RISK MANAGEMENT IN BUSINESS VALUATION IN THE CONTEXT OF DIGITAL TRANSFORMATION

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Abstract

The paper deals with business valuation in unstable conditions of the external environment. Economic recession and the need for digital transformation is coming to the fore in Russia. As a result of this, the valuation of assets and business acquires additional complexity and issues related to effective risk assessment become relevant. The main objective of this paper is to offer non-traditional methods of risk assessment for business valuation at the moment. The qualitative and quantitative risk analysis will help to improve the quality of the assessment reports of the property in an unstable period. The paper focuses on the non-traditional methods of risk assessment (Monte Carlo method, game theory) which must be used in determining the market value of the object of assessment in the current time. A practical example of using the simulation modeling method is given in detail. Summarizing, the use of the simulation modeling method for calculating the market value of the appraisal object will provide additional (compared to the standard method) information and increase the reliability of the results. Moreover, in the period of the coronavirus pandemic, this paper becomes even more relevant and important, seeing as how uncertainty is becoming inherent in countries around the world. Thus, this study is of value to researchers in the field of economic modeling and appraisers across the globe.

Key words: *business valuation, market value, risks, simulation modeling method, Russian economy, digital transformation.*

JEL Classification: C5, G32.

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1. Introduction

Having survived two recessions in 10 years, the Russian economy grew by an average of 0.4% per year. According to the World Bank, this is 8 times slower than the global economy as a whole. The International Monetary Fund forecasts a growth rate of the Russian economy of 1.7%, with a slowdown to 1.5% in the next five years. This is a third slower than developed countries' economies are growing (2.4% in 2018 and 2.2% in 2019), half the rate of the global economy (3.9% for the next two years) and almost three times worse than developing countries, whose growth is estimated at 4.9% in 2018 and 5.1% in 2019.

Along with this, Russia must integrate itself with the global movement of the digital

transformation of the economy. In modern conditions, the role of digitalization is significantly increasing, which is becoming the main factor in the development of the world economy. Since 2011, the Fourth Industrial Revolution has been actively developing in the world, which the digital economy is a fundamental basis of. The current state of the Russian economy, under the conditions of the Fourth Industrial Revolution, is characterized as the beginning of new way (Gromova, 2019; Vasin et al., 2018; Romanova, 2018; Pogodina et al., 2019). As a result, the introduction of modern digital technologies in various areas of activity is a priority for the development of the national economy.

Many efforts and actions need to be applied to the development of the digital economy in Russia (Rudskaya & Rodionov, 2018). The digital transformation of the economy is accompanied by the destruction of traditional economic models, changes in the nature of work, increasing uncertainty and risks. For the first time, the task of forming a digital economy was identified by the President of the Russian Federation V.V. Putin in his annual address to the Federal Assembly in 2016: "... launch a large-scale system program for the development of the economy of a new technological generation, the so-called digital economy". Approved by the decree of the Government of the Russian Federation of July 28, 2017, No. 1632-r, the Digital Economy of the Russian Federation program, guided by the "Strategy for the Development of the Information Society in the Russian Federation for 2017-2030", defines the concept of digital economy, the goals and objectives.

Thus, the current state of the Russian economy can be described as unstable, seeking to get rid of the effects of the crises and to achieve pre-crisis growth rates, as well as the need for digital transformation.

In connection with the above described situation of the Russian economy, such a direction of activity as the valuation of assets and business acquires additional complexity (Damodaran, 2002). Issues related to effective risk assessment, which are mandatory attributes of the modern economy, come to the fore.

In addition, all countries of the world are experiencing an extremely difficult period at the moment - the coronavirus pandemic, which characterized primarily by uncertainty. So far, no one knows what consequences the pandemic will cause to the development of the world community. It is already clear, however, that the economic sphere will suffer very seriously. Risk and uncertainty prevail in all economic processes throughout the world.

Thus, the main aim of this research is to offer non-traditional methods of risk assessment, which should be used in determining the market value of the object of assessment at the present unstable time.

