

POSSIBILITIES OF MODELING COMPETITIVENESS INDICES RELEVANCY*Cristina Coculescu¹***ABSTRACT**

Measurement of competitiveness is – even in a well-defined conceptual frame – more a compromise between available data and the big number of different criteria and objectives. Additionally, in the building of competitiveness indices, many technical problems occur that have not always a unique not ambiguous solution, even theoretically. For measurement information relevancy of competitiveness indices, in this work we purpose an original econometric model relied on subtle sets. After a short qualitative and quantitative study of information relevancy, it was showed that there is a synergy of information relevancy of economic concepts and, therefore, this is applied also over the concept of competitiveness. Basic idea of purposed model was that the variables (determinants) of competitiveness indices could be the pieces of a subtle set. The program realized for implementation of purposed model accompanied by a database having necessary variables for competitiveness indices, showed that information relevancy is useful in management decisions and can be a real working instrument.

Keywords: competitiveness, information relevancy, synergy, economic concepts.

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1. GENERAL CONSIDERATIONS ABOUT QUALITATIVE AND QUANTITATIVE STUDY OF INFORMATION RELEVANCY

In a watching system implemented in an enterprise, there are used a lot of specific economic concepts, as example: efficiency, profit, demand, quality, made production, production capacity, putting out of operation, indices of accomplishment of contract items of range j , insurance level of i - range resource etc. These concepts are information sources that sustain management decision and which represent elements of the subtle set we define in this context.

A set of elements having certain property (feature) estimable from several criteria, conditions, tests etc. represents one of simplified definitions given to the concept of subtle set. According to the sense of this definition, there is also information relevancy [3]. The property (characteristic) followed here is information relevancy (IR) which establishes decision quality and gives the name of subtle set.

Information relevancy can be considered from several quantitative and qualitative criteria marked $f_1, f_2, \dots, f_m$, whose it associates them significations marked g_{0j}, g''_{0j} etc.[4].

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In consequence, to the criterion f_1 there is associated signification g_{0j} , which represents relevancy degree of order $I(g_{0j})$ of an economic concept of range j , that is computed by relation (1):

$$g_{0j} = \frac{\sum_{t=1}^{n_j} \rho_{tj} + \sum_{z=1}^{m_j} \rho_{jz}}{n_j + m_j} \quad (1)$$

where:

- ρ_{tj} - index of correlation between concept of range t and concept of range j ;
- ρ_{jz} - index of correlation between concept of range j and concept of range z ;
- n_j - number of economic concepts which influence concept j ;
- m_j - number of economic concepts that concept j influence them.

To criterion f_2 , there is associated signification g_{0j}'' , which represents relevancy degree of I order (g_{0j}'') of an economic concept having range j , which is computed by the means of relation (2):

$$g_{0j}'' = \frac{\sum_{(t,s) \in D_j} R_{j/ts} + \sum_{(j,u) \in E_j} R_{z/ju} + \sum_{(v,j) \in F_j} R_{w/vj}}{\text{card}D_j + \text{card}E_j + \text{card}F_j} \quad (2)$$

where:

- $R_{j/ts}$ - whole correlation concept that measures the dependence between concept j and the combination of two concepts t and s , which influences it;
- $R_{z/ju}$ - whole correlation concept between a variable z , that is influenced by the combination of concepts between v and j ;
- $R_{w/vj}$ - whole correlation concept between a size w that is influenced by the combination of concepts between v and j ;
- D_j - set of pairs of concepts (t, s) that influence concept j ;
- E_j - set of pairs of concepts that hold concept j , mixed with other concept u and that influence z ;
- F_j - set of pairs of concepts (v, j) that influence concept w ;
- $\text{card}D_j, \text{card}E_j, \text{card}F_j$ - the cardinal (number of elements) of the sets D_j, E_j, F_j ;

Likely, we define the criteria:

