

On manipulation in information space

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Abstract. Any open system of measurements, aimed at estimation of information objects in information space, creates the possibilities of results manipulation. The defining property of systems of measurement is their structuredness. In the context of the designated property of the system of accounting (financial) reporting the algorithms of regions rating can also be referred to one level formally structured systems of measurement, which creates the possibility of translation of the approaches of estimation of certainty of financial reporting to estimation of certainty of regional investment attractiveness. The authors methodology of estimation of misrepresentations in financial reporting, based on successive use of mathematical and statistical models (typology, clustering, multi-criteria estimation) for construction of the resulting probabilistic model of integrated index, making it possible to reveal facts of misrepresentation of financial results of business activity and define the focus of the revealed misrepresentations, was developed and tested on existent populations to carry out the research. Convergence of key foundations of investment space of financial market and investment attractiveness of regions is shown. The experiment, making it possible to find similarities in bias (misrepresentation) of the investment climate upwards or downwards, was developed. Information base of the carried out research was formed by: data of the Federal State Statistics Service of the Russian Federation; Screen data base of Russian companies by types of activity and regions; data of rating agencies; electronic network resources.

Keywords. Estimation of information objects, Information space, Manipulations, Ratings of regions.

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1 Problem statement

Any open system of measurements, aimed at estimation of information objects in information space, creates the possibilities of results manipulation. Let us provide an incomplete list of the objects under observation where researchers face the stated problem: accreditation requirements for higher educational institutions; systems of monitoring of effectiveness of activity of higher educational institutions and scientific establishments, publication activity indices (h-index, impact factor), indicators of intensity of the Internet resources visits; systems of accounting (financial) reporting; algorithms of formation of region ratings by various aspects of assessment of social and economic development. The defining property of the systems of measurement is their structuredness. In terms of the designated property, systems of accounting (financial) reporting and algorithms of formation of region ratings may be referred to one level formally structured systems of measurement, which enables translation of the approaches of the assessment of financial reporting reliability to the assessment of regional investment attractiveness reliability.

Several authors reviewed accounting reporting of the companies which carry out activities in 85 regions of the Russian Federation and have legal form of JSC, CJSC or public company.

The conducted research is of the most immediate interest since it revealed material accounting misstatements almost in every region of the Russian Federation.

2 Analysis of the available approaches

Global economic community has been studying detection of the degree and lines of accounting misstatements in recent decades. The authors discovered the following regularities in the development of the approaches to the assessment of financial reporting reliability. Let us list them in the order of origin:

1. analysis of accounting reporting of certain economic entities for detection of conscious misstatements and reception of adequate certainty of the quality of disclosed earnings;
2. formation of ratings of economic entities on the basis of comparison of specific financial indicators against their reference values, followed by conversion of the obtained misstatements into points (shares) and derivation of the summative assessment;
3. formation of integrated indicators, confirming accounting information reliability and determination of the structure, forming their data;
4. extension of the quantitative approaches to formation of the indicators of accounting information reliability via use of the variational calculation algorithms (probit-, logit regression);
5. development of the indicators of the assessment of accounting information reliability on the basis of the aggregate concept of data typological grouping.



Fig. 1. Map of share of manipulators by regions of the Russian Federation [8].

We turn our attention to the approaches listed above in more detail.

1. *The analysis of financial reporting of certain economic entities for detection of conscious misstatements and reception of adequate certainty of the quality of disclosed earnings.* The approach was actively developed in the late 1980s early 1990s of the last century. A proposition was put forward and proved that

earnings, disclosed in financial reporting, are related to actual performance of the company via some functional dependence, possessing unique characteristics for each certain economic entity. The lack of absolute identity between actual performance and reflection in financial reporting was established. Similar regularity is caused by a number of objective factors: first, internal mismatch of the accounting principles in terms of compliance with the interests of certain groups of stakeholders; secondly, high normative standardization in recognition in accounts, that generally leads to predominance of the form over economic content; thirdly, in wide use in preparation of financial reporting of the imputations and professional judgments, supported by the concept of creative accounting, that causes inevitability of emergence of mistakes and systematic bias of an estimate.

The initiators of the development of analytical procedures within the approach were DeAngelo L. [6] and Healy P.M. [10] who suggested application of the accruals coefficient, based on comparison of the financial results report data with cash flow statement results data.