2. Statement of a problem

The currently observed transition stage of the Russian economy and complete uncertainty in forecasting the duration of this period complicate the modeling of the behavior of a typical seller and a typical buyer in determining the market value of the object of evaluation. The high sensitivity of the cost of the object to the factors and forecasts laid in the model leads to distrust on the part of the customer when expected to work based on a single expert opinion of the appraiser.

3. Methods

Standard methods, such as the scenario approach (Cherepovitsyn et al., 2018), are widely used in investment design and in assessing the value of the object, using the income approach. In the works (Ozerov, 2007; Pupentsova & Livintsova, 2018), it was shown that, when choosing the best and most effective use of the object, uncertainty in the source data and in the predictions of their changes can lead to an erroneous choice. Creating scenarios for each use of the object will allow the selection of not only the criterion of income maximization (NPV, land value), but also the option with minimal risks (minimum coefficient of variation) (Nikolova et al., 2017; Bril et al., 2019).

The use of game theory (Zavadskas & Turkis, 2008; Roth & Wilson, 2019; Halperin, 2017; Peleckis, 2015), in particular the Savage criterion, the Wald criterion (Makarova, 2017; Ivanenko et al., 2018; Turskis et al., 2009; Kaklauskas et al., 2007; Zavadskas et al., 2002; Maron & Maron, 2019; Chursin et al., 2017; Gaspars-Wieloch, 2018; Korotkov et al., 2015), allows the best option to be chosen at this stage, without assigning a probability to each scenario (Ozerov, 2007).

The use of the simulation modeling method (Law & Kelton, 1991; Atliok & Meamed, 2007; Danielsson et al., 2016; Kumar & Reinattz, 2016; Chen, et al., 2018) when choosing the best and most effective use of the object, allows to:

1. simultaneously simulate random changes of several components of the project, taking into account the conditions of correlation,
2. automatically generate scenarios from the ranges of possible changes in random variables and selected distribution laws,
3. avoid errors when assigning probabilities for each scenario,
4. make a decision, being guided not only by maximizing the effective variable, but also by an acceptable (minimal) measure of risk.

It should be noted that the use of the simulation modeling method for calculating the market value in the relevant empirical literature is not typical (Evans & Olson, 1998; Cellmer & Kobylinska, 2014, 2019; Mangialardo & Micelli, 2017).

An example of the use of a simulation modeling method in the analysis in order to select the best and most effective option of using the land plot, as conditionally free, is given below. The data used for the study are taken from the professional database of analogues by authors who are professional appraisers. This database was formed in the course of the authors' professional activities. The database is characterized by a comprehensive nature and sufficiency of parameters taken into account. The residue technique is used to determine the value of the land. The distribution of factors (cost of improvements, capitalization ratio for improvements, net operating income, and capitalization ratio for land) is chosen uniformly, since the input parameter ranges are found for a specific object, and it is considered that the factor can take any value with equal probability in a given interval. Based on the dependence of the test result on their number (Pupentsova, 2007), the number of tests is assumed to be 10,000. There is no multicollinearity between the factors. The results of the analysis in order to select the best and most effective option for using the land plot according to the criterion of value maximization have been presented in Fig. 1.

Fig. 1. Bar chart for land use options. *Source:* own study.

A graphical representation of the results of numerical simulation in the form of a histogram allows us to conclude about the advantage of the second option. That is, despite the large scatter of the obtained values, even in the worst case, it will lead to a cost not lower than that of other options (shifted to the right along the x-axis, it has a maximum value of the ground). Options 1 and 3 are superimposed on each other, and have about the same the value of land. Option 1, however, has a smaller spread (the polygon is narrow and stretches upwards), and, consequently, less risk than option 3.

In assessing the property, the question of the comparability criteria of the compared options in terms of the choice regarding the sizes of the compared buildings of various functional purposes is not affected. Meanwhile, in accordance with the principle of incremental productivity and the principle of increasing and decreasing returns, the value of a land plot will first increase with the size of the building, after which it begins to decrease. Indeed, with a fixed size of land, the change in the size of

the building will be carried out mainly by increasing the height of the building, which will entail an increase in the cost of building per square metre.

