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Optimization of the variables selection in the process of real estate markets rating

Małgorzata Renigier-Biłozor
Andrzej Biłozor

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Małgorzata Renigier-Biłozor
Andrzej Biłozor
malgorzata.renigier@uwm.edu.pl
University of Warmia and Mazury in Olsztyn
The Faculty of Geodesy, Geospatial and Civil Engineering
Department of Real Estate Management and Regional Development
Department of Cadastre and Spatial Management

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Abstract

The growing significance of the real estate market prompts investors to search for factors and variables which support cohesive analyses of real estate markets, market comparisons based on diverse criteria and determination of market potential. The specificity of the real estate market is determined by the unique attributes of property. The Author's assume that developing real estate market ratings identifies the types of information and factors which affect decision-making on real estate markets. The main objective of real estate market ratings is to create a universal and standardized classification system for evaluating the real estate market. One from the most important problem in this area is collection of appropriate features of real estate market and development dataset. The main problem involves the selection and application of appropriate features, which would be relevant to the specificity of information related to the real estate market and create a kind of coherent system aiding the decision-making process. The main aim of this study is to optimization of variables set that were used to develop the real estate market ratings. To this purpose Hellwig's method of integral capacity of information was applied. In this particular case, this method shows what set of variables provides information most sufficiently. The results lead to obtain the necessary set of features that constitute essential information which describes the situation on the local real estate market.

The study was prepared as a result of implementation of research project No. UMO-2014/13/B/HS4/00171 financed from the funds of the National Science Centre.

Introduction

The real estate market is one of the most rapidly developing goods markets that attract massive investments, but as an object of research, it poses numerous problems.

The level of knowledge about the market and its participants is a factor that determines the efficiency of the real estate market, but is often disregarded in market analyses. Knowledge gaps may originate with active market participants who have limited information about the system and its constituent elements. Other market participants may also have limited knowledge in this area. The knowledge manifested by entities conducting transactions on the RE market is (according to theoretical assumptions) limited or negligent. The above implies that market participants conduct transactions without mutual knowledge which leads to asymmetry in the decision-making process. This could lower the efficiency and, consequently, the effectiveness of the entire market. Researchers analyzing the real estate market should also demonstrate a sufficient level of knowledge about the mutual relationships between the subjects and objects of market transactions (Renigier-Biłozor, Wiśniewski, 2012, str. 95-110).

Providing access to the knowledge of the real estate market developed in the form of a simple message is the only way to solve this problem. The authors assumed that it can be achieved by developing a measure of the rating real estate markets providing general and unambiguous/clear information classifying the object of analysis and being an effective decision-making support system.

The specificity of the real estate market is determined by the unique attributes of property. For this reason, rating methodologies applied on capital markets cannot be simply copied to the real estate market.

The main objective of real estate market ratings is to create a universal and standardized classification system for evaluating the real estate market. A rating system contributes to objectivity in the decision-making process and it shortens decision-making time (Renigier-Biłozor et al., 2014).

Real estate market ratings serve a variety of practical purposes. They are used to develop portfolio investment strategies (Anglin and Yanmin, 2011, Collett, Lizieri and Ward, 2003) and formulate long-short portfolio strategies on housing indices for more risky and less risky assets characterized by low liquidity (Berach and Skiba, 2011). The scarcity of relevant information results from the shortcomings of market

effectiveness analyses (Case and Shiller, 1989, Fama, 1990, Grossman and Stiglitz, 1980, Dawidowicz and oth 2014). According to Case and Shiller (1989, 1990), the ineffectiveness of the analyzed market can be attributed to individual investors who do not have access to objective knowledge about the real estate market.

One from the most important reasons behind undertaking research in this area is the problem which occurs in the advanced real estate analysis, as collection of appropriate features of real estate market and development dataset. Market features are usually divided into macroeconomic and microeconomic factors, including socio-demographic development, overall economic development and political, legal condition and property market. The main problem involves the selection and application of appropriate features, which would be relevant to the specificity of information related to the real estate market and create a kind of coherent system aiding the decision-making process.

The main aim of this study is to verify the variables that were used to develop the real estate market ratings in the author's previous work entitled: "Rating methodology for real estate markets - poland case study" (Renigier-Biłozor et al., 2014). At this target Hellwig's method of integral capacity of information was applied. This method, in this particular case it is showing, what store of features are providing information with the almost full source.

The results lead to obtain the necessary set of features that constitute essential information which describes the situation on the local real estate market.

The study was prepared as a result of implementation of research project No. UMO-2014/13/B/HS4/00171financed from the funds of the National Science Centre.

