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Methodology of integral evaluation of enterprise financial potential in the information society

INTRODUCTION

Ukrainian enterprises are presently engaged in resolving problems of their activity and financial development as well as of searching for optimal forms of capital and current expense provision. These issues are of primary importance. They determine the necessity for a quantitative evaluation of an enterprise real financial ability. It is possible to solve the given task by means of such special instrument for evaluating an enterprise economic growth opportunities such as financial potential. This category of financial management provides methodological approach for the development of different ways of enterprise evaluation abilities, which may be helpful determining an enterprise current conditions, degrees of provision of financial resources and in creating efficient strategy of enterprise development. The strategy aims at the possibility of flexible adaptation to changeable market environment, increasing the degree of self-sufficiency and economic stability, achieving competitive positions etc.

THE RULE OF COMPOSITE INDEXES

The complicated nature of the financial potential category becomes apparent in multidimensional description of its components i.e. the necessity to take cognisance of and analyse large numbers of diverse indexes. In many cases, it is impossible to precisely determine its causes and effects and choose the appropriate index from the aggregate. In such cases indexes ought to be correlated to form a system. The study of this system by means of one-dimensional statistical method does not offer the possibility of considering all diversities and complica-

tions in the correlation of indexes. This often leads to simplified and, very often, false conclusions.

It is possible to solve the above mentioned problem by means of data aggregation which aims at creating a compact and visible database, that is suitable for further research, making decisions and drawing conclusions. A wider approach to the aggregation of empiric data is their transformation from primary indexes into small amount of some generalized characteristics which are functionally connected with the primary ones and also possess similar optimal characteristics. This composite method of evaluation is efficient so long as it helps to take into consideration the influence of different factors on economic processes, thus eliminating the ambiguity of factors influencing evaluation and to obtain more precise results [p. 137][1]. It enlarges and expands possibilities of traditional analysis if it is based on the application of existing evaluation methods and index systems and makes it possible to compare indexes of different dimensions and indications.

Aggregation of output quantity is, in practice, often determined in terms of complete scalar reduction, that result in the construction of indivisible, the so called generalized or composite index. The popularity of this direction is determined by the wide range of tasks, which may be solved by means of the above mentioned method. The list of tasks to be resolved is given below:
▪ ranging of objects;
▪ comparing objects;
▪ structural determination of the objects;
▪ classification of objects for the level of the researched quality;
▪ determination of the general quality level;
▪ classification of new objects for the determined structure;
▪ determination of congruence level of the researched objects to some imaginary 'ideal' and searching the ways of improvement of the situation etc.

Some conventional numerical measure of latent quality of the researched phenomenon for the composite index will be undertaken. The aim of an composite index construction is to provide a compact description of some qualities of the researched phenomenon while preserving the main structural characteristics of the researched objects.

THE CONSTRUCTION COMPOSITE INDEXES

Implementing the idea of composite index construction is connected with three basic components which make up its fundamental base:

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[1] М.І. Баканов, Теория экономического анализа / М.І. Баканов, А.Д. Шеремет. – М.: Финансы и статистика. – 2000. – С. 201-205.

▪ determination of its concept;
▪ formation of information base;
▪ finding the algorithm of its calculation.

The concept of the composite index is a system of abstract ideas of targets, tasks, principles, requirements and approaches for the construction and inter-prettation of obtained results. The main hypothesis, underpinning the concept, is its usefulness in describing the researched phenomenon and in obtaining the same conclusions which can be obtained from the whole aggregate of indicators received. Theoretical basis of algorithms for the construction of composite indexes is quality control, theory of utility functions, theory of economic indexes, and theory of social indicators. The process of constructing an composite index is based on the following principles[2]:

– linearization. It allows for transformations from partly systematized advantage of a set of vectors of the separate objects indexes to linearly systematized set of the summarized evaluation of these objects;

– arithmetization. It allows for the attainment of numerical evaluation for benchmarks, presented in non-numerical form, that makes it possible to calcu-late all indexes irrelevant of method of their measurement;

– randomization. It allows for the simulation of information deficit, which is present at all levels of summary evaluation synthesis of complicated multi-parameter objects.

It is possible to distinguish the following approaches to the composite index construction depending on the forms of benchmarks representation adopted among the general ones[3]:

▪ criterial approach. If the benchmarks have evaluation character, i.e. they are the criteria, and aggregates of objects are the alternatives which are to be cho-sen then the best decision regarding these alternatives, is for the alternatives to be accepted according to some criteria but are not acceptable based on others;

▪ discrimination approach. If the benchmarks are represented in the form of 'ob-ject-quality', and some structure, which determines relation between objects, dividing them into classes which do not intersect is given;

▪ conclusive approach. If the matrix of simmetrical binominal ratios plays the role of the benchmarks;

▪ expert and statistic approach. If the data represent the results of expert evalua-tion of the researched qualities.

