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Mathematical Modelling of Postindustrial Land Use Value in the Big Cities in Ukraine

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Abstract

The research paper deals with theoretical and methodological approaches to rational urban land use. Basing on the international scientific research, the authors offer original interpretation of the term «postindustrial land». Taking into account a drastic rapid dynamics of urbanization in large urban agglomerations worldwide and de-industrialization as a trend of urban land-use exemplified by the city of Kyiv in Ukraine a mathematical model of setting the price of postindustrial land with aimed to prediction the efficiency of industrial land transformation was developed in this study.

Keywords- Land transformation, Postindustrial land, Urban land, Economic and mathematical model.

1. Introduction

Problem of land-use is a complex social, economic, ecological and security problem (Kopachevsky et al., 2016; Shevchenko et al., 2017; Openko et al., 2017; Ievsiukov et al., 2018). A major task of modern urban land use is the release of great areas, used before for industrial production, which due to ineffectiveness of industries are being shifted now out of cities or transformed into highly profitable, green enterprises and territories (Mishenin and Koblyanska, 2012). Because now the major part of labor resources is employed in service sector, operation management and data processing, the employment rate of economically active population in material production is decreasing (Tsvyakh and Openko, 2017). Therefore, management decision concerning enterprises placement is more depends of logistics, the use of adjacent land, eco-economic factors and value of land (Mishenin and Koblyanska, 2012). At the same time, there are some important issues which are still not well-developed. In particular, streamlining the use of big city spaces, elaborating the system of economic liability of real estate developers in urban land-use, rational decision-making system based on eco-economic ground should be developed in view of industrial land transformation (Guo et al., 2018). The current land use structure in big cities with extensive postindustrial areas should be transformed according to the tendencies of industries decentralization and balanced urban use of resources (Guo et al., 2018). That is why the development of scientifically-grounded basis for rational use of postindustrial land is a topical task. According to (Voronina, 2012), the context of urban land use deindustrialization is quite ambiguous, since it is a deep transformation of a big city space. Beyond the positive effect of the release of urban territories from negative consequences of industrial period, the process of deindustrialization may be accompanied with negative social processes, because deindustrialization may be caused by an economic and social crisis, enterprises shutting down and the production decreasing. Researchers found (Guo and Xiong, 2014; Silva et al., 2014) that the decreasing of the industrial sector in the big city is connected with economy restructuring and growing a share of service sectors. This, in turn, is made possible by effective industrial development, with productivity level allowing to meet people`s material needs at a high level and, in doing so, releasing ever more resources for service industries development. Deindustrialization may be viewed in this case as a so-called by-product of industrial society evolution, based on knowledge and geo-information technologies. On the base of analysis of theoretical and methodological justification of transformation, deindustrialization, re-development of industrial facilities in a big city proposed in publications of Loures, Burley, Panagopoulos (Loures and Panagopoulos, 2007; Loures, 2008; Loures et al., 2008; Loures and Panagopoulos, 2010; Loures and Burley, 2012), Brandt et al. (2000), Berger (2006), Shevchenko et al. (2017) and others, the term of post-industrial lands was proposed. As the particularly interesting example of rational use of urban lands of non-functional industrial facilities, the Buttersea power station may be examined. This station was constructed in the 1930s on the South Bank of the River Thames in the area of Nine Elms. Reconstruction of the station and adjacent area is going to become the greatest construction in the history of modern London. The construction is scheduled to be completed in 2026. According to the plans of Battersea Power Station Development Company (BPSDC), which was set up by the investors for overseeing the project, renovation will affect not only the former power station, but also the adjacent territory of 16 ha. The industrial monument of the first half of XX century will be transformed into leisure and cultural and business center of the city district (Five most promising areas of Europe under construction, 2015).

In our research, we use term “postindustrial lands” to denote destroyed by human activities landscapes, empty and non-functional industrial facilities on deserted (not used for purposes intended) industrial territories, damaging adjacent settlements, having negative effect on mental condition of population, shaping unfavorable environment and resulting geo-ecological imbalances in urban system.

Therefore, the purpose of this research is to propose a mathematical model for setting the prices of postindustrial lands in big cities in the context of predicting the efficiency of industrial land transformation. The object of the research is the process of improving postindustrial land use.

