J.A. Harrison, C.D. Cohen, *Identification and Measurement of Consumer Confidence: Methodology and Some Preliminary Results*, "Journal of the Statistical Society" 1973, Series A, Vol. 136, No. 1.

[20] W. Eichhorn, op. cit.

The similarity of formulas Π_1 and Π_2 and formulas defining additive and multiplicative price levels is not accidental. It can be easily noticed that the axioms included in the definition specifying the function of price level L implicate that the function

$$\Pi(C^1, C^2) = \frac{L(C^2)}{L(C^1)}$$

is a price index. It is the most important class of examples, given the definition of inflation. Basically, while examining inflation one should restrict the scope only to such a type of indices. That the thesis is right may be proved not only by the compliance of those functions with the definition, but also the fact that it is the sole class of price indices which permits comparability of data from different periods. It may be proved[21] that the price index defined as the quotient of price levels meets the condition of comparability, that is for every $C^1, C^2, C^3 \in \boldsymbol{R}_+^n$,

$$\Pi(C^1, C^2)\Pi(C^2, C^3) = \Pi(C^1, C^3)$$

and inversely, fulfilling that equation implies that the function Π has the form $\Pi(C^1, C^2) = \dfrac{L(C^2)}{L(C^1)}$.

In Polish public statistics the system of weights using for the calculation of the primary inflation measure, which is CPI, is modified annually according to the consumption model of households. Therefore, it is an indicator reflecting changes in average living costs rather than inflation according to previous definitions. It can be justified since that index in many cases serves as a tool for correcting various types of benefits, e.g. social ones, and in that case its connection with the living costs is very significant. One cannot resist the impressions, though, that certain changes of the composition of the basket do not have much in common with the changes in the consumption model.

Analysing the basket structure since 2004, a constant growth tendency of the share of expenses on restaurants and hotels can be noticed. In this case modifications may be of permanent nature. It is connected with the change of lifestyle, particularly in large cities. More and more money is spent on such services there and it can be argued that development direction will be retained in the following years. However, it is difficult in that context to speak of differences in the share of a different component, namely transport. It seems that the progressing changes are mainly a consequence of very significant changes in the crude oil prices. Many consumers failed to limit the consumption and therefore an increase of the share in the basket at the expense of other items occurred. Comparing the consumption model from 2006

[21] W. Eichhorn, op. cit.

and 2008, the growth equals to one percentage point. It is worth mentioning, though, that the change resulting from the increase in crude oil prices was taken into account in the basket structure with one-year delay, and therefore when the fuel prices were dynamically surging their share in the expense structure was lower than actually since it came from the previous year. As a consequence, the role of price increase in that segment was decreased in the general indicator. In 2008 a rapid crude oil price plunge occurred. In addition, petrol prices at petrol stations decreased significantly. That change, however, was not appropriately reflected in CPI. At that time the share of fuels in general consumption was too high.

There are no perfect solutions. Therefore, there is room for many structures. They may be encountered in statistical practice of various institutions. Taking into consideration definitions suggested in the literature and the presented theoretical concept of price level and price index, those should be considered with particular attention which make use of constant or rarely corrected systems of weights.

Literature

Adams E.W., *Elements of a Theory of Inexact Measurement,* "Philosophy of Science" 1965, Vol. 32, No. 8.

Bauc J., Belka M., Czyżewski A., Wojtyna A., *Inflacja w Polsce 1990-1995*, Wyd. Prywatnej Wyższej Szkoły Bussinesu i Administracji, Warszawa 1996.

Begg D., *Makroekonomia*, PWE, Warszawa 2000.

Eichhorn W., *Functional Equations in Economics*, Addison-Wesley Publishing Company. London--Amsterdam-Ontario-Sydney-Tokyo 1978.

Kamerschen D., McKenzie R., Nardinelli C., *Ekonomia*, Fundacja Gospodarcza NSZZ „Solidarność", Gdańsk 1991.

Kołodko G., *Polska w świecie inflacji*, Książka i Wiedza, Warszawa 1987.

Laspeyres E., *Die Berechnung einer mittleren Warenpreissteigerung*, "Jahrbücher für Nationalökonomie und Statistik" 1871, Nr 16.

Magiera J., *Ogólna teoria pomiaru*, [in:] *Elementy metrologii ekonomicznej*, ed. A. Smoluk, Wyd. Akademii Ekonomicznej, Wrocław 2000.

Neal F., Shone R., *Proces budowy modeli ekonomicznych*, PWN, Warszawa 1976.

Paasche H., *Über die Preisentwicklung der letzten Jahre, nach den Hamburger Borsennotierungen*. "Jahrbücher für Nationalökonomie und Statistik" 1874, Nr 23.

Pfanzagl J., *Theory of Measurement*, Physica-Verlag, Wurzburg-Wien 1971.

Pickering J.F., Harrison J.A., Cohen C.D., *Identification and Measurement of Consumer Confidence: Methodology and Some Preliminary Results*, "Journal of the Royal Statistical Society" 1973, Series A, Vol. 136, No. 1.

Roberts F.S., *Measurement Theory,* Addison-Wesley Publishing Company, London-Amsterdam-Ontario-Sydney-Tokyo 1979.

Samuelson P.A., Nordhaus W.D., *Economics*, McGraw-Hill Inc., New York 1992.

Schreider J.A., *Equality, Resemblance and Order*, Mir Publishers, Moscow 1975.

Słownik ekonomiczny, Znicz, Szczecin 1994.

Smoluk A., *Metoda homomorfizmów w teorii zbiorów uporządkowanych*, "Ekonomia Matematyczna" 1998, No. 2.
Woźniak P., *Inflacja bazowa*, CASE, Warszawa 2002.

UKŁADY WAG W ANALIZIE INFLACJI

Streszczenie: Analiza zmian wielu wielkości ekonomicznych dokonywana jest za pomocą indeksów. Niektóre z nich, np. indeksy giełdowe czy indeksy służące pomiarowi inflacji, mają złożoną budowę. Końcowa wartość zależy od dwóch wielkości: cen i ilości. Ilości w pewnym sensie stanowią układ wag dla wektora cen. Praca poświęcona jest problematyce zmian układu wag służących obliczaniu indeksu cen konsumpcyjnych.