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AN ALTERNATIVE METHODOLOGICAL APPROACH TO VALUE ANALYSIS OF REGIONS, MUNICIPAL CORPORATIONS AND CLUSTERS

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Abstract

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The paper deals with theoretical conception of value analysis of regions, municipal corporations and clusters. The subject of this paper is heterodox approach to sensitivity analysis of finite set of variables based on non-additive measure. For dynamic analysis of trajectory of general value are sufficient robust models based on maximum entropy principle. Findings concern explanation of proper fuzzy integral – Choquet integral. The fuzzy measure is represented by theory of capacities (Choquet, 1953) on powerset. In fine, the conception of the New integral for capacities (Lehler, 2005) is discussed. Value analysis and transmission constitutes remarkable aspect of performance evaluation of regions, municipal corporations and clusters. In the light of high ratio of soft variables, social behavior, intangible assets and human capital within those types of subjects the fuzzy integral introduce useful tool for modeling. The New integral afterwards concerns considerable characteristic of people behavior – risk averse articulated concave function and non-additive operator. Results comprehended tools enabling observation of synergy, redundancy and inhibition of value variables as consequence of non-additive measure. In fine, results induced issues for future research.

powerset, fuzzy integral, Choquet integral, New intergral for capacities, non-additive measure

A general theoretical approach to value analysis of particular crisp set of discrete value variables of open systems, f. i. regions, municipal corporations or clusters, stems from fundamental arithmetic nowadays. The reasons for grouping are implicitly anticipating but seldom realized by variables. The synergic effects result from interpenetration of particular elements of the system. The aim of the paper is theoretical explanation of non-additive measure based on theory of capacities. The object of this paper is to presents the results of the study in progress on math modeling of interdisciplinary relationship concerning intangibles and network effects of value variables within value analysis.

MATERIALS AND METHODS

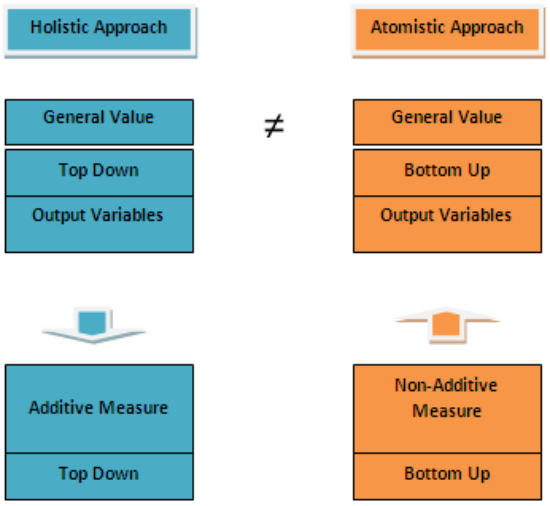
Entropy Theory of Value

…the laws of physics tell us that we cannot create something from nothing (Chen, 2005). Specific premise of value is assigned to thermoeconomics in general. Thermoeconomics is ranked to heterodox school economics based on laws of nature Energy Economics. An explanation of rudimental reasons conveys classical and statistical thermodynamics. The corner stone for rationale of this domain is the Second law of thermodynamics and entropy (Clausius, 1865). The paradigm's characteristics are immanent attributes of economics subject's behavior. Entropy principle enlarged Shannon into mathematical formulation of information entropy (Shannon, 1948; Weaver, Shannon, 1963). The analytic formula for entropy law of economics processes was introduced by Roegen in 1966. The entropy in economics was clarified in phenomenological meaning. (Roegen, 1986) Mathematical formulation of economic value as a function of scarcity articulated Applebaum. (Applebaum, 1996) Consequently, an Entropy Theory of Value derived Chen (Chen, 2005). The

value analysis of regions, municipal corporations and clusters extremely limits data availability. For dynamic analysis of trajectory of general value are sufficient robust models based on maximum entropy principle (Applebaum, 1996; Kovanic, Humber, 2009).

Methods

For value analysis are classified holistic and atomistic approach, see Fig. 1. On the first stage of survey a historical literature review was carried out. The atomistic approach was selected for capture of mutual effect within the internal system. On the second stage the theoretical analysis of properties of fuzzy integral and analytic solution was explored.



