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THE METHOD OF CALCULATED VALUES ADJUSTMENT OF LAND PLOTS COST

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Problem statement

One of the main principles of carrying out land reform in Ukraine is charged nature of land use. A necessary precondition of charged nature land use implementation is conducting monetary valuation of land plots. Approved in 1995 Method of normative monetary valuation of different functionality land plots contained an array of measures and ratios having set values which made monetary valuation of lands insensitive to market conditions [1]. The practice of using monetary (normative) valuation has shown that its results do not reflect actually formed level of purchase-sale prices and rent on the land plots market.

Connection with important scientific and practical tasks

At present two kinds of land monetary valuation – the normative valuation and the expert valuation coexist in Ukraine. Normative valuation is carried out in cases of defining land tax rate, the rate of rent for state and community property land plots, state duty etc. Expert monetary valuation is conducted in cases of alienation, insuring and mortgage of land plots, determining investment contribution to implementation of investment project on land improvements, defining losses to owners or land users, while concluding civil law deals. Due to this fact the formation of normative and methodological basis of land valuation activity is relevant.

The analysis of recent research and publications on the problem

Theoretical and practical aspects of land valuation activity are being investigated and reflected in the works of many foreign and domestic scholars, in particular A. Drapikovs'ky, M. Lykhohrud, L. Petrovych, I. Petrovych and others.

Unsolved parts of the general problem

In the process of defining the value of a land plot the unity of its physical elements – the land and the land improvements is taken into account. According to the Method of expert monetary valuation of land plots [2] and the Procedure of conducting expert monetary valuation of land plots [3] expert monetary valuation is carried out with applying such methodological approaches: capitalization of net operational or rent income (income approach), taking into account the expenses on land improvements (expenses approach), comparing the selling prices of similar land plots (comparative approach). The difference between calculated values of one particular land plot as the result of applying different methodological approaches can be rather essential. The evaluator faces the task of logical grounding of final value.

The statement of the problem task The aim of this article is investigation of theoretical aspects and working out of practical recommendations as for the adjustment of calculated values of land plots cost received as the result of different methodological approaches.

The main material of the problem presentation

In the theory of evaluation the answer to the question of how to adjust the results of valuation received with the help of different methodological approaches is absent. On the basis of practical experience we can draw a conclusion that in domestic practice of evaluation the procedure of adjusting the results most often is ignored and the result received by means of using only one methodological approach – the comparative one is chosen. In H. Sternyk's opinion "… Comparative approach as the consequence of a range of its peculiarities is the most widespread if not the basic one … People try to use comparative approach even when data are not enough to receive reliable … evaluation of the object" [4]. While applying such a univariate approach useful information received in the process of applying of two other approaches is not taken into account. The evaluator's judgments, logics, intuition, subjective assumptions within one approach may turn out to be inaccurate and collected information and processed information may be not enough. We will additionally notice that while using different approaches to valuation of land plots of certain functionality one and the same segment of the market is analyzed but different aspects of it. While using the expense approach current cost of the valuation object is determined by the costs spent in retrospective period. While using comparative approach the information on the sale (offering) prices of similar objects at current time is used. It is logical to check the accuracy of the results received with the help of these two approaches in terms of income which may be got from the valuation object in the future.

In view of the above mentioned, we may draw a conclusion that the process of the results adjustment should be carried out on the basis of the holistic approach which will allow taking into account the whole set of information received in the valuation process. To H. Harrison's point of view " … while adjusting the results the evaluator collects data and measures of cost received

on the basis of the three approaches and estimates them with the help of causal analysis which leads to a grounded conclusion about the cost being the aim of the valuation. The evaluator should clearly define the character and the volume of the ordered work and start considering relative importance and appropriateness of different data and approaches to the problem …" [5, p. 22]. We should note that adjustment of valuation results is a complex, time-consuming and methodologically ambiguously defined process. D. Feedman and N. Ordway noted that "… adjustment is called "examination of conscience", in this process all assumptions are checked for reasonableness and reliability …" [6, p. 31]. We may agree with the opinion of D. Fishman, K. Pratt, K. Griffith and K. Wilson that "… it is not quite simple to determine which valuation measures need to be given more weight and how appropriate method can be weighed in comparison with others …" [6, p. 271].