Calculation of the composite index algorithm

Determination of the composite index algorithm calculation is a logical con-tinuation of an operational process which actually is the final stage of its con-

[2] Н.В. Хованов, *Анализ и синтез показателей при информационном дефиците* / Н.В. Хованов. – СПб. : Изд-во С.-Петербуржского ун-та, 1996. – 196 с. – ISBN 5-288-01533-3.

[3] П.О Авен, *Функциональное шкалирование* / П.О. Авен, И.Б. Мучник, А.А. Ослон ; [отв. ред. д. ф.-м. н. Б. А. Березовский]. – М. : Наука, 1988. – 177 с. – ISBN 5-02-006597-8.

struction. The algorithm of the composite index construction which is based on the above mentioned methodological principles, will have the following form[4].

1. Formation of the aggregate of the starting characteristics for the researched phenomenon.

$$X = \{X_1, X_2, ..., X_n\}.$$

2. Vector of the separate indexes formation $q = \{q_1(X), q_2(X), ..., q_s(X)\}$. The indexes represent functions from the aggregate of the benchmarks and are assigned to evaluate separate aspects of the researched objects with application of different criteria.

3. Selection of the synthesizing function form $Q = Q(w_1, w_2, ..., w_s, q_1, q_2, ..., q_s)$ which puts in correspondence to the vector q the value of the aggregated index Q, which characterises an object in general, taking into consideration a vector of some positive parameters $w = \{w_1, w_2, ..., w_s\}$ which reflect the value of separate constituents of the vector q.

4. Selection of the vector value w of numerical coefficients, the value of which satisfies the following terms: $w_1 + w_2 + ... + w_s = 1$.

In most cases, construction of the composite index is based on principle of presenting all the values as stimulating agents. In this case, a positive correlational connection with the researched quality is preserved. Moreover, as it was above mentioned, the values of the composite index should not depend on the units of measurement of the characteristics. In order to meet these requirements we should make unification of scales, which were primarily used to measure the starting charecteristics. This is the process of scale transformation (transfer of reading and changing of the scale). As a result, the range of possible measurement values is limited by the segment [0; N], where the number N determines a new scale amplitude and is chosen by the researcher's meaningful considerations.

In this case, a zero value of the transformed index must correspond to the lowest quality of the given characteristic, and value equal to N must correspond to the highest value. As a rule, an composite index is constructed in such a way, that its meaning is within 0 to 1. It improves meaningful interpretation of its value and makes it possible to compare different objects. In case of scale unification, N value is also equal to 1. This case will be described further on.

The process of the index unification may be conducted according to the following rules[5]. If an indicator is a stimulator, the transformation will be carried out according to the rule:

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[4] Н.В. Хованов, *Анализ и синтез показателей при информационном дефиците* / Н.В. Хованов. – СПб. : Изд-во С.-Петербуржского ун-та, 1996. – 196 с. – ISBN 5-288-01533-3.

[5] П.М. Григорук, *Методи побудови інтегрального показника* / П.М. Григорук, І.С. Ткаченко // Бізнес-Інформ. – 2012. – №4 (411). – С. 34–38.

$$\tilde{x}_{ij} = \frac{x_{ij} - x_{j\min}}{x_{j\max} - x_{j\min}} \tag{1}$$

where:

$x_{j\min} = \min_{i} x_{ij}$ – is the lowest value of the index within the researched time,

$x_{j\max} = \max_{i} x_{ij}$ – is its highest value.

If an indicator is a destimulator, the transformation will be carried out according to the rule:

$$\tilde{x}_{ij} = \frac{x_{j\max} - x_{ij}}{x_{j\max} - x_{j\min}} \tag{2}$$

It should be pointed out that some indexes may take place of destimulators in case the quality improvement corresponds to the indexes decrease under the conditions of their positive values. Zero or negative value define the quality deterioration. Relevant transformations take the following form:

$$\begin{cases} x_{j\min} = \begin{cases} \min_{x_{ij} \geq 0} x_{ij}, & \text{if there are positive values among } x, \\ 0, & \text{if all the values are negative,} \end{cases} \\ x_{j\max} = \max_{i} |x_{ij} - x_{j\min}|, \\ \tilde{x}_{ij} = \left(1 - \frac{|x_{ij} - x_{j\min}|}{x_{j\max}}\right), \end{cases} \tag{3}$$

Whenever an indicator takes the place of a nominator, the transformation takes the following form:

$$\tilde{x}_{ij} = \left(1 - \frac{|x_{ij} - x_{jnom}|}{\max\{(x_{j\max} - x_{jnom}), (x_{jnom} - x_{j\min})\}}\right) \tag{4}$$

where:

x_{jnorm} – is a boundary (nominative) value of an indicator which has the highest quality.