1: *Value Analysis Approaches*

On the third stage the Choquet and the New integral were compared. In fine, the consequences for value analysis and on-coming research were induced.

Research Question Formulation

Value analysis is the process determined by the ability of extraction of information from the pure data. (Applebaum, 1996; Kovanic, Humber, 2009) Variations in general value of specific system, economic subject particularly, can be measured by the changes in entropy in stated paradigm. Research question formulation appears from Zadeh's principle of incompatibility. *As the complexity of a system increase, human ability to make precise and relevant (meaningful) statements about its behavior diminishes until a threshold is reached beyond which the precision and the relevance become mutually exclusive characteristics. It is then that the fuzzy statements are the only bearers of meaning* (Zadeh, 1973). Research question: **Does fuzzy integral enables to measure mutual interaction of system's elements within the scope of value analysis with interception of general value changes?**

RESULTS AND DISCUSSION

Value discrepancies

Fig. 1 shows two fundamental approaches to value analysis – atomistic and holistic approach. The holistic approach is more obvious. The value of mutual interactions of elements of system is derived top down. The value is an integral part of the whole. The higher value than intrinsic can be assign to some elements. This property of holistic approach obviously results to over or undervaluation. Atomistic approach methodology is bottom up. The value of particular elements is assessed more properly by this procedure. In precise application the results of both approaches should be equal.

The relevance of particular values results to further value changes (Casta, Bry, 1998):

- Synergy – mutual interactions results to higher value of joint elements than the value elements per partes.
- Redundancy – mutual interactions results to recognition of otioseness in value creation.
- Inhibition – mutual interactions results to negation of values.

Standard analytical tools based on elementary arithmetic marginalize the property mentioned above. The motivation for the research was the draft and explanation of fuzzy integral in financial valuation (Casta, Bry, 1998; Casta, Lesage, 2001; Casta, Bry, 2003, Casta *et al.*, 2005). Our contribution is an extension the approach of Casta *et al.* from internal business environment to network economics. The particular agents represent the variables describing the elements of system (region, municipal corporation, and cluster). For numerical solutions has to be selected appropriate variables, f. i. UTRIN methodology (UTRIN, 2006).

Conventional approach to value analysis use additive computation, see [1] (Casta, Bry; 2003). The results of additive approach failure in the case of higher ratio of quantitative property of the elements of the system.

$$H(\{x_i\}_{i=1}^{I}) = \sum_{i=1}^{I} h(x_i), \qquad [1]$$

H ... General value of the whole
h .... Value of particular variable of the system
x_i.... Elements of the system.

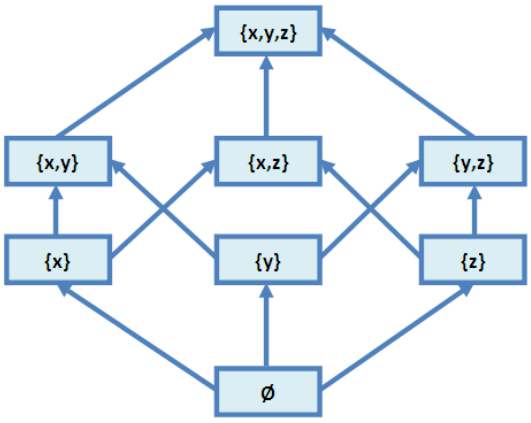
Casta, Bry (2003) emphasize the dependency of general value on the sequence of variables – commutative law infringement. Group order is the resource of addition changes of general output value [2].

$$H(\{x_i\}_{i=1}^{I}) > \sum_{i=1}^{I} h(x_i). \qquad [2]$$

Aggregate operators represent considerable factors which markedly influence results. Casta and Bry (Catsa, Bry; 2003) mention Average Operators, Weighted-Average Operators, Symmetrical Sums,

t – norms, t – conforms, Mean Operators, Ordered Weighted Averaging. The math property of the model stated Grabish (Grabish, 1995): continuity, the highest and the best increase, commutativity, asociativity and complementarity.