According to the results of the literature sources analysis we may draw a conclusion that the most often the process of results adjustment is offered to be carried out by means of calculating the weighted average of the results received by different methodological approaches. In a formalized view this process may be represented as following:

$$V = \sum_{i=1}^{3} w_i V_i \text{ , (1)} \quad \sum_{i=1}^{3} w_i = 1$$

where V – weighted average of the cost, hrn;

V_i – cost value determined by means of *i*-approach, hrn;

w_i – the importance level of each methodological approach in the final cost value.

In this context the method of quality control offered by H. Azhaldov [8] and the method of hierarchies analysis suggested by T. Saaty [9] deserve attention. The general idea of these two methods consists in decomposition of the choosing problem into simpler constituent parts, namely constructing of the properties (hierarchies) tree and defining the relative importance of investigated alternatives on the basis of the chosen properties. The top of the hierarchies' tree is the aim, the elements of the lower level are the variants of achieving the aim (alternatives) and the elements of the intermediate levels correspond to the criteria of choosing alternatives. We should point out that the idea of gradual breaking of a complex task into simpler ones (until the moment when such tasks that may be solved are left) belongs to French philosopher, physicist and mathematician R. Decart [10].

Fig. 1 shows the hierarchies tree for making a decision concerning the final market cost value of the estimated land plot calculated by means of the three methodological approaches.

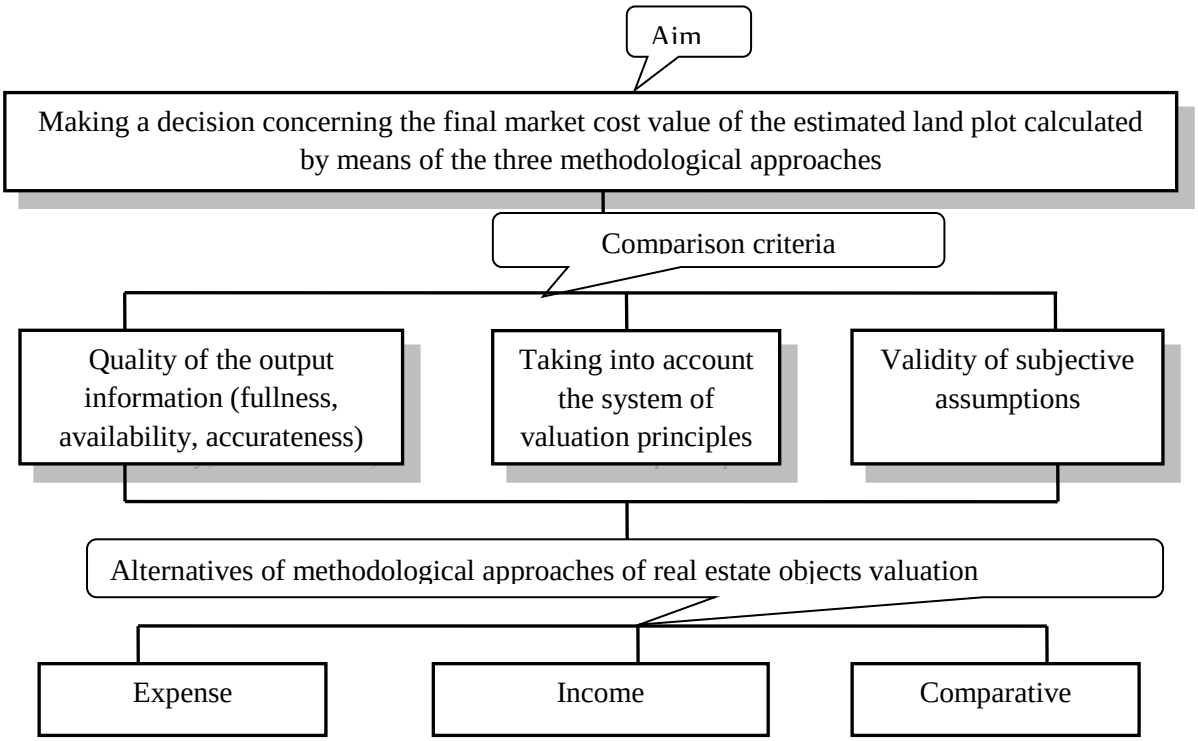

Fig. 1 Hierarchies tree for making a decision concerning the final market cost value of the estimated land plot calculated by means of the three methodological approaches.