- f_3 - speed propagation of considered economic concept from the source wherefrom it has been taken or observed till the place where the decision is taken;
- f_4 - implications of considered concept over decision process which can operate depending on different hypothesis;
 - f_{41} - blocking decision considering lack of information hypothesis;
 - f_{42} - decision errors quantifiable by value, through evaluation, when hypothesis of using wrong information is on;
 - f_{43} - chaos generation, supposing that we have a surprisingly fast propagation which has as effect a chain of wrong decisions, especially at manipulation by a rumor directed by false ("occult") forces;
- f_5 - degree of information incompatibility with existing database and knowledge base etc. , using relation:

$$g_c = \frac{mas(Iinc)}{mas(It)} \quad (3)$$

where:

- $Iinc$ - set of incompatible information;
- It - the set of all information;
- mas - size of a set

For every concept j there are established the consequences a_{ij} in rapport to criterion f_i . Some cases like: f_1 , f_2 and f_5 , these consequences are evaluated within the interval (0,1) and thus, they can be considered degrees of appurtenance of some fuzzy sets [4].

In other situations like: f_3 , f_4 , estimation of consequences is made using several measure units like: number of posts run per time, value units etc. In this case, appurtenance degree μ_{ij} is established in rapport to the consequences a_{ij} by the means of one of the relations:

$$\mu_{ij} = \frac{a_{i \max} - a_{ij}}{a_{i \max} - a_{i \min}} \quad (4)$$

when criterion f_i must be maximized and

$$\mu_{ij} = \frac{a_{ij} - a_{i \min}}{a_{i \max} - a_{i \min}} \quad (5)$$

when criterion f_i must be minimized.

So, a subtle set IR called *information relevancy* is gained, whose shape is the following:

$$IR = \left\{ \begin{array}{cccccc} 1 & 2 & \dots & j & \dots & n \\ \mu_{11} & \mu_{12} & \dots & \mu_{1j} & \dots & \mu_{1n} \\ \mu_{21} & \mu_{22} & \dots & \mu_{2j} & \dots & \mu_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \mu_{m1} & \mu_{m2} & \dots & \mu_{mj} & \dots & \mu_{mn} \end{array} \right\} \quad (6)$$

when m is the number of considered criteria.

In manager's dashboard it must consider priorities to economic concepts used in decision taking. For sorting the elements of this set, there is necessary to make operation of their aggregation. After running aggregation, it results the synergy of the relevancy of economic concepts or information that allows the foundation of these priorities [5].

2. SYNERGY OF INFORMATION RELEVANCY OF ECONOMIC CONCEPTS

For each economic concept j we can use appurtenance degrees to criterion i , μ_{ij} for quantize global relevancy synergy GR_j of concept or information j .

Before running aggregation operation, there is necessary to cancel the redundancy of some concepts or information. If between concept k and concept j there is a potential dependence, evaluated by correlation index ρ_{jk} , then in the case of an aggregation operation of type Cobb-Douglas, the exponents are multiplied by $(1 - \rho_{jk})$. In this case, the exponents of the concept k remain unchanged [5].

In these hypotheses, global relevancy of the concept is:

$$GR_j = \sqrt[m]{\left(\mu_{1j}^{\alpha_{1j}} \cdot \mu_{2j}^{\alpha_{2j}} \cdot \dots \cdot \mu_{ij}^{\alpha_{ij}} \cdot \dots \cdot \mu_{nj}^{\alpha_{nj}} \right)^{1 - \rho_{jk}}} \quad (7)$$

where α_{ij} are the exponents established by statistical correlation.

If we have inequality:

$$(\alpha_{1j} + \alpha_{2j} + \dots + \alpha_{ij} + \dots + \alpha_{mj}) \frac{1 - \rho_{jk}}{m} > 1 \quad (8)$$

then manager's used concepts in watching system have a positive synergy of information relevancy. This shows mutual filling out of used economic concepts and adopted decisions are therefore efficient.