This is followed by the application of game theory on the example of choosing the best and most effective use of a free land plot of 1000 sq. m. At the same time, the height of an office building varies from 2 to 20 floors. The maximum building area of the land is 750 sq. m. Construction costs, rental rate, underload factor, default ratio was accepted at market level. The replacement cost of improvements is calculated using the standard "Integrated replacement cost indicators". Operating expenses vary according to the polynomial law (PUPENTSOVA, 2007):

$$OE = 0,089 x^2 - 2,288 x + 117,12, R^2=0,86 \quad (1)$$

where x is the number of floors, OE is the unitary operating expenses per 1 sq. m.

The cost of the object is most sensitive to the value of the capitalization ratio, therefore this indicator will also be taken into account in the modeling of the situation. The total capitalization ratio was taken at the level of 17% ÷ 22%. The cost of land is determined by the technique of the remainder.

The results of calculating the cost of land depending on the number of floors and the capitalization ratio can be represented as a matrix. The choice of the optimal number of floors is based on the criteria proposed in game theory. The results of the analysis have been shown in Fig. 2.

Fig. 2. The dependence of the cost of land on the number of floors of the building. Source: own study.

This presentation clearly demonstrates that, for this example, by all criteria (except for the pessimist Wald), a ten-story building (according to Wald – an eight-story building) will be considered the optimal development of a land plot. This algorithm can be used to select the optimal development of a land plot in the analysis in order to select the best and most efficient option for using a free land property.

4. Problem solving

Qualitative and quantitative risk analysis will help to improve the quality of the assessment reports of the object in an unstable period.

In the process of the qualitative analysis of the risks of the company (project), the list of events leading to financial and temporary losses is investigated at the initial stage. The second step is to describe the possible damage and determine its value. Determining the degree of impact and the likelihood of risk occurring on a project will help to create a risk sorting map, during the drawing up of which it is best to use 9-10 point scales in order not to further rank within enlarged groups. If we

postpone the degree of risk impact on the project along the y-axis and the probability along the abscissa, then, for the risks located in the upper right corner of the risk sorting card, it is necessary to conduct an additional analysis of the causes of such events and factors contributing to their dynamics. As a result of a qualitative risk analysis, recommendations are made to reduce losses associated with the onset of adverse events. There are systematic and non-systematic risks. Systematic (or external) risks are such that are more or less common to all companies. These are macroeconomic changes, such as a economic recession or political crisis. No company is immune from the influence of these factors. For example, a slowdown in GDP growth or a rise in tax rates is likely to affect all companies in the economy. The response of individual industries and companies to external risks may vary:

- there are companies that are more sensitive to systematic risks than others (for example, selling luxury goods, the cost of electrical goods and sports cars increase when the economy is growing intensively and fall during an economic downturn),
- some sectors of the economy experience limited changes in demand due to growth and decline in the economy (for example, industries producing and distributing food products).

Such sensitivity is estimated when determining the rate of return on equity by the coefficient β in the CAPM model. A positive value of β confirms the same direction of change in the company's profitability with the change in the profitability of the market as a whole. If the specified ratio is higher than one, this indicates a greater sensitivity of the company to external changes than that of the market. As a measure of market return, a securities portfolio or stock index is selected.

A technique of alternative projects, which is recommended for the interval assessment of the rate of return on capital, confirms that systematic (external) risks are already taken into account in the discount rate. In this case, the rate of return on borrowed capital is a quantitative measure of the risk associated with inflationary expectations and economic instability caused by politics, the global financial crisis, imperfect laws and exchange rate volatility.

The development of scenarios for further development of events and their further analysis formed the basis for quantitative risk assessment. Actual revenues received during the forecast period of time may be very different from the expected values. This distinction between expected and actual income is a source of risk. Possible deviations from expected events are modeled in extreme scenarios. The variance of actual returns relative to expected returns is measured using the standard deviation of the distribution. A rational investor, who chooses between two investments with the same standard deviations but different expected returns, will undoubtedly prefer an investment with a higher return. The coefficient of variation is very often used in assessing the relative measure of the uncertainty (risk) of a project. The greater the coefficient of variation, the greater the uncertainty in the project scenarios, the greater the risk.