2. Methodology of Modeling

According to the United Nations data since 2008, for the first time in history half the world`s population will live in urban areas. However, urbanization rate significantly varies by countries and regions (see Table 1).

Table 1. Dynamics of urban and rural population, 1950-2050*

	1950	1975	2007	2025	2050	1950-1975	1975-2007	2007-2025	2025-2050
	Urban population (mln people)					*Rate of urban population change (%)*			
Worldwide	**737**	**1519**	**3294**	**4584**	**6398**	**2,9**	**2,4**	**1,8**	**1,3**
Developed countries	427	702	910	995	1071	2,0	0,8	0,5	0,3
Developing countries	310	817	2384	3590	5327	3,9	3,3	2,3	1,6
Least developed countries	15	53	225	452	967	5,0	4,5	3,9	3,0
Africa	33	107	373	658	1234	4,8	3,9	3,1	2,5
Asia	237	574	1645	2440	3486	3,5	3,3	2,2	1,4
Latin America and the Caribbean	69	198	448	575	683	4,2	2,5	1,4	0,7
North America	110	180	275	337	401	2,0	1,3	1,1	0,7
Europe	281	444	528	545	557	1,8	0,5	0,2	0,1
Oceania	8	15	24	30	37	2,6	1,4	1,2	0,9
	Rural population (mln people)					*Rate of rural population change (%)*			
Worldwide	**1798**	**2558**	**3377**	**3426**	**2793**	**1,4**	**0,9**	**0,1**	**-0,8**
Developed countries	386	346	313	264	174	-0,4	-0,3	-0,9	-1,7
Developing countries	1412	2211	3064	3162	2619	1,8	1,0	0,2	-0,8
Least developed countries	185	305	580	734	775	2,0	2,0	1,3	0,2
Africa	192	309	592	736	764	1,9	2,0	1,2	0,1
Asia	1174	1820	2384	2339	1780	1,8	0,8	-0,1	-1,1
Latin America and the Caribbean	98	126	124	113	87	1,0	-0,1	-0,5	-1,1
North America	62	64	63	56	44	0,1	-0,1	-0,5	-1,1
Europe	267	232	204	170	107	-0,6	-0,4	-1,0	-1,8
Oceania	5	6	10	12	11	0,9	1,6	0,8	0,0

* according to «World Urbanization Prospects: The 2007 Revision» (UN, 2008)

Transformational effect of urbanization became first visible in the developed regions of the world, with the rate exceeding 80 % in Australia, New Zealand and North America. In the developed world Europe is the least urbanized, with 72% of population living in urban areas. Among developing countries particularly high urbanization rate (78%) has been reached in Latin America and the Caribbean, where it is higher than the same rate for Europe as a whole (UN, 2008). Urbanization rate is expected to rise in the decade to come in all key regions of the world, with the process in Africa and Asia proceeding faster, than in other key regions, even if the anticipated pace of urbanization drops compared to that, observed in the past decades (see Table 2). However, till the middle of the century urbanization rate in developing countries of Africa, Asia, Oceania is expected to be lower than that of developed countries, Latin America and the Caribbean. In general, the world`s population is likely to be 70% urban by 2050. The greatest number of urban dwellers is forecast to live in Asia (54 %) and Africa (19 %) (UN, 2008).

Table 2. Dynamics of urbanization, 1950-2050*

	1950	1975	2007	2025	2050	1950-1975	1975-2007	2007-2025	2025-2050
	Percentage of population in urban areas					*Rate of urbanization (%)*			
Worldwide	**29,1**	**37,3**	**49,4**	**57,2**	**69,6**	**1,0**	**0,9**	**0,8**	**0,8**
Developed countries	52,5	67,0	74,4	79,0	86,0	1,0	0,3	0,3	0,3
Developing countries	18,0	27,0	43,8	53,2	67,0	1,6	1,5	1,1	0,9
Least developed countries	7,5	14,8	27,9	38,1	55,5	2,7	2,0	1,7	1,5
Africa	14,5	25,7	38,7	47,2	61,8	2,3	1,3	1,1	1,1
Asia	16,8	24,0	40,8	51,1	66,2	1,4	1,7	1,2	1,0
Latin America and the Caribbean	41,4	61,1	78.3	83,5	88,7	1,6	0,8	0,4	0,2
North America	63,9	73,8	81,3	85,7	90,2	0,6	0,3	0,3	0,2
Europe	51,2	65,7	72,2	76,2	83,8	1,0	0,3	0,3	0,4
Oceania	62,0	71,5	70,5	71,9	76,4	0,6	0,0	0,1	0,2