According to atomistic approach, see Fig. 1, the model requirements can be articulated by present literature review (Hand, Lev, 2004; Ohlson, 1995; Casta *et al.*, 1998, 2003, 2005; Cummis, Derrig, 1997; Kosko, 1993; Sugeno, 1977; Zadeh, 1965; Sabolovic, 2009; Damodaran, 2006). Standard additive operators do not enable phenomena of mutual value interaction in ordered set – synergy, redundancy and inhibition. For those phenomena realizing is the most appropriate tool fuzzy measure. Mathematical statement is fuzzy integral particularly Sugeno, Choquet and New integral. The property of allows non-additive measure. Graphical expression of mutual interaction shows Fig. 2 – Fuzzy Powerset. Mutual relations are expressed by membership function.



2: *Fuzzy powerset*

Fuzzy integral

The virtues of fuzzy integral are math formulation of non-additive measure. (Casta, Bry; 2003) Fuzzy integral integrates real function in relation to fuzzy measure (Grabisch *et al.*, 1995; Dennberg, 1994). For finite nonempty set *X* with *n* elements exists variable μ which is an element of *P(X)*. Fuzzy variable gain value in the interval (0;1) (Casta, Bry; 2003).

$$(1)\ \mu\{\} = 0 \qquad [3]$$

$$(2)\ \mu(\Phi) = 1 \qquad [4]$$

$$(3)\ \forall A \subseteq B,\ \mu(A) \leq \mu(B). \qquad [5]$$

The approach is based on non-additive axiom. With respect to model requirements two discrete sets swell property [6], [7] and [8].

$$(1)\ \mu(E \cup F) = \mu(E) + \mu(F) \qquad [6]$$

$$(2)\ \mu(E \cup F) \geq \mu(E) + \mu(F) \qquad [7]$$

$$(3)\ \mu(E \cup F) \leq \mu(E) + \mu(F). \qquad [8]$$

Equation [6] expresses possible additive attributes, equation [7] expresses over-additive synergy), equation [8] express redundancy. The powerset, see Fig. 2, with respect to all fuzzy subset exact 2^n coefficients (Casta, Bry; 2003).

Fuzzy system definition implies selection of proper integral with respect to measure (Sugeno, 1977; Choquet, 1953). Sugeno integral of measurable function [9] with respect to fuzzy variable μ can be defined by the conditional probability [10].

$$f: X \rightarrow [0;1] \qquad [9]$$

$$S_{(f)} = \max_{\alpha \in [0;1]}(\min(\alpha; \mu(\{x|f(x) > \alpha\}))). \qquad [10]$$

Sugeno integral concerns function maximum and minimum. In the point of view of the whole system (f. i. region, municipal corporation, cluster) the subset representing the particular entities of real economics the fuzzy integral has cover supremum and infimum. Sugeno integral seems to be unacceptable for modeling of mutual value relations (Casta, Bry; 2003). Casta and Bry (2003) encourage the Choquet integral. Choquet integral of measurable function with respect to fuzzy measure μ, see [11].

$$C_{(f)} = \int \mu(\{x|f(x) > y\})dy. \qquad [11]$$

Whether is defined finite set $X = \{x_1, x_2, \ldots x_n\}$ which take the function value $0 \leq f(x_1) \leq \ldots \leq f(x_n) \leq 1$, where $Ai = \{x_i, \ldots, x_n\}$ Choquet integral is expressed [12] (Casta, Bry; 2003).

$$C_{(f)} = \sum_{i=1}^{n} [f(x_i) - f(x_{i-1})]\mu(A_i). \qquad [12]$$

Whether *1 (A = B)* is an indicator function which take the function value *1* if *A = B*, differently *0*, is expressed [13], [14] (Casta, Bry; 2003).

$$C_{(f)} = \int \left(\sum_{A=P(X)} \mu(A) \times 1(A = \{x|f(x) > y\}) \right) dy. \qquad [13]$$

$$C_{(f)} = \sum_{A=P(X)} \mu(A) \times \int \left(\sum_{A=P(X)} \times 1(A = \{x|f(x) > y\}) \right) dy. \qquad [14]$$

Substitution the value of integral in equation [14] by function A(f) concludes to equation [15] (Casta, Bry; 2003).