Methodology of the research

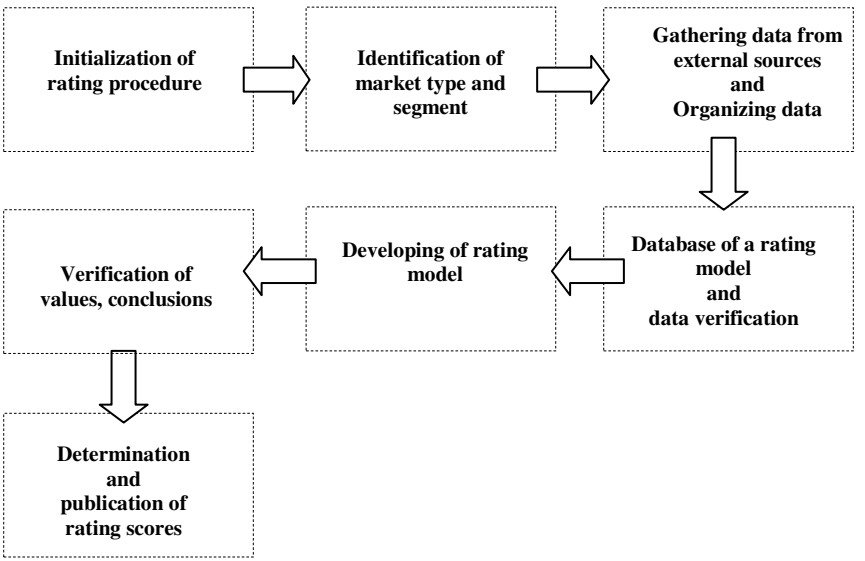
Although recent year have witnessed the growing popularity of various support systems, comprehensive and effective information systems that facilitate real estate management and analyses continue to be in short supply. The above results from the specific character of real estate management operations which involve complex procedures and decisions, as well as the unique character of real estate data. Those factors prevent smooth flow of information which is required for the implementation of rational decisions and actions in business, investment, financial and promotional projects (Renigier-Biłozor, 2013).

The growing significance of the real estate market prompts investors to search for factors and variables which support cohesive analyses of real estate markets, market comparisons based on diverse criteria and determination of market potential. Investors search for similarities that would enable them to develop risk minimizing strategies. Ratings are a modern tool that can be deployed in analyses and predictions of real estate market potential.

The Author's assume that developing real estate market ratings identifies the types of information and factors which affect decision-making on real estate markets. The detailed objectives of developing scoring systems for real estate markets are: to introduce objective benchmarks for comparing real estate markets, to reduce the number of variables in the decision-making process, to evaluate real estate markets' potential for economic and spatial growth, to evaluate social benefits/losses resulting from the development of a given real estate market, to provide for effective flow of information about the real estate market.

A rating methodology has to be adapted to the specific attributes of a real estate market. A general diagram of a real estate market rating procedure is shown in Fig. 1.

Figure 1. Diagram of a rating procedure.



Source: Own study based on Renigier et al., (2014).

The above diagram has been expanded to include detailed information about the type of the analyzed real estate market, its structure and functions. A detailed diagram can be then used to evaluate any real estate market. Rating scores are diversified for different market types and market segments at the level of rating variables, i.e. information and factors describing real estate functions. The proposed system has a modular structure to ensure greater methodological openness. A given market can be rated with the involvement of all or selected modules.

In this study, we assume that the type and the segment of the real estate market are identified, and the utility function of real estate is determined. Market type is indicative of the utility function of real estate: investment market, commercial market, industrial market, agricultural market. etc. Market segment accounts for a specific group of real estate which is identified in a given type of a market in view of its utility function. A real estate market would be very difficult to rate without prior classification. The aim of the proposed division is to introduce a certain degree of uniformity to the rating procedure. The main standardizing factor is the utility function of the market and real estate, which implies that markets will be evaluated based on their utility rather than legal status (Renigier et al., 2014).

In order to collect appropriate data set of variables that diagnosed situation on the residential real estate market the many publication (Kaklauskas et al. (2011) Irwin et al. (1993), Jaffe and Sirmans (1989), Bryx and Matkowski (2001), Case (2000) , Źróbek and Grzesik (2013)) has been analyzed. The authors compiled the existing knowledge to propose an indicator sets for evaluating the real estate markets (table 1) that identify the types of information and factors which affect decision-making on real estate markets.

Mainly residential real estate market is selected for the analysis, due to the lack of such solutions on the market, and the universality of participation from the viewpoint of customers.

Since the main aim of a rating is to provide quick, objective, reliable and updated information, a dataset has to be developed as a platform for quantitative and qualitative analyses. In view of the specific character of the real estate market, the availability of market information and the sudden and unpredictable changes that often occur on that market, the developed system for gathering market data should be flexible enough to enable frequent modifications.

From the analytical point of view, the solution to the problem requires the selection of appropriate methods for analyzing the available

information rather than, as it is often observed in practice, the adaptation of the existing information to analytical methods. In the era of globalization, quick and unified solutions (procedures, algorithms) are needed to enhance the objectivity and the reliability of research results. The preferred solutions should address the problem on a global scale while accounting for the local characteristics of the analyzed markets and the relevant information.

In this case, the authors suggest use of Hellwig's method (Hellwig, 1976) as a tool for determining an optimum set of variables to evaluate real property market rating.