*according to «World Urbanization Prospects: The 2007 Revision» (UN, 2008)

As it was pointed by Percyk (Voronina, 2012), the "urban giants" of 21st century – countries with population more than 100 mln – will include in 2025: China (832 mln), India (630 mln), the US (281 mln.), Brazil (205 mln), Indonesia (167 mln.), Nigeria (147 mln), Pakistan (142 mln), Russia (119 mln), Mexico (117 mln), and Japan (103 mln). At the same time, this data is slightly different than that set presented in the report of the UN Social and Economic Council (Table 3).

Table 3. Population Forecast for key countries of the world in 2025*

No.	Name of country	Rural population (mln people)	Urban population (mln people)	Proportion of urban population, %	Proportion of urban population in relation to world population, %	Population growth rate for 2007-2025, %	Urban population in 2025 (mln people)
	Worldwide	**3377**	**3294**	**49,4**	**100,0**	**1,8**	**4584**
1	China	767	561	42,2	17,0	2,1	822
2	India	828	341	29,2	10,4	2,5	538
3	USA	57	249	81,4	7,6	1,1	305
4	Brazil	28	163	85,2	5,0	1,3	207
5	Indonesia	115	117	50,4	3,5	2,4	179
6	Russian Federation	39	104	72,4	3,2	-0,4	96
7	Japan	43	85	66,3	2,6	0,1	86
8	Mexico	25	82	76,9	2,5	1,2	102
9	Nigeria	78	71	47,6	2,1	3,3	127
10	Germany	22	61	73,5	1,8	0,1	62
11	Pakistan	105	58	35,7	1,8	3,2	104
12	The Philippines	31	57	64,2	1,7	2,4	86
13	The United Kingdom	6	55	89,9	1,7	0,5	60
14	Turkey	24	51	68,2	1,6	1,6	68
15	Iran	23	48	68,0	1,5	1,8	67
16	France	14	48	77,1	1,4	0,7	54
17	Bangladesh	116	42	26,6	1,3	3,3	77
18	Italy	19	40	67,9	1,2	0,3	42
19	The Republic of Korea	9	39	81,3	1,2	0,4	42
20	Argentina	3	36	91,8	1,1	1,0	43
21	Columbia	12	34	74,2	1,0	1,4	44
22	Spain	10	34	77,0	1,0	0,5	38
23	Egypt	43	32	42,6	1,0	2,0	46
24	Ukraine	15	31	67,9	1,0	-0,5	28
25	South Africa	19	29	60,2	0,9	1,2	36

*according to «World Urbanization Prospects: The 2007 Revision» (UN, 2008)

In Ukraine the process of urbanization as a complex economic phenomenon has resulted to expansion of the urban areas and, consequently, to growth of proportion of urban dwellers, basically due to reduction of the number of rural population. Urban population in Ukraine is about 69,12 % (29,673 mln people), while rural population stands at 30,88 % (13,256 mln people). Expansion of the Dynamics of urban population in Ukraine was studied on the example of Kyiv capital city. Results of the study of processes of deindustrialization in the context of urban land use were tested on the model city of Kyiv, as one of the most densely populated industrial centers of Ukraine (Tsvyakh and Openko, 2017). According to the Kyiv City Development Strategy - 2025, the following key projected figures of demographic change of the city were accepted as a basis for Kyiv master plan calculations: resident population – 3,15 mln people, actual – 3,68 mln people, daytime – up to 4,0 mln people (The general plan of the city of Kyiv for the period till 2020, 2001). It was found that historically local industrial areas, enterprises, storages, factories are located within valuable for urban development sites such as coastal areas, health protection zones or near the residential buildings. According to data of the Main Department of the State Statistics Service of Ukraine in Kyiv, at the moment of January 01, 2016 the total area of Kyiv covered 83,6 k ha, including 4,6 k ha agricultural lands; 35,1 k ha of woods and other forested areas; 6,7 k ha of residential areas; and 3,3 k ha of industrial lands. Analysis of dynamics of land use in Kyiv during 1995–2016 demonstrates a tendency of expanding of the building sites: from 34,0 k ha in 1995 to 37,0 k ha in 2016. At the same time, total area of industrial lands decreased during this period from 5,9 to 3,3 k ha. In our opinion, the long-term economic development of Kyiv should be based on rational urban land-use, including deindustrialization, modernization and restructuring of productive capacities, reduction its resource consumption, and improving its competitiveness.