After constructing the hierarchies' tree it is necessary to analyze by means of pairwise comparisons of the selected criteria the advantages of each approach. We should note that the hierarchies' tree (fig. 1) is only the model of real situation which reflects the analysis conducted by us. With the aim of defining the degree of results received by each of the approaches influence on the final market cost value (the top of the hierarchy tree) it is necessary to

determine the degree of each approach influence (the elements of the lower level) on the criteria of alternatives choosing (the elements of the intermediate level). For this we construct matrices of pairwise comparisons of alternative variants. According to T. Saaty estimation of domination degree of one alternative over the other is carried out in nine point scale of quality estimates shown in table 1 [9, p. 53].

Table 1

Scale of Quality Estimates

Degree of importance	Definition	Explanation
1	The same importance	The two approaches pay the same contribution to achieving the aim
3	Insignificant advantage according to the criterion being analyzed	Experience and judgments give insignificant advantage to one approach over another
5	Significant advantage according to the criterion being analyzed	Experience and judgments give significant advantage to one approach over another
7	A very strong advantage according to the criterion being analyzed	Practically obvious advantage of one approach over another
9	Absolute advantage according to the criterion being analyzed	Unequivocal evidence of one approach being advantageous over another
2, 4, 6, 8	Intermediate values	Situation when compromise decision should be made
Reciprocal values of the above mentioned figures	If actions *i* in comparison with action *j* are attributed one of the given figures then action *j* in comparison with action *i* is attributed reciprocal value	Reasonable assumption

We shall note that scales of quality estimates are only the quantitative indicators of the evaluator's judgments who compares methodological approaches according to the criteria chosen. The results of the pairwise comparisons of influence criteria on making decision concerning the final market cost value of a land plot being estimated calculated by means of the three methodological approaches and the three methodological approaches according to the criteria chosen are summarized in tables 2-5.

Table 2

Results of Criteria Pairwise Comparisons

	Quality of input information	Taking into account the system of evaluation principles	Validity of subjective assumptions
Quality of input information	1,000	0,333	0,500
Taking into account the system of evaluation principles	3,000	1,000	2,000
Validity of subjective assumptions	2,000	0,500	1,000

Table 3

Results of pairwise comparisons according to the criteria "quality of input information"

	Expense approach	Comparative approach	Income approach
Expense approach	1,000	3,000	3,000
Comparative approach	0,333	1,000	1,000
Income approach	0,333	1,000	1,000

Table 4

Results of pairwise comparisons according to the criteria "taking into account the system of evaluation principles"

	Expense approach	Comparative approach	Income approach
Expense approach	1,000	0,250	0,167
Comparative approach	4,000	1,000	0,333
Income approach	6,000	3,000	1,000

Table 5

Results of pairwise comparisons according to the criteria "validity of subjective assumptions"

	Expense approach	Comparative approach	Income approach
Expense approach	1,000	1,000	0,167
Comparative approach	1,000	1,000	0,167
Income approach	6,000	6,000	1,000

According to the results of pairwise comparisons we construct square matrices $\mathbf{A} \equiv \| a_{ij} \|$, in which value a_{ij} shows advantage of approach i over approach j ($i, j = \overline{1,3}$). While comparing a methodological approach with itself we have the same importance, correspondingly the main diagonals of all matrices consist of units, $a_{ij} = a_{ji}$, that is matrix $\mathbf{A}$ is reciprocally symmetric.

Matrix of pairwise comparisons $\mathbf{A}_1$ of influence criteria on decision making concerning final market cost value of real estate object being estimated calculated by means of the three methodological approaches according to table 2 is the following:

$$\mathbf{A}_1 = \begin{pmatrix} 1 & 0,333 & 0,5 \\ 3 & 1 & 2 \\ 2 & 0,5 & 1 \end{pmatrix}.$$

Matrix of pairwise comparisons $\mathbf{A}_2$ formed by criterion "quality of input information" according to table 3 is the following:

$$\mathbf{A}_2 = \begin{pmatrix} 1 & 3 & 3 \\ 0,333 & 1 & 1 \\ 0,333 & 1 & 1 \end{pmatrix}.$$

Corresponding matrix of pairwise comparisons $\mathbf{A}_3$ formed by criterion "taking into account system of evaluation principles" according to table 4 is:

$$\mathbf{A}_3 = \begin{pmatrix} 1 & 0,25 & 0,167 \\ 4 & 1 & 0,333 \\ 6 & 3 & 1 \end{pmatrix}.$$