If restriction (8) isn't satisfied, then manager's watching system has negative (or at most balanced) synergy and this reflects either a big degree of information redundancy or of a big incompatibility degree of those, case when decision is heavy to be taken and has doubtful results [7].

As like, we can compute the synergy of the relevancy of criteria $f_1, f_2, \dots, f_m$ associated to subtle set R_I . For this, we define a new subtle set φ_I , whose elements are the criteria $f_1, f_2, \dots, f_m$. The criteria used for this subtle set remain those of the set R_I , so there are $f_1, f_2, \dots, f_m$ [5].

We compute appurtenance degrees X_{ij} and we get:

$$\varphi_I = \left\{ \begin{matrix} f_1 & f_2 & \dots & f_j & \dots & f_m \\ x_{11} & x_{12} & \dots & x_{1j} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2j} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ x_{j1} & x_{j2} & \dots & x_{jj} & \dots & x_{jm} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mj} & \dots & x_{mm} \end{matrix} \right\} \quad (9)$$

If we mark r_{jk} correlation index between criteria f_j and f_k , we get global relevancy of criterion j :

$$RGC_j = \sqrt[m]{\varphi_{1j}^{\beta_{1j}} \cdot \varphi_{2j}^{\beta_{2j}} \cdot \dots \cdot \varphi_{ij}^{\beta_{ij}} \cdot \dots \cdot \varphi_{mj}^{\beta_{mj}}} \quad (10)$$

where β_{ij} are exponents established by statistical methods.

If inequality:

$$(\beta_{1j} + \beta_{2j} + \dots + \beta_{ij} + \dots + \beta_{mj}) \frac{1 - r_{jk}}{m} > 1 \quad (11)$$

is satisfied for every j , then criteria f_j used by manager have a positive synergy of relevancy $RGC_j (j = \overline{1, m})$.

If there are criteria wherefore restriction (11) is off, than there is necessary that management to re-analyze criteria of testing relevancy of the system of used economic concepts.

3. PROPOSAL OF MODELING INFORMATION RELEVANCY OF COMPETITIVENESS INDICES

Measurement of competitiveness is – even in a well-defined conceptual frame – more a compromise between available data and the big number of different criteria and objectives. Additionally, in the building of competitiveness indices many technical problems occur that have not always a unique not ambiguous solution, even theoretically.

A first problem is about competitiveness “definition”. The choice of variables and of their weights is based on several approaches of competitiveness concept. Indices of competitiveness use several definitions also for factors that modify competitiveness. Hence, competitiveness indices are different in feature, chosen variables and used data sources (Reut-Institute, p4).

Because complexity of concept, competitiveness measurement is well to be done using a synthetic composed index built of particular determinants.

Main stages in building a compound index of measuring competitiveness are (Bruneckiene, 2008):

- founding competitiveness factors (building the ”diamond of competitiveness”);
- analysis of rapport between factors and building of model (theoretical frame);
- gathering factors in indices of competitiveness;
- normalizing values of indices and establishing their weight;
- computing global index of competitiveness (methodology of index building);
- analysis (testing) sturdiness and sensitivity of built model.

From the analysis of several sets of indices used for establishing an aggregate index of competitiveness computed at country, regional or world level, it sees that those can be parts of a subtle set.

To each line of matrix described in relation (6) we can associate a certain set of operators. Through statistical-mathematical methods we can establish the weights of indices that make that set and so there is accomplished the property that the sum of elements on every line of matrix to be equal to 1. In fact, it will be built an extended shape of information relevancy matrix. Because the sets haven’t the same number of elements, we’ll extend every line of the matrix, filling out with imaginary elements, to whose we establish to set zero weight. Thus we’ll get a matrix having the number of lines equal to the number of indices groups

needed for establishing a certain aggregate index and the number of columns defined by the most numerous group.

For making easy the study, we purpose a kind of numerical simulation of a matrix having the property that the sum of elements of every line is equal to 1, its elements being real positive numbers, therefore between 0 and 1. For this, we'll use function *rnd*, random numbers generator.