$$C_{(f)} = \sum_{A \in P(X)}^{n} \mu(A) \times g_A(f). \qquad [15]$$

Fuzzy measure assessment according to Casta *et al.* (1998, 2001, 2003, 2005) imply the task concluded in several studies (f. i. Grabish *et al.*, 1995). Suppose *I* systems characterized by general value *v* and set

of X from J real variables x^j (value of particular elements of system). Let f_i assigns every variable x^j the general value of the system [16].

$$i: f_i: x^j \rightarrow x_i^j. \quad [16]$$

Fuzzy measure μ is determined to comply with equation [17].

$$\forall \mathrm{i}: C_{(fi)} = v_i. \quad [17]$$

Let A is subset and $g_a(f_i)$ is generator relative to A, defined by equation [18].

$$i \rightarrow g_A(f_i) = \int 1(A = \{x | f_i(x) > y\}) \times dy. \quad [18]$$

Derived model is expresses equation [19]. In equation u_i expresses residuum which can be modeled by standard approaches (random variable, least square method etc.).

$$\forall i \rightarrow v_i = \sum_{A \in P(X)} \mu(A) \times g_A(f_i) + u_i. \quad [19]$$

Equation [20] shows model with 2^j parameters and fuzzy measure $\mu(A)$ for all subset A of variable x_j. Dependent variable express the general value v and explanatory variables are generators corresponding to subset X. Required parameters can be estimated by standard multiple regression (Casta, Bry; 1998, 2003):

$$y_0 = 0, y_1 = dy, \ldots, y_n = n \times dy. \quad [20]$$

For every group A of accordant variables x_s are derived generators in equation [21].

$$g_A(f_i) = dy \times \sum_{h=0}^{n} 1(A = \{x | x_i > y_h\}). \quad [21]$$

For interpretation of results Casta and Bry (Casta, Bry; 1998, 2003) uses the principle [22].

$$\mu(A \cup B) \geq \mu(A) + \mu(B) \Leftrightarrow \textit{synergy btw A and B}$$
$$\mu(A \cup B) \leq \mu(A) + \mu(B) \Leftrightarrow \textit{inhibition btw A and B.} \quad [22]$$

The model proposed is linear with respect to generator but non-linear with respect to variables x_j. The model is sufficient for small number of variables x_j (Casta, Bry; 1998). But the results imply other question and its interpretation, f. i. [23] (Damodaran, 2006).

$$\mu(A \cup B) - (\mu(A) + \mu(B)). \quad [23]$$

For a large number of variables x_j Casta and Bry (Casta, Bry; 1998, 2003) recommend Principal Components Analysis.

New integral for capacities

For alternative theoretical concept of fuzzy integral Lehrer (Lehrer, 2005) proposed so called the New integral with respect to capacities which differentiate from the Choquet integral. The newness of the integral consists in concavity. The integral of the sum of two functions is less than or equal to the sum of particular integrals. The concavity of the function expresses an aversion to uncertainty.

In addition, Lehrer (Lehrer, 2005) postulated three axioms:

1. Whether the capacity is additive then the integral coincides with the regular one.
2. The axiom of monotonicity with respect to capacities.
3. The integral of function X does not depend on the values that the capacity takes on the subset where X disappears.

Lehrer (Lehrer, 2005) defined capacity as a function v which assigns non-negative real number to every subset of finite set N under the conditions $v\{\} = 0$, v is defined over $N = n$, v is a capacity defined over it. P is additive if for any two disjoit subset hold generally equation [24].

$$S, T \subseteq N, P(S) + P(T) = P(S \cup T). \quad [24]$$

The concavification cav of v is defined as the minimum of all concave and homogenous function $f: \Re_+^n \rightarrow \Re$ such that $f(I_R) \geq \rightarrow v(\Re)$ for every $\Re \subseteq N$ and every $X \in \Re_+^n$, see function [25] (Lehrer, 2005).

$$cav\, v = (X) = \int^{cav} X dv. \quad [25]$$

Lehler (Lehrer, 2005) explain the minimum of a concave and homogenous function over $\Re_+^n$ as a function of X. Suppose v and w are two capacities then $v \geq w$ if $(S) \geq w(S)$ for every $S \subseteq N$. For every $X \in \Re_+^n$ the New integral is expressed [26], [27].

$$\int^{cav} X dv = \max \left\{ \sum_{R \subseteq N} \alpha_R v(R);\ \sum_{R \subseteq N} \alpha_R I_R = X, \alpha_R \geq 0 \right\} \quad [26]$$

$$\int^{cav} X dv = \min_{P\, is \ldots\ additive\ and\ P \geq v} \int^{cav} X dP. \quad [27]$$

The proof propounded Azrieli and Lehler (2005). The property of the New integral, comparison with Choquet integral and extension of Lebesgue integral to fuzzy capacity application derived Lehrer (Lehrer, 2005).