Matrix $\mathbf{A}_4$ formed by criterion "validity of subjective assumptions" (table 5) has the following look:

$$\mathbf{A}_4 = \begin{pmatrix} 1 & 1 & 0,167 \\ 1 & 1 & 0,167 \\ 6 & 6 & 1 \end{pmatrix}.$$

We should highlight that points in the process of filling out the matrices of pairwise comparisons are given on the basis of estimator's subjective judgments. Thus, with the aim of ensuring final result objectivity it

is necessary to calculate consistency of judgments ratio. For not contradictory judgments the following condition is fulfilled: if value a_{ij} shows advantage of approach i over approach j, and value a_{ik} shows advantage of approach j over approach k then $a_{ik} = a_{ij}a_{jk}$. Initial matrices may be not adjusted and their elements may turn out to be intransitive. Due to this fact, it is necessary for us to estimate error which appears as the consequence of judgments contradiction. The index of pairwise comparisons matrix consistency is calculated according to the formula [9, c. 66]:

$$CI = (\lambda_{\max} - n)/(n-1), \quad (2)$$

where CI - index of pairwise comparisons matrix consistency of expense, income and comparative approaches of real estate objects valuation,

$\lambda_{\max}$ - maximum own value of pairwise comparisons matrix $\mathbf{A}$,

n - order of square matrix $\mathbf{A}$ for given case $n = 3$.

It has been proven that matrix $\mathbf{A} \equiv \left\| a_{ij} \right\|$ is absolutely adjusted only in case when $\lambda_{\max} \geq n$ [9]. It should be pointed out that left part of equation (2) is dispersion of error which appeared as the consequence of inaccurateness of matrix $\mathbf{A}$ elements evaluation. In general case, for accepted level of adjustment ratio value $\leq 0{,}1$ for matrices of order $n = 3$ it is desirable to apply the value of adjustment ratio $\leq 0{,}05$ [9, p. 66]. " ... If for any matrix of pairwise comparisons this ratio exceeds 0,1 it testifies about significant breach of judgments logics admitted by an evaluator while filling out the matrix that is why the evaluator is offered to look through the data used in construction of the matrix. Such a procedure assumes unknown beforehand number of looking through iterations and values changes in pairwise comparisons matrices with repeated check for adjustment until accepted level of valuations adjustment is reached" [11].

According to the definition [12, p. 398] own values (characteristic numbers, own numbers) of a square matrix $\mathbf{A} \equiv \left\| a_{ij} \right\|$ are called the values of scalar parameter λ for which matrix $\mathbf{A} - \lambda\mathbf{I}$ is degenerated. Here $\mathbf{I}$ is a single matrix:

$$\mathbf{I} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \text{ i } \lambda\mathbf{I} = \begin{pmatrix} \lambda & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \lambda \end{pmatrix}. \quad (3)$$

Then matrix $\mathbf{A} - \lambda\mathbf{I}$ looks like

$$\mathbf{A} - \lambda\mathbf{I} = \begin{pmatrix} a_{11} - \lambda & a_{12} & a_{13} \\ a_{21} & a_{22} - \lambda & a_{23} \\ a_{31} & a_{32} & a_{33} - \lambda \end{pmatrix}. \quad (4)$$

If a matrix is degenerated its determinant is equal zero, that is

$$\det(\mathbf{A} - \lambda\mathbf{I}) = 0. \quad (5)$$

In case of order 3×3 equation (5) is reduced to the following look:

$$\lambda^3 - \alpha_1\lambda^2 + \alpha_2\lambda + \alpha_3 = 0, \quad (6)$$

where $\alpha_1 = a_{11} + a_{22} + a_{33}$,

$$\alpha_2 = a_{11}a_{22} + a_{22}a_{33} + a_{11}a_{33} - a_{12}a_{21} - a_{13}a_{31} - a_{23}a_{32}$$

$$\alpha_3 = -a_{11}a_{22}a_{33} + a_{23}a_{32}a_{11} + a_{12}a_{21}a_{33} + a_{13}a_{31}a_{22} - a_{12}a_{23}a_{31} - a_{13}a_{21}a_{32}$$

To find the solution for cubic equation (6) in relation to own values λ we shall reduce this equation to incomplete look. For this we shall make a replacement $\lambda = y - \alpha_1/3$ [12, p. 43]. Then we have

$$y^3 + py + q = 0, \quad (7)$$

where $p = -\alpha_1^2/3 + \alpha_2$,

$$q = 2(\alpha_1/3)^3 - \alpha_1\alpha_2/3 + \alpha_3.$$

Then the roots of the incomplete equation are found in the look

$$y_1 = 2\sqrt{-p/3}\cos(\alpha/3), \quad (8)$$

$$y_{2,3} = -2\sqrt{-p/3}\cos(\alpha/3 \pm \pi/3). \quad (9)$$

Here $\cos\alpha = -\dfrac{q}{2\sqrt{-(p/3)^3}}$.