Let be r a big natural number ($r > 10000$) and we consider matrix A having n lines and m columns. For every line of matrix, there are computed the numbers $x_1, x_2, \dots, x_m$ defined as:

$$x_i = rnd(r) \text{ for } i = \overline{1, m}. \quad (12)$$

$$\text{Let be: } S = \sum_{i=1}^m x_i \quad \text{and} \quad y_i = \frac{x_i}{S}, \quad i = \overline{1, m}. \quad (13)$$

$$\text{There is clear that: } \sum_{i=1}^m y_i = 1.$$

In the followings, we'll show a C program for making such a matrix having the function *rnd* made to return a 32-bit unsigned integer.

```
#include <stdio.h>
#include <windows.h>

DWORD aaaa,bbbb,cccc,xxxx;
unsigned long int rnd(unsigned long int);
int m,n;
float mat[100][100];
FILE* rezultat;

void main()
{
    int i,j;
    float s;
    printf("Input parameters of random numbers generator:\n");
    printf("a=");scanf("%d",&aaaa);
    printf("b=");scanf("%d",&bbbb);
    printf("c=");scanf("%d",&cccc);
    printf("x=");scanf("%d",&xxxx);
    printf("nr. linii= ");
    scanf("%d",&n);
    printf("nr. linii= ");
    scanf("%d",&m);
    srand(cccc);
    aaaa=4*aaaa+1;bbbb=2*bbbb+1;
    rezultat=fopen("rezultat.dat" ,"w+");

    for(i=0;i<n;i++) {
```

```
for(j=0;j<m;j++) {
    mat[i][j]=1+rnd(99999); }

for(i=0;i<n;i++) {
    s=0;
    for(j=0;j<m;j++) {
        s=s+mat[i][j]; }
    for(j=0;j<m;j++) {
        mat[i][j]=mat[i][j]/s; }
    }

fprintf(rezultat,"S-a generat matricea :\n");
for(i=0;i<n;i++) {
    for(j=0;j<m;j++) {
        fprintf(rezultat,"%7.5f ",mat[i][j]); }
    fprintf(rezultat,"\n");
}
fclose(rezultat);
}

unsigned long int rnd(unsigned long int val)
{
    DWORD v;
    unsigned long int t;
    _asm {
        moveax,aaaa
        movebx,xxxx
        mulebx
        addeax,bbbb
        movxxxx,eax
        movv,eax
    }
    v=v+rand();
    t=v-(v/val)*val;
    return t;
}
```

4. CONCLUSIONS

Competitiveness is, last years, a new paradigm of economic development. Competitiveness indices allow watching country evolution at world level, founding market challenges, integration of competitiveness in world context, founding soft and hard points of each country in competitiveness domain, evaluation of the success of past adopted politics, (trough the analysis of the evolution in rapport to prior whiles or to other countries).

The existence of several indices for the same kind of competitiveness is not a negative aspect but contrarily. Every index shows certain aspects ("faces") of competitiveness and in the whole, it gets a more complete and useful information for taking strategic decisions. Because complexity of concept, competitiveness measurement is well to be done using a synthetic composed index built of particular determinants. This appears to be already a consensus in academic world because it is the most efficient kind to integrate a big amount of information in an easy-to-understand format. However there are opponents of this idea,

the researches forecast an extension if using composed indices (compositions) in the measurement of every multidimensional phenomena.

The problems which troubles correctness and relevancy of competitiveness measuring through composed indices aim:

- technique of selection the factors which establish competitiveness,
- techniques of establishing weights of factors and indices;
- data normalizing models;
- techniques of grouping factors in (sub)indices;
- intensity of correlation between factors;
- data taking methods.

And however, using of competitiveness indices must be made in a relevant country context (to consider the objectives of every country, its particular aspects etc.). Not all the elements which give “individuality” of a country are considered within competitiveness indices (culture, demography for example) though there is an increased attention for including such factors.

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