Input variables

Property of fuzzy integral is suitable for value analysis namely regions, municipal corporations and clusters. By virtue of data scarcity is used decomposition of synthetic index for analytical purposes. Selection of arbitrary variables is extremely subjective and depends on purpose of analysis. For regions Kutscherauer (Kutscherauer, 2010) proposes 14 integrated indicators: standards of living, health state, social facilities, housing, social pathology, economic potential, economic structure, unemployment, development potential, settlement, environment, transport infrastructure, technical infrastructure, quality of life. Živělová, Jánský (Živělová, Jánský, 2007) draft as fundamental

variables: economic structure, GDP per capita, gross value added, gross fixed capital, and employment. For municipal corporations are used economic quality classes. Halášek *et al.* (Halášek *et al.*, 2005) covers property class (property structure, profitability of property), finance class(incomes, expenditures, debt service) and development class (municipality performance indicators). Marešová (Marešová, 2010) proposes as the fundamental variables for cluster analysis: business performance of economic subjects, efficiency indexes of activities located in cluster, cluster performance indicators, effectiveness of management indicators, cluster policy indicators.

CONCLUSIONS

Value analysis using conventional tools do not enable realize effect in value caused mutual interactions of particular variables. Pursuant to findings of literature review pertinent approach concern powerset. Extensions of powerset within fuzzy logic possess accordant framework. The main three patterns can be described stem from the mutual interactions – synergy, redundancy and inhibition. For analysis were deigned fuzzy integrals with property proper for non-additive measure. The value analysis of regions, municipal corporations and clusters extremely limits data availability. For dynamic analysis of trajectory of general value are sufficient robust models based on maximum entropy principle. Primer model was based on Choquet integral. The extension for more accurately articulation was formulated using Lebesque integral. For comparison with up to date mathematical research were referred the New integral. With regard to results of theoretical analysis the statement of the research question was formulated. The stated research question was: Does fuzzy integral enables to measure mutual interaction of system's elements within the scope of value analysis with interception of general value changes? Findings of observation imply positive statement of model propriety. Value analysis and transmission constitutes remarkable aspect of performance evaluation of regions, municipal corporations and clusters. In the light of high ratio of soft variables, social behavior, intangible assets and human capital within those types of subjects the fuzzy integral introduce useful tool for modeling. The new integral afterwards concerns considerable characteristic of people behavior – risk averse articulated concave function and non-additive operator. In fine, results induced issues for future research. The domain of the ongoing research will be empirical verification of models. The population covers region NUTS – 0 Czech Republic. Preliminary research ended in confirmative approach in research hypothesis statement. Findings of preliminary research indicates growing ratio of intangibles in value analysis.

SUMMARY

The aim of the paper is theoretical explanation of non-additive measure based on theory of capacities. The subject of this paper is heterodox approach to sensitivity analysis of finite set of variables based on non additive measure. The paper deals with theoretical conception of value analysis of regions, municipal corporations and clusters. The fuzzy measure is represented by theory of capacities (Choquet, 1953) on powerset. On the first stage of survey a literature review was carried out. The atomistic approach was selected for capture of mutual effect within the internal system. On the second stage the theoretical analysis of properties of fuzzy integral and analytic solution was explored. The value analysis of regions, municipal corporations and clusters extremely limits data availability. For dynamic analysis of trajectory of general value are sufficient robust models based on maximum entropy principle. Findings concern explanation of proper fuzzy integral – Choquet integral. In fine, the conception of the New integral for capacities (Lehler, 2005) is discussed. Results comprehended tools enabling observation of synergy, redundancy and inhibition of value variables as consequence of non-additive measure. In fine, results induced issues for future research.

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