Some remarks should be made regarding the given formulas. First, in the above mentioned transformations the highest and the lowest qualities are calculated on a random sample.

The important issue is the determination of x_{jnom} boundary value when the indexes are nominators. It may be selected by means of additional calculations depending on the quality of the researched phenomenon evaluation according to the indexes or may be appointed as normative. If this information is absent, this value may be determined according to the following form:

$$x_{jnom} = \frac{x_{j\min}^{(1)} + x_{j\max}^{(1)}}{2}, \tag{5}$$

where:

$x^{(1)}_{j\min}$ – is the lowest value of the index, which is the starting point of quality decrease observation;

$x^{(1)}_{j\max}$ – is the highest value of the index, which shows the quality improvement.

It should be mentioned that transfer to the unified scale in terms of the above presented algorithm, may be observed as q_j function selection:

$$\widetilde{X}_j = q_j(X_j) \tag{6}$$

The given formulas (1–5) may have another form. It depends on the specific behavior of the index. For example, if the indexes reflect relevant characteristics of dynamic variations of some other indexes or structural characteristics, the form of the q_j function will be different, although the final result will be the scale unification.

Formation of the synthetized function is applied by means of linear additive or multiplicative convolution:

$$Q_A = \sum_{j=1}^{n} w_j \widetilde{X}_j \tag{7}$$

$$Q_M = \prod_{j=1}^{n} \widetilde{X}_j^{\,w_j} \tag{8}$$

It should be stated that in this case, the value of the composite index will have variation of value range [0; 1].

Additive convolution is spread and used when we have reasons to consider that every linea and additive constituent influences the researched quality of the objects.

There are practically no limitations on the quantity of the constituents dependence. Multiplicative convolution is used when basic indexes characterize relevant quantity.

Usually no more than seven constituents may be chosen. Moreover, the lowest value of the unified scale for indexes evaluation which equals to zero is not practically used.

It should also be mentioned that the convolution of this type is too sensitive to low values of basic indexes: close to zero value of one of them can actually annihilate influence of other indexes. It may deteriorate the differential ability of the composite index.

If some standard object which possesses the best values (received from the selection) of all indexes (in terms of the unified scale equal to one) is used, then the form of the additive convolution can be transformed into the following form:

$$Q_\Sigma = \left(\sum_{j=1}^{n} w_j \left| \widetilde{x}_{ij} - 1 \right|^p \right)^{1/p} \qquad (9)$$

where:

p – is an index of degree.

Formula (9) is considered a direction of Minkovsky, so the relevant method of calculation got its name as method of directions. Growth of the p value causes higher weight of maximum deviation from the standard in general. Decline of the p value, on the contrary, causes lower weight of deviation.