In general, in big developing cities there is an acute lack of lands of residential and civil use, especially in downtown. In this context, the question of territory choice for real estate construction became a topical: most convenient and optimal on technical indicators and town-planning conditions areas turn out to be occupied with industrial facilities, many of which eventually become unprofitable, environmentally hazardous or non-functional. This situation is caused by the following factors: historically formed urban infrastructure, lack of systematic approach to the process of zoning and overall city planning, as well as its rapid and eventually chaotic development, when radically different zones, e.g. industrial and residential zones become mixed.

Development of mathematical model for setting the price of postindustrial lands in a big city requires determination of factors directly affecting to market land value.
In our opinion, among the key factors, affecting the market value of postindustrial land (Y), the following are distinguished:

- inflation rate in Ukraine (X_1), %;
- inflation rate in Ukraine (progressive total) (X_2), %;
- average US dollar rate for the respective assessment period (X_3), UAH;
- existence of a subway station nearby (X_4), m;
- distance from downtown (X_5), m;
- existence of water bodies (X_6), m;
- distance from recreation areas – parks, squares, woodlands etc.) (X_7), m;
- existence of residential areas nearby (X_8), m;

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- existence of railway nearby (X_9), m;
- distance to city center (city center – site of the main post office) (X_{10}), km;
- total area of land (X_{11}), ha;
- proportion of the land, belonging to industrial zones as per the master plan (X_{12}), %;
- dynamics of the average monthly wage of those, employed in industries (X_{13}), UAH;
- average income of the population of Kyiv (X_{14}), mln UAH;
- fixed investments in the city (X_{15}), mln UAH.

Before constructing a mathematical dependence, the impact of factors (X_1, X_2, X_3, …, X_{15}) to the final outcome – postindustrial land value (Y) – was assessed. To that effect, possible combinations of pair coefficients of correlation between resultant figure (Y) and factors (X_1, X_2, X_3, …, X_{15}) were determined.

Adhering to the scheme of the least-squares method, we have to find min F (b, c), which is formulated as the following optimization problem:

$$\sum_{j=1}^{m} R^2\left(y_j, b\mathrm{x}_j + c\right) \to \min_{b,c}, \tag{1}$$

Which in fuzzy numbers becomes:

$$\sum_{j=1}^{m} \int_0^1 \left[\frac{1}{2}\left(b \times {}^a x_{0j} + c - {}^a y_{0j}\right)^2 + \frac{1}{2}\left(b \times {}^a x_{1j} + c - {}^a y_{1j}\right)^2 \right] da \to \min, \tag{2}$$

where ${}^a x_{0j}$ and ${}^a y_{0j}$ – left limits of ranges α–cuts of the fuzzy numbers x and y; ${}^a x_{1j}$ and ${}^a y_{1j}$ – respective right limits of ranges.

In the determination of regression coefficients b, c we have two equations, expressed in the derivatives:

$$\frac{dF(b,c)}{db} = 0; \frac{dF(b,c)}{dc} = 0, \tag{3}$$

Since derivatives of the function (3) equal:

$$\begin{aligned} \frac{dF}{db} &= \sum_{j=1}^{m} [\int_0^1 (b \times {}^a x_{0j} + c - {}^a y_{0j}) \times {}^a x_{0j}\, da + \int_0^1 (b \times {}^a x_{1j} + c - {}^a y_{1j}) \times {}^a x_{1j}\, da], \\ \frac{dF}{dc} &= \sum_{j=1}^{m} [\int_0^1 (b \times {}^a x_{0j} + c - {}^a y_{0j}) da + \int_0^1 (b \times {}^a x_{1j} + c - {}^a y_{1j}) da], \end{aligned} \tag{4}$$