5. Discussion

Calculating the cost of an object (V_o) using the capitalization technique according to the rate of return using the simulation modeling method consists in determining the average value of the object obtained by iterating a sufficiently large number of options (10,000) combinations of variable factors (Table 1), to which the value of V_o is sensitive.

In each trial, the value of the object, given by 1 sq. m. improvements, was determined from equation (2):

$$V_o = \sum_{i=1}^n \frac{A_m (1+g)^i (1-K_v)(1-K_{oe})}{(1+Y_o)^i} + \frac{V_o (1+\Delta)}{(1+Y_o)^n}, \quad (2)$$

where:

- A_m - is the rental value of 1 sq. m. of the total area of the object,
- g - is the annual change in rental value,
- K_v - is the coefficient of losses from underloading,
- K_{oe} - is the ratio of operating expenses,
- Δ - is the increase in the value of the object during the operation period,
- Y_o - is the rate of return on capital,
- n - is the period of operation.

Expressing the value of the object (V_o) from equation (2), we get:

$$V_o = \frac{\sum_{i=1}^n \frac{A_m (1+g)^i (1-K_v)(1-K_{oe})}{(1+Y_o)^i}}{1 - \frac{(1+\Delta)}{(1+Y_o)^n}}, \quad (3)$$

When building a model, the distribution of factors will be considered uniform, since the ranges of input parameters are determined for a particular object, that is, they have such a spread that, in a given interval, the factor can take any value with equal probability (Table 1).

Table 1

Factors for applying the Monte Carlo method in the model (3)

Factor	Designation	Minimum value	Maximum value
Rental rate for the object, conventional units per 1 sq. m.	Am	200	250
Rental Rate Forecast	g	4%	10%
Underload factor	Kv	1%	5%
Operating expense ratio	Koe	33%	35%
The rate of return on capital takes into account only external risks	Yo	16%	20%
Forecast cost changes for the period of operation	Δ	33%	45%

Source: own study.

The results of the performed numerical simulation with a normal distribution can be represented graphically in the form of a histogram (Fig. 3).

The performed numerical simulation increases the reliability of the results by identifying possible variability of the resulting feature (with a probability of 68%, the cost of the object will be in a confidence interval of 1620 ± 250 conventional units per 1 sq. m., coefficient of variation - 15%), the standard approach with the use of scenario methods increases the spread of the resulting variable by approximately twofold.

Fig. 3. Box Fractal Dimension in Four Investment Styles Over 25 Quarters. Source: own study.

In the automatically generated scenarios, a forecast of an increase (decrease) in the rental rate by the exponential (linear) dependence of the specified range is laid. In conditions of unstable economic development, it is difficult to describe forecasts with such an addition, therefore, it is better to remove this factor from the simulation model, and to take into account the uncertainty of forecasting the duration of an unstable period and exit from it with a scenario approach, including the forecast in

the extreme scenarios as "L" (pessimistic view) or "U" (optimistic view).

If the value of the object in the cost approach is determined by the formula (3), then the initial data for the model, as a rule, have a variation which must be taken into account when numerically modeling the resulting variable by the simulation modeling method. The source data for the analysis are summarized in Table 2.

$$V_o = E_b(1 + K_E)(1 + Pr)(1 - D) + V_l, \quad (4)$$

where:

- E_b - direct costs, given in 1 sq. m. of improvements,
- K_E - is the indirect cost ratio,
- Pr - is the profit rate of the entrepreneur,
- D - is the building depreciation rate,
- V_l - is the value of the land plot calculated for 1 sq. m. of improvement.