THE APPLICATION
OF THE COMPOSITE INDEX

When we apply this method, we take weighting coefficients equal to 1/n. It makes the calculations easier.
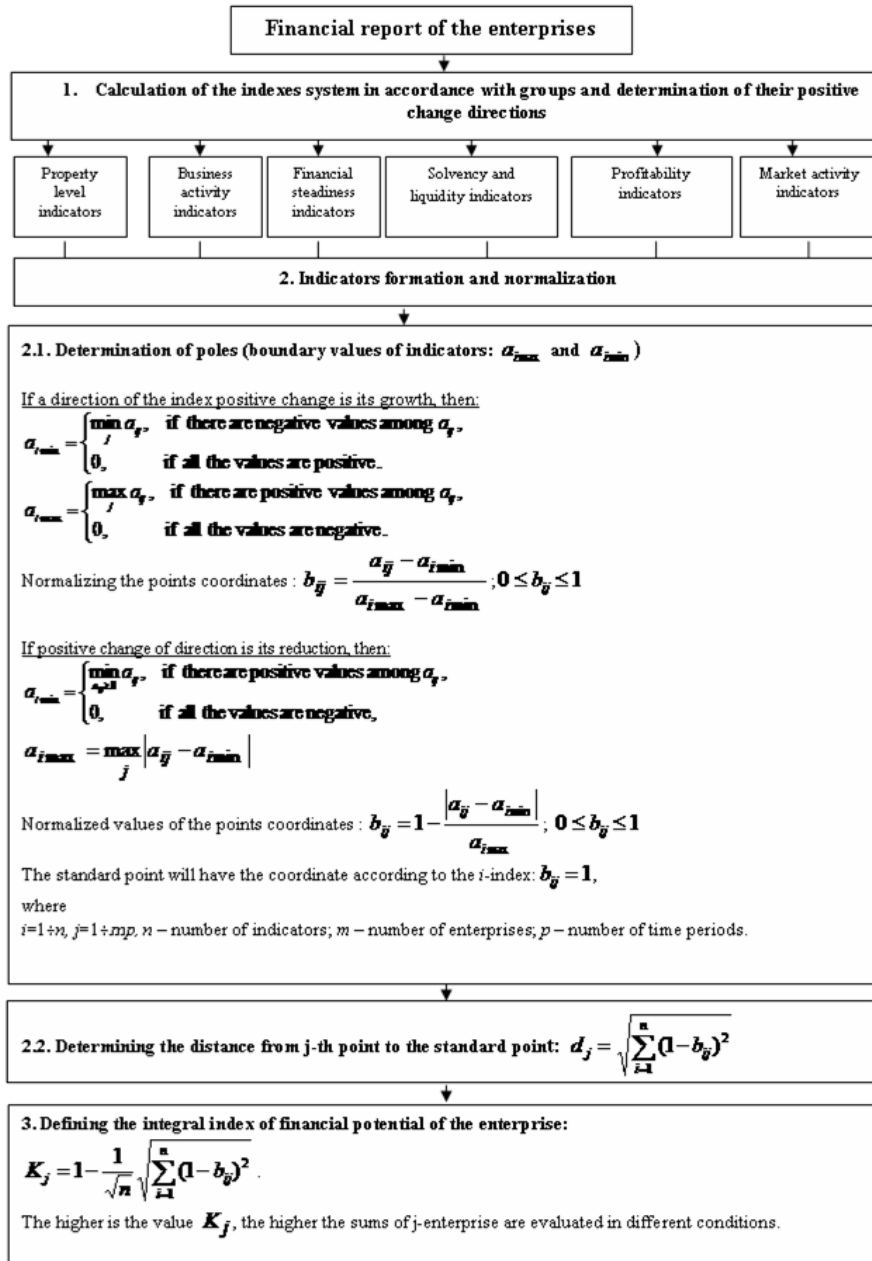
The creation of the composite index of the enterprise financial potential level will be implemented by means of method of directions[6]. If during the process of formation of indexes for a standard enterprise maximal, average or minimal values of every index among their values at the researched enterprises are selected, then the directions and peculiarities of action of some indexes should not be taken into consideration. According to the results of the calculated indexes, which constitute the system of indexes of enterprise financial potential evaluation, in dynamics, some indexes may change the direction of action (negative value of the index; the index equals to zero; positive value of the index or any other order). These changes do not always mean that the given index is becoming worse.

For example, the direction of positive changes of the 'period of the financial cycle' index is decreasing, but the negative value of this index shows the lack of costs of the enterprise; or the direction of positive changes of the 'coefficient of financial dependence' and 'coefficient of debt' indexes is decreasing, but their negative value shows the lack of capital for the enterprise. The above mentioned defect may be calculated if we make indexes normalization using formula (3).

The process of composite evaluation of financial potential level is presented in figure 1.

Determination of the poles is necessary for the calculation of the rationed values (from 0 to 1) of coordinates points in multidimensional space of the indexes. We need the rationed values to exclude the influence of the indexes

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[6] Н.А. Хрущ, *Інтегральна оцінка рівня фінансового потенціалу підприємств у сфері телекомунікацій* / Н.А. Хрущ, М.В. Желіховська / Вісник Хмельницького національного університету. – № 6. – Т. 2 «Економічні науки». – 2011. – С. 304–308.

Financial report of the enterprises

1. Calculation of the indexes system in accordance with groups and determination of their positive change directions

| Property level indicators | Business activity indicators | Financial steadiness indicators | Solvency and liquidity indicators | Profitability indicators | Market activity indicators |

2. Indicators formation and normalization

2.1. Determination of poles (boundary values of indicators: $a_{i_{max}}$ and $a_{i_{min}}$)

If a direction of the index positive change is its growth, then:

$$a_{i_{min}} = \begin{cases} \min_{j} a_{ij}, & \text{if there are negative values among } a_{ij}, \\ 0, & \text{if all the values are positive.} \end{cases}$$

$$a_{i_{max}} = \begin{cases} \max_{j} a_{ij}, & \text{if there are positive values among } a_{ij}, \\ 0, & \text{if all the values are negative.} \end{cases}$$