To do the sum we get a system of equations:

$$\begin{cases} \overline{X^2} \times b + \overline{X} \times c = \overline{XY} \\ \overline{X} \times b + 2m \times c = \overline{Y} \end{cases}, \tag{5}$$

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In which the following symbols are accepted:

$$\overline{X}=\sum_{j=1}^{m}[\int_0^1 {}^a x_{0j}da+\int_0^1 {}^a x_{1j}da],\ \overline{Y}=\sum_{j=1}^{m}[\int_0^1 ({}^a y_{0j}da+\int_0^1 {}^a y_{1j}da],$$
$$\overline{XY}=\sum_{j=1}^{m}[\int_0^1 {}^a x_{0j}\times {}^a y_{0j}da+\int_0^1 {}^a x_{1j}\times {}^a y_{1j}da], \tag{6}$$
$$\overline{X^2}=\sum_{j=1}^{m}[\int_0^1 {}^a x_{0j}^2 da+\int_0^1 {}^a x_{1j}^2 da],$$

Doing the system of equations, we get the value of regression coefficients: $b=\frac{\begin{vmatrix}\overline{XY} & \overline{X}\\ \overline{Y} & 2m\end{vmatrix}}{\Delta}, c=\frac{\begin{vmatrix}\overline{X^2} & \overline{XY}\\ \overline{X} & \overline{Y}\end{vmatrix}}{\Delta}$,

where: $\Delta=\begin{vmatrix}\overline{X^2} & \overline{X}\\ \overline{X} & 2m\end{vmatrix}$ – determinant of the system of equations (5).

Consequently, having done the system of equations, (5) we get the following values of coefficients: $b=\frac{2m\overline{XY}-\overline{X}\times\overline{Y}}{2m\overline{X^2}-\overline{X}^2}$; $c=\frac{\overline{X^2}\times\overline{Y}-\overline{X}\times\overline{XY}}{2m\overline{X^2}-\overline{X}^2}$ – that is an analogue of formulas for calculating coefficients of two-dimensional regression for exact numbers.

3. Results of the Modeling

The findings allow extending methods of regressive analysis of fuzzy numbers from a relatively narrow range of triangular fuzzy numbers to the whole range of fuzzy arbitrary numbers (Table 4).

To create the mathematical model, stepwise multiple regression was used, which is applicable when the resultant figure (Y) depends on multiple factors (X), in our case – on X_1, X_2, X_3, X_4, X_{10}, X_{13}, X_{14}, X_{15} (7):

$$Y=a_0 x_1^{a_1}\times x_2^{a_2}\times\ldots\times x_m^{a_m}=a_0\prod_{j=1}^{m}x_j^{aj}, \tag{7}$$

x_1, x_2, …, x_m – factors, affecting the result figure Y;
a_0, a_1, a_2, …, a_m– unknown regression parameters.

Using the least-square method, we can found the unknown parameters a of the searched mathematical model by means of Microsoft Excel software, namely, built-in LINEST function. To obtain a form of linear dependence (eq. 8) it is necessary to turn the stepwise regression into a linear form by taken the logarithms of the regression equation and make a replacement of variables.

$$\ln y=\ln a_0+a_1\ln x_1+a_2\ln x_2+\ldots+a_m\ln x_m, \tag{8}$$

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Table 4. Determination of various combinations of pair correlation coefficients (R) along the main diagonal*