Significant changes of economic conditions can lead to uncertainty of the results obtained within the models by Healy P.M. and DeAngelo L. External impact leads to change in conditions for carrying out normal operating activities of the specific company and, as a result, estimated values of obligatory charges vary. Similar changes can happen both in time and between various economic entities. For example, change in market and growth of credit sales of goods could lead to increase in estimated values of obligatory charges without any aspiration of the company management to manipulation of financial accounting. Thus, the models by Healy P.M. and DeAngelo L. are based on underrealistic hypotheses that estimated values of obligatory charges are constant in time and the same for various economic entities.

J. Jones [11] puts his model forward where there are no downsides in the ideas of the authors analyzed above. The model is based on the assumption that most obligatory charges are formed by depreciation, dependent on original cost of the fixed and intangible assets, and overdue accounts receivable provisioning, which is some function of earnings.

Further development of the approach was carried out by H. Xie [16], S. Kang and K. Sivaramakrishnan [12], and S.P. Kothari, A.J. Leone and C.E. Wasley [13]. It is important to note pioneer research by V. Bernard, T. Stober and J. Noel, who studied the dependence between financial results of economic activity of the economic entity and inventoried value, accounts receivable in the previous periods [4, 5]. The development of the approach made it possible to establish that the quality of earnings, disclosed in financial reporting, is worth mentioning when financial performance reflects the results of current operating activities most fairly, makes it possible to predict the outlook of economic development adequately and provides an unbiased basis for business evaluation.

2. Formation of ratings of economic entities on the basis of comparison of specific financial indicators against their reference values, followed by conversion of the obtained misstatements into points (shares) and derivation of the summative assessment. The approach in the context of revelation of financial

reporting misstatements was offered by D. Piotrovski [15], professor of The University of Chicago Booth School of Business, who published the results of his research on the retrospective analysis of corporate financial reports from 1976 till 1996 in 2002. D. Piotrovsky developed and proved practical applicability of the integrated indicator, formed from nine estimate financial indicators subdivided into three groups: profitability indicators; indicators of liquidity and sources of funds; indicators of operating efficiency. The quantitative value of each estimate indicator is compared with some “reference”, followed by assignment of discrete estimates 1 if the estimate indicator is better than reference and 0 otherwise. The obtained points are summarized, forming total rating assessment. The companies which gained the maximum rating (8/9 points) are considered strong, not inclined to financial difficulties in the long term, and those gained 2 or less points weak with high probability of bankruptcy in the future.

3. *Formation of integrated indicators, confirming accounting information reliability and determination of the structure, forming their data.* Analytical procedures, focused on revelation of signs of conscious manipulation, were introduced into practice of the assessment of financial reporting reliability within the approach in the 1990s. It is important to note the studies by M. Beneish [2, 3] as key research. The author and his followers managed to conclude statistically and prove a possibility of use of the integrated indicator of manipulation the M-Score index, consisting of eight components, for formation of professional judgment of completeness and reliability of accounting reporting preparation. At that, numeric values of each particular component of the M-Score index also obtained predictive power and are capable of pointing at the reporting sections where manipulations were made. Components of the index of manipulation can be divided into three groups: the indicators estimating the rate of development of the company; the indicators estimating aggression of the accounting policy applied by the company; the indicators estimating the level of economic and financial difficulties.

4. *Extension of the quantitative approaches to formation of the indicators of accounting information reliability via use of the variational calculation algorithms (probit-, logit regression).* The feature of the approaches is use of the algorithms of determination of parameters of continuous logistic regression via the method of maximum likelihood [7]. When forming the indicators of the designated group, predictors (exogenous variables) used for determination of value of the dependent variable are united into three groups: indicators of assessment of asset quality; indicators of assessment of operating efficiency; extra-financial indicators. The model predicts the probability of finding a dependent variable over the interval $[0, 1]$ under certain values of independent attributes (predictors). Reliable and full preparation of financial reporting causes zero value of the dependent variable. It should be noted that due to their features the considered approaches don't consider dynamic aspects of functioning of the company or don't estimate adequacy of increment rates of the corresponding financial indicators. While a similar technique gives advantages in determination of reporting reliability, making it possible to eliminate external disturbances under the eco-

conomic crisis conditions, the fraud index weakened predictive force in the period of economic stability.