Table 2

Factors for applying the Monte Carlo method in the model (4)

Factor	Designation	Minimum value	Maximum value
Land value, conventional units per 1 sq. m.	V_l	420	540
Direct costs, conventional units per 1 sq. m.	E_c	1000	1400
Indirect costs	K_E	20%	25%
Profit entrepreneur	Pr	18%	20%
Depreciation	KD	35%	30%

Source: own study.

As a result of the analysis, a confidence interval of 1660 ± 120 conventional units per 1 sq. m. was obtained, the relative result error was 7%.

Calculating the market value of real estate using a comparative approach involves adjusting the pricing factors for the price of objects of comparison for their difference from the object of evaluation. Justification of the adjustment is probabilistic in nature and, if the values of the correction are from the analysis of market segments, the source data always have variation. Then the procedure for adjusting the analogs will be complicated by the simulation modeling method in the specified ranges of the pricing factor, but the result will be calculated taking into account all possible deviations, which will increase its reliability.

Further, to determine the adjustments, information about the objects of one segment is collected and analyzed, groups are formed according to the state and distance from the metro and the dependences of the cost of the object on these characteristics are obtained (Table 3).

Table 3

Average market adjustments obtained for the analyzed segment

Pricing factors	Average value	Standard deviation	With a probability of 67%		Relative adjustment	
			Minimum value	Maximum value	Minimum value	Maximum value
			State			
Excellent	1800	252	1548	2052	-	-
Good	1500	225	1275	1725	19%	21%
Satisfactory	800	160	640	960	80%	99%
Distance from the metro						
up to 5 minutes	1700	170	1530	1870	-	-
5-10 minutes	1600	192	1408	1792	30%	32%
10-30 minutes	1300	143	1157	1443	22%	24%

Source: own study.

As a result of the analysis of the collected information, the relative adjustment of pricing factors was calculated using the growth formula. Table 4 contains data on three similar objects for calculating the value of the object. For each analogue object, the possible results of the adjusted price, obtained by iterating through a sufficiently large number of variants of combinations of relative adjustments, are determined.

Table 4

An example of the use of the Monte Carlo method in factor analysis techniques with relative adjustments

Object of evaluation		Analog 1	Analog 2	Analog 3
Price, conventional units per 1 sq. m.		1980	2300	1100
State	good	excellent	good	satisfactory
Adjustment		19%-21%	0	80%-99%
Distance from the metro	10-30 minutes	10-30 minutes	до 5 minutes	5-10 minutes
Adjustment		0	30%-32%	22%-24%
Adjusted price (conventional units per 1 sq. m.)		1580±10	1590±10	1590±50

Source: own study.

Numerical simulations of the initial investment cost using three standard Monte Carlo approaches have allowed us to calculate the relative cost error for each approach and present the results graphically (Fig. 4).

Fig. 4. Box Fractal Dimension in Four Investment Styles Over 25 Quarters

This presentation will allow the variation in the results of the value of the object to be evaluated at each approach, thereby simplifying the approval procedure. The result of the analysis may be the area of intersection of the value obtained in three approaches.

6. Conclusion

The study suggests using not only traditional methods of the quantitative assessment of possible losses (sensitivity analysis and scenario analysis), but also methods that are not used in standard packages – simulation modeling, game theory, qualimetric modeling and hierarchy analysis—at the stage of choosing the best and most effective use of an object, which is strategically important for an investor. The use of the simulation modeling method for calculating the market value of the appraisal object will provide additional (compared to the standard method) information and increase the reliability of the results due to:

- identifying possible variability and the area of intersection of the value of the object at each approach,

- graphical presentation of the results in the form of a histogram,
- automatic formation of scenarios, in which it is not required to determine the subjective probability, which improves the indicators of the relative measure of risk.

The theoretical and applied provisions of the article can be applied in solving practically important problems of investment design under conditions of risk and uncertainty. The practical part of the work holds special value. The large database of collected data allows us to consider non-traditional methods of risk assessment. Moreover, in the current reality of the coronavirus pandemic, the advantages of these methods are becoming increasingly important on a global scale. This research is hence of value to researchers in the field of economic modeling and appraisers around the world.

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