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
Y		0,35	0,49	0,31	0,27	0,06	-0,13	-0,05	0,18	-0,07	-0,41	-0,07	-0,12	0,45	0,44	0,28
X1			0,57	0,49	-0,01	-0,04	0,16	-0,11	-0,03	-0,12	0,09	-0,02	0,02	0,49	0,50	0,36
X2				0,87	-0,07	-0,13	0,13	-0,09	0,03	-0,14	0,04	0,03	0,01	0,99	0,99	0,66
X3					0,00	-0,06	0,06	-0,02	0,11	-0,14	-0,02	-0,05	-0,13	0,86	0,86	0,90
X4						0,32	-0,17	0,10	0,07	-0,16	-0,49	-0,09	-0,06	-0,09	-0,09	0,03
X5							-0,20	0,04	0,09	0,01	-0,26	-0,08	0,06	-0,14	-0,14	-0,02
X6								-0,23	-0,08	-0,04	0,23	0,15	0,09	0,13	0,13	-0,04
X7									-0,07	0,15	-0,04	0,11	0,04	-0,09	-0,09	0,06
X8										-0,30	-0,19	-0,13	-0,62	0,03	0,02	0,12
X9											0,05	0,05	0,36	-0,12	-0,13	-0,03
X10												0,01	0,06	0,07	0,07	-0,05
X11													0,15	0,05	0,05	-0,06
X12														0,01	0,01	-0,17
X13															1,00	0,66
X14																0,65
X15																

*Calculated by the authors

Having regard to the scale of interpretation of the correlation coefficient, eight factors (X_1, X_2, X_3, X_4, X_{10}, X_{13}, X_{14}, X_{15}) were singled out, which to a certain extent affect the market value of postindustrial land (Y), from among X_1, X_2, X_3, X_{10}, X_{13}, X_{14} – having a mean effect; factors X_4, X_{15} – a low effect, a X_5, X_6, X_7, X_8, X_9, X_{11}, X_{12}, do not affect the land value at all (Table 5).

Table 5. Choice of factors, affecting the market value of land underlying industrial facilities by correlation coefficient*

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
Y		0,35	0,49	0,31	0,27	0,06	-0,13	-0,05	0,18	-0,07	-0,41	-0,07	-0,12	0,45	0,44	0,28
X1			0,57	0,49	-0,01	-0,04	0,16	-0,11	-0,03	-0,12	0,09	-0,02	0,02	0,49	0,50	0,36
X2				0,87	-0,07	-0,13	0,13	-0,09	0,03	-0,14	0,04	0,03	0,01	0,99	0,99	0,66
X3					0,00	-0,06	0,06	-0,02	0,11	-0,14	-0,02	-0,05	-0,13	0,86	0,86	0,90
X4						0,32	-0,17	0,10	0,07	-0,16	-0,49	-0,09	-0,06	-0,09	-0,09	0,03
X5							-0,20	0,04	0,09	0,01	-0,26	-0,08	0,06	-0,14	-0,14	-0,02
X6								-0,23	-0,08	-0,04	0,23	0,15	0,09	0,13	0,13	-0,04
X7									-0,07	0,15	-0,04	0,11	0,04	-0,09	-0,09	0,06
X8										-0,30	-0,19	-0,13	-0,62	0,03	0,02	0,12
X9											0,05	0,05	0,36	-0,12	-0,13	-0,03
X10												0,01	0,06	0,07	0,07	-0,05
X11													0,15	0,05	0,05	-0,06
X12														0,01	0,01	-0,17
X13															1,00	0,66
X14																0,65

*Calculated by the authors

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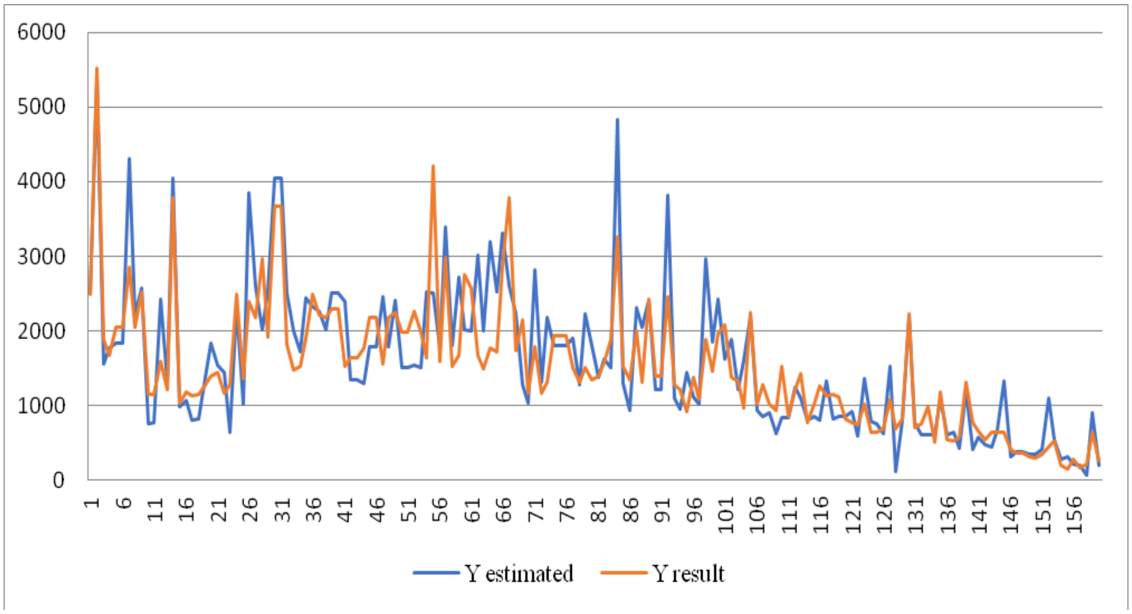