3 Authorial approach to the solution of the set problem

The authorial methodology of estimation of misrepresentations in financial reporting, based on successive use of mathematical and statistical models (typology, clustering, multicriteria estimation) for construction of the resulting probabilistic model of integrated index, making it possible to reveal facts of misrepresentation of financial results of business activity and define the focus of the revealed misrepresentations, was developed and tested on existent populations.

The authorial technique is based on typological grouping which rests upon a behavior pattern of economic entities as information providers, which makes it possible to obtain the generalized assessment of the financial component of investment climate of the object under examination.

The definition of the main behavioral types is realized through creation of typological grouping of information space of the financial market in the context of separation of the public and confidential, expressed and hidden information (Table 1) [1, 9].

Table 1. Classification of information providers.

Predictors	Independent term	Expressed information	Hidden information
Open access information	Public information	Herbivorous	Plants
	Information noise	Parasites	Carnivorous
Confidential information	Inside information	Symbionts	Mimicry

The companies belonging to the type, designated as “herbivorous” (Table 1), seek to disclose information about them as much as possible and provide participants of the financial relations with authentic data. Realization of similar information strategy promotes formation of the maximum investment attractiveness of the corresponding financial assets since large and detailed amounts of information on the company, which assets are traded in the financial market, promote self-complacency of investors and generate restriction of aspirations in search of its shortcomings.

Information strategy of the companies - “plants” is focused, on the one hand, on conversion of confidential information into public, and on the other hand assumes existence of significant hidden component. Similar behavior leads to gradual formation of feelings of uncertainty with the investors owning the specified assets. “Parasites”, when building their information strategy, are focused on

formation of the maximum information noise around the expressed information disclosed by them and expect that high frequency, particularity and volumes of public disclosures will attract additional speculators that will increase liquidity of the financial assets offered by them.

Information strategy of the companies, included into the “carnivorous” group, is pointed at use of the information noise at maximum non-disclosure of information, characterizing real condition of the economic entity. Disclosed information is imposed upon participants of the financial relations to the uttermost.

Symbionts, when preserving information related to company performance within confidential limits, are ready to share it for establishment of long-term partner relations and take systematic actions, aimed at elimination of the possible negative influence of hidden information on interaction with contract partners.

The companies with information strategy marked as mimicry not only aim to make confidential information public, but also carry out maximum non-disclosure within inside information. Such behavior is very common in such industry of the Russian Federation as fishery, which is confirmed by statistical analysis of the financial indicators. The developed concept of information space of the financial market forms the basis of the methodology of studying processes of evolutionary interaction between various groups of economic entities in the financial market. The offered theoretical approach makes it possible to assess the financial component of investment climate and types of economic activity in terms of time and territory. Comparison of various classifiers sections forms the basis of the analysis of the implemented investment strategies and facilitates elaboration of effective managerial decisions.

The authorial methodology includes the following stages: determination of main behavioral types of economic entities and preselection of companies; formation of training samples; selection of financial indicators; probit regression model building, definition of boundaries and results check.

Preselection of companies is realized via analytical procedures, which make it possible to mark out companies, composing cash flow statement generally without significant errors or misstatements. The companies, which prepare cash flow statement fairly in terms of the joint balance of current and investment transactions, were revealed. Formation of the training samples is realized via use of algorithms of mixture separation for charge coefficients, calculated by cash method and accrual basis. Separation is done according to estimation of the difference bias of the coefficients from zero to negative or positive values. The mixture separation procedures assist in restoration of the statistical characteristics of the desired normal distributions with aggregate weight of one [1].

48 financial coefficients, significant for the following designation of the companies to each of the marked out types regardless of form of ownership or quality of cash flow statement preparation, were studied during selection of the financial indicators. The whole aggregate of the financial indicators values was analyzed by statistical methods in order to reveal the signs, demonstrating the biggest difference in the training sample, and four financial coefficients were chosen.

Determination of the parameters of the probit regression, making it possible to define the probability of accounting (financial) reporting misstatement, was carried out for the chosen indicators using STATISTICA program (Table 2).

Table 2. Parameters of the probit regression model.

Predictors	Independent term	Current cash debt coverage ratio	Cash liquidity ratio	Leverage	Share of inventory and accounts receivable in assets
Estimation	-0.545163	0.081045	-0.214496	-0.013610	1.412424

The task of estimation of the financial component of the investment climate of the territory is solved on the basis of the offered approach via revelation of the prevailing modes of behavior of economic entities. The enterprises, involved in food production in the Novosibirsk region, were objects under observation (Table 3).