We should note that the whole specter of own matrix values is found by formulas (8), (9) from which we choose the biggest.

The results of calculating maximum adjustment indices and matrices $\mathbf{A_1}$, $\mathbf{A_2}$, $\mathbf{A_3}$, $\mathbf{A_4}$ own values are generalized in table 6.

Table 6

Results of adjusting own values calculation and adjustment indices

Matrices	Own meanings, $\lambda_{\max}$	Adjustment index, *CI*
$\mathbf{A_1}$	3,009	0,005
$\mathbf{A_2}$	3,000	0
$\mathbf{A_3}$	3,054	0,027
$\mathbf{A_4}$	3,000	0

To define the influence degree (weight coefficients) of lower level elements on the elements of the next level we find vector of priorities which is normalized own matrix vector corresponding to its biggest own value [9, p. 64-66, 11].

$$\mathbf{W}_i = \frac{\sqrt[n]{\prod_{j=1}^{n} a_{ij}}}{\sum_{i=1}^{n} \sqrt[n]{\prod_{j=1}^{n} a_{ij}}} \quad (10)$$

For matrices $\mathbf{A_1}$, $\mathbf{A_2}$, $\mathbf{A_3}$, $\mathbf{A_4}$ normalized priorities vectors correspondingly $\mathbf{W_1}, \mathbf{W_2}, \mathbf{W_3}, \mathbf{W_4}$ will be the following:

$$\mathbf{W}_1 = \begin{pmatrix} 0{,}163 \\ 0{,}540 \\ 0{,}297 \end{pmatrix}, \quad \mathbf{W_2} = \begin{pmatrix} 0{,}6 \\ 0{,}2 \\ 0{,}2 \end{pmatrix}, \quad \mathbf{W_3} = \begin{pmatrix} 0{,}085 \\ 0{,}271 \\ 0{,}644 \end{pmatrix},$$

$$\mathbf{W_4} = \begin{pmatrix} 0{,}125 \\ 0{,}125 \\ 0{,}750 \end{pmatrix}.$$

The resulting vector of priorities $\mathbf{W}$ we find as a product of the matrix formed from vectors $\mathbf{W_2}, \mathbf{W_3}, \mathbf{W_4}$ on vector $\mathbf{W_1}$.

$$\mathbf{W} = \begin{pmatrix} 0{,}6 & 0{,}085 & 0{,}125 \\ 0{,}2 & 0{,}271 & 0{,}127 \\ 0{,}2 & 0{,}644 & 0{,}750 \end{pmatrix} \cdot \begin{pmatrix} 0{,}163 \\ 0{,}540 \\ 0{,}297 \end{pmatrix} = \begin{pmatrix} 0{,}180 \\ 0{,}217 \\ 0{,}603 \end{pmatrix}.$$

We received the following values of weight coefficients: for expense approach $w_V = 0{,}180$, for comparative approach $w_P = 0{,}217$, and for income approach $w_D = 0{,}603$. Thus, the most meaningful are the methods of net operational or rent income capitalization (income approach).

Conclusions

According to the results of the research we may draw the following conclusions:

1. The process of adjusting the results of land plots valuation received by means of different methodological approaches is the process of making a strategic decision, the choosing of the most optimal alternative among several alternatives (the results received by means of the three methodological approaches).
2. The meaningfulness level of each methodological approach in final cost value is reasonable to be calculated by means of the suggested method of calculated values of land plots cost adjusting which will give a possibility to reduce the degree of subjectivity when adjusting the results as well as it will make more understandable the logics of the estimator's judgments for the users of valuation results.

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The Method of Calculated Values Adjustment of Land Plots Cost

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The problem of calculated values adjustment of land plots cost received by three methodological approaches, namely expense, income and comparative ones has been investigated. The method of calculating the level of meaningfulness of each methodological approach in final cost value giving an opportunity to reduce the degree of subjectivity while adjusting the results has been suggested.