Figure 1. Graphic representation of adequacy of the mathematical model of land deindustrialization in Kyiv, developed on the basis of stepwise multiple regression, UAH/m^2.

Linear elements were substituted for the nonlinear: $x_j^{'} = \ln x_j, (j = 1, \overline{m}); y^{'} = \ln y; a_0^{'} = \ln a_0 \cdot$

As a result, we got the following transposed equation (9):

$$y^{'} = a_0^{'} + a_1 x_1^{'} + a_2 x_2^{'} + \dots + a_m x_m^{'}, \tag{9}$$

According to our parameters, the general regression equation will be following:

$$y^{'} = a_0^{'} + a_1 x_1^{'} + a_2 x_2^{'} + a_3 x_3^{'} + a_4 x_4^{'} + a_{10} x_{10}^{'} + a_{13} x_{13}^{'} + a_{14} x_{14}^{'} + a_{15} x_{15}^{'}, \tag{10}$$

If we calculate (based on the least squares method) y' and x', we can determine the regressors a'_0, a_1, a_2, a_3, a_4, a_{10}, a_{13}, a_{14}, a_{15}. Hence, the mathematical model of stepwise multiple regression, allowing to evaluate postindustrial land in Kyiv, will be presented as follows:

$$y = 4{,}58011E - 12 \times x_1^{0{,}035} \times x_2^{0{,}931} \times x_3^{-1{,}015} \times x_4^{0{,}145} \times x_{10}^{-0{,}390} \times x_{14}^{1{,}374} \times x_{15}^{2{,}758}, \tag{11}$$

where x_1, x_2, x_3, x_4, x_{10}, x_{13}, x_{14}, x_{15}– factors x, affecting the resultant figure (postindustrial land value).

Thus, we develop the mathematical model, allowing to predict postindustrial land value in Kyiv based on the known factors x_1, x_2, x_3, x_4, x_{10}, x_{13}, x_{14}, x_{15} and, consequently, to model the efficiency of land deindustrialization.

Based on the economic and mathematical model, expert monetary evaluation of the researched land was made (N =160) and depicted graphically (Figure 1), showing that curve Y (estimated) somehow describes curve Y (result).

4. Conclusions

The proposed economic and mathematical model of stepwise multiple regression allowing to predict a postindustrial land value, can be used for analysis of typical big cities. It should also be noted that this model enables to simulate rational land use and determine key directions of transforming postindustrial urban lands into a highly profitable territorial resource. It was found that the prime costs, related to the application of the mathematical model of expert monetary evaluation of postindustrial lands in a big city, cover the maintenance and upkeep the costs of data matrix of an expert monetary evaluation of typical lands. The determined dependency will allow automating the process of expert evaluation of similar lands in a big city based on the model developed. Economic efficiency of its application may be manifested in lower transaction costs related to staffing of immovable property valuators. In addition, positive effects of application of the economic and mathematical model in the field of management were determined, in particular objective and impartial decision-making as to the market postindustrial land value. For this reason, regardless the long-term process of creating, populating and updating an info-base of expert monetary evaluation of postindustrial land, which underlies the development of the model, it is emphasized, that its further application will reduce the subjective impact of valuators to the land evaluation.

Conflict of Interest

The authors confirm that this article contents have no conflict of interest.

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