Normalizing the points coordinates : $b_{ij} = \dfrac{a_{ij} - a_{i_{min}}}{a_{i_{max}} - a_{i_{min}}}; 0 \le b_{ij} \le 1$

If positive change of direction is its reduction, then:

$$a_{i_{min}} = \begin{cases} \min_{j \ge 1} a_{ij}, & \text{if there are positive values among } a_{ij}, \\ 0, & \text{if all the values are negative,} \end{cases}$$

$$a_{i_{max}} = \max_{j} \left| a_{ij} - a_{i_{min}} \right|$$

Normalized values of the points coordinates : $b_{ij} = 1 - \dfrac{\left| a_{ij} - a_{i_{min}} \right|}{a_{i_{max}}}; \; 0 \le b_{ij} \le 1$

The standard point will have the coordinate according to the i-index: $b_{ij} = 1$,

where

$i = 1 \div n$, $j = 1 \div mp$, n – number of indicators; m – number of enterprises; p – number of time periods.

2.2. Determining the distance from j-th point to the standard point: $d_j = \sqrt{\sum_{i=1}^{n} (1 - b_{ij})^2}$

3. Defining the integral index of financial potential of the enterprise:

$$K_j = 1 - \frac{1}{\sqrt{n}} \sqrt{\sum_{i=1}^{n} (1 - b_{ij})^2} \; .$$

The higher is the value K_j, the higher the sums of j-enterprise are evaluated in different conditions.

**Picture 1. Chain of calculation of the integral index
of the enterprise financial potential level.**

measuring units on the final result. Multiplier $\dfrac{1}{\sqrt{n}}$ is needed to normalize the value of distance. Since, under the root sign all b_{ij} may be equal to zero, the maximum value d_j may be equal to $\sqrt{n}$. In case the higher index value corresponds to its better quality, we need to supplement to 1.

CONCLUSIONS

Thus, the suggested approach to determination of the enterprise financial potential level, makes it possible to receive objective evaluation of the enterprise activity results and contributes to the rational selection of strategic development alternatives, since during the process of the composite index construction with application of the method of directions, new definition of the poles is used (boundary values of the indexes $a_{i\,\max}$ and $a_{i\,\min}$,) that takes into consideration the direction and peculiarities of separate financial indexes impacts on the final result of the enterprise activity.

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Summary

Companies in the Ukraine are presently researching optimal forms of capital and current expense provision in an effort towards resolving their financial problems through quantitative evaluation of enterprises' real financial ability. Bearing in mind the multidimensional nature of financial potential i.e. large numbers of diverse indexes, it is often impossible to precisely determine its causes and effects and choose the appropriate index from the aggregate. In such cases indexes ought to be correlated to form a system. The study of this system by means of one-dimensional statistical method does not offer the possibility of considering all diversities and complications in

the correlation of indexes. It is possible to solve the above mentioned problem by means of data aggregation which aims at creating a compact and visible database, that is suitable for further research, making decisions and drawing conclusions. The concept proposed herein is an composite index system for the construction and interpretation of obtained results. The main hypothesis is its usefulness in describing the phenomenon and in obtaining the similar conclusions as those obtained from the whole aggregate of available indicators.

Metodologia całościowej oceny potencjału finansowego przedsiębiorstw w gospodarce opartej na wiedzy

Streszczenie

Przedsiębiorstwa na Ukrainie poszukują obecnie optymalnych form kapitału oraz realizacji bieżących płatności i w celu rozwiązywania problemów finansowych wykorzystują ilościową ocenę rzeczywistej zdolności finansowej. Wielowymiarowy charakter potencjału finansowego i bardzo liczny zbiór wskaźników go opisujących powodują, że często nie jest możliwe wybranie tylko jednego właściwego wskaźnika. W takich przypadkach konieczne jest wykorzystanie grupy wskaźników, które są ze sobą powiązane i tworzą pewien układ. Natomiast badanie tego potencjału za pomocą jednowymiarowej metody statystycznej nie pozwala na uwzględnienie wszystkich różnic i powiązań występujących między wskaźnikami.

Możliwe jest rozwiązanie powyższego problemu poprzez agregację wskaźników i utworzenie indeksu złożonego, który będzie wykorzystywany w dalszych badaniach oraz do oceny uzyskanych wyników, podejmowania decyzji i wyciągania wniosków. W niniejszej pracy przedstawiono propozycję metody wyznaczania indeksu złożonego, który pozwala na obiektywną ocenę wyników działalności przedsiębiorstwa i może być wykorzystany do racjonalnego wyboru strategicznych kierunków jego rozwoju.