Table 3. Typological grouping of the companies of the Novosibirsk region involved in food production in information space.

		Expressed information (weight -4)	Hidden information (weight -2)
Open access information	Public information (weight -5)	9 (Herbivorous)	0 (Plants)
	Information noise (weight -3)	1 (Parasites)	3 (Carnivorous)
Confidential information	Inside information (weight -1)	76 (Symbionts)	11 (Mimicry)

Existence of corporate web sites, as well as customer feedback in social media was analyzed for categorizing the chosen objects by the information availability criterion of classification. The analysis was carried out not only via search of official names, but also through comparison of postal addresses and contact telephone numbers, specified in registration data, with the information used in brand promotion. Additional check was performed for the companies with public information to reveal information noise. The analysis was carried out by assessment of texts using freeware content analysis program. Authorial approach was used for classification of the chosen objects by the information availability criterion.

When considering the offered typological grouping of information space as display of investment activity (behavior) of economic entities, it is necessary to point out dual dynamic nature of relations, where, on one hand, investment activity (behavior) is the display of investment attractiveness factor in terms of financial information fairness, and on the other hand the display of the factor, forming investment preferences, in terms of availability of financial and non-financial information. Dynamic nature of the relations is interdependent and it arises in the process of formation of development strategies by the respective stakeholders. For example, actions of the state authorities, elaborating strategy of the investment climate development on the basis of the analysis of the offered information space typology, form prerequisites for changes in strategies of certain economic entities development, which is iterative and it is revealed in another transformation of information space.

The calculations found that no company was categorized as plants, as expected a priori: current state of the investment climate in the region is not sufficient enough for formation of the financial relations, specific for this category. Herbivorous companies, focused on openness and attraction of external financing, formed a relatively small group. Their share in food industry of the Novosibirsk region is only 9%. We believe it is consequence of ineffective policy of regional authorities since the share of the symbionts companies is significant.

Main group of the studied companies are symbionts. The development policy of the enterprises, involved in food production in the Novosibirsk region, should be aimed at this group. Share of the companies, carrying out activities within information noise, aggressive marketing policy, aimed at consumer fraud, is small (5%). Emergence of the companies, focused on such behavior, must cause concerns to state authorities. Increase in the number of the companies, acting in accordance with such behavior strategies, may cause serious public tension. The results of the obtained typological grouping via assignment of the respective weights to the designated characteristics can be contracted into integral estimation of the investment climate, which lies in the interval of [2:20] (Table 4). Value of the integral estimation is 5.25, which makes total integral estimation of 0.26 after normalizing by maximum value. Obtained estimates can be compared with ratings of investment attractiveness of the regions, calculated by other organizations, Higher School of Economics in particular.

Convergence of the key bases of investment space of the financial market and investment attractiveness of the regions is presented in Table 5.

The following experiment is planned to check estimates of the regional investment attractiveness: random selection of 30 regions; random formation for each region of the research selection, composed of economic entities, making it possible to implement typological grouping in information space; contraction of the results of the obtained typological grouping via assignment of the corresponding weights to the designated characteristics; comparison of the obtained results with estimation values of the verified methods via tests for the equality of the means and equality of the variances.

Table 4. Integral estimate of the investment climate for the companies of the Novosibirsk region involved in food production.

		Expressed information (weight -4)	Hidden information (weight -2)
Open access information	Public information (weight -5)	$5.25/20 = 0.26$	
	Information noise (weight -3)		
Confidential information	Inside information (weight -1)		

Table 5. Comparison of the development of the methods of the investment climate estimation and financial reporting reliability.

Methods of the investment climate of the region [9]	Methods of the financial reporting reliability
Via formation of the base of the entities involved in investment activities	Analysis of financial reporting of certain economic entities
Formation of ratings of regions	Formation of ratings of economic entities on the basis of comparison of specific financial indicators against their reference values
Formation of integrated indicators on the basis of the estimation of combination of factors	Formation of integrated indicators
Clustering of groups of regions on the basis of variational calculation	Extension of the quantitative approaches to formation of the indicators of accounting information reliability via use of the variational calculation algorithms
Development of estimation of the investment climate on the basis of the typological grouping	Development of the indicators of the assessment of accounting information reliability on the basis of the aggregate concept

Preliminary results give ground to find similarities in bias (misstatement) of estimates of the investment climate upwards.

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