The heuristic proposed by Hellwig (1969) takes into account both class feature correlation and correalation between pairs of variables. The best subset of features is selected from among all possible subsets that maximizes the so-called "integral capacity of information.

Development of an optimal set of variables to assess the rating of real estate market

Residential property (apartment) markets in capital cities of Polish regions were rated in this study.

The dataset for the residential property market was developed for supply and demand categories (Table 1 and 2) based on the available information.

Table 1. Demand of data categories

Cities	x1	x2	x3	x4	x5	x6	x7	x8	x9	...	x23
Gdańsk	0,67	12677,00	1034,00	0,75	-1,68	101,50	14,00	0,86	-1,68	...	38,00
Olsztyn	0,85	11888,00	-222,00	0,47	-5,80	94,22	3,00	0,80	-5,80	...	35,00
Szczecin	0,85	9696,00	96,00	0,52	-3,07	116,44	6,00	0,87	-3,07	...	42,00
Bydgoszcz	0,92	10101,00	-401,00	1,07	-7,50	71,61	4,00	0,82	-7,50	...	31,00
Białystok	0,84	12389,00	-576,00	0,48	-3,60	111,61	9,00	0,71	-3,60	...	34,00
Poznań	0,66	13112,00	472,00	0,65	-0,06	102,50	11,00	0,74	-0,06	...	45,00
Warszawa	0,52	18684,00	1181,00	0,85	-5,25	118,60	11,00	0,69	-5,25	...	46,00
Łódź	0,92	10850,00	-312,00	0,44	-6,30	84,20	3,00	0,84	-6,30	...	34,00
Wrocław	0,67	14915,00	-19,00	1,02	-3,57	105,48	8,00	0,66	-3,57	...	41,00
Lublin	0,75	10886,00	-58,00	0,32	-1,30	126,40	3,00	0,73	-1,30	...	35,00
Kraków	0,57	13056,00	123,00	0,20	-1,16	145,64	4,00	0,59	-1,16	...	42,00
Rzeszów	0,81	11525,00	-16,00	0,46	-1,56	121,96	10,00	0,80	-1,56	...	33,00
Zielona Góra	1,06	11627,00	-670,00	1,13	0,13	90,04	9,00	0,87	0,13	...	39,00
Kielce	0,80	13553,00	-414,00	0,54	-2,10	109,77	4,00	0,71	-2,10	...	33,00

Katowice	0,87	12804,00	1309,00	0,55	-10,50	100,46	11,00	1,18	-10,50	...	34,00
Opole	0,89	12752,00	-172,00	0,22	-4,32	105,56	6,00	0,85	-4,32	...	35,00

x1 - average purchasing power in comparison with the national average, x2 - local government's spending per 1 resident in recent years, x3 - difference between the national average salary and the average salary on the local market, x4 - local government's spending on promotion, x5 - changes in local property prices, x6 - ratio of replacement value of 1 m2 of property and the average transaction price on the local real estate market, x7 - number of property transactions per 1000 residents, x8 - purchasing power on the local housing market, x9 - changes in local property prices, x10 - ratio of replacement value of 1 m2 of property and the average transaction price on the local real estate market, x11 - average time on the market in months, x12 - number of real estate agents on the local market, x13 - availability of mortgages in terms of m2, x14 - value of property transaction per 1 resident on the local market, x15 - population density per m2, x16 - number of marriages, x17 - number of divorces, x18 - net migration rate, x19 - population growth, x20 - age structure of potential clients (25-45 population group vs. total population in a given area), x21 - unemployment rate, x22 - quality of life, x23 - number of new registered businesses per 1000 residents.

Source: own study based on Renigier et al. (2014).

Table 2. Supply of data categories.

Cities	x1	x2	x3	x4	x5	x6	x7	x8	x9	...	x14
Gdańsk	419	3203	279	50	123,59	22863	52,00	168,74	299,00	...	64,32
Olsztyn	93	911	72	28	102,86	4926	19,00	131,46	375,00	...	44,36
Szczecin	247	2704	226	39	128,04	15918	45,00	151,26	739,00	...	41,44
Bydgoszcz	35	1255	139	64	76,67	22786	25,00	158,00	1017,00	...	30,66
Białystok	393	1184	156	20	123,35	5879	10,00	139,27	273,00	...	33,46
Poznań	340	4438	526	33	115,07	18072	45,00	143,28	1396,00	...	31,39
Warszawa	379	15663	980	90,5	142,06	155703	266,00	116,17	-634,00	...	28,77
Łódź	359	2562	655	20,6	93,50	15186	52,00	141,62	936,00	...	5,33
Wrocław	621	8053	479	75,5	119,98	47823	100,00	107,45	13,00	...	46,09
Lublin	26	2267	207	23	131,93	8043	20,00	152,43	87,00	...	44,17
Kraków	221	8620	494	82,5	153,64	62393	154,00	125,43	148,00	...	35,79
Rzeszów	226	1486	669	13	127,35	2301	110,00	136,75	-187,00	...	11,66
Zielona Góra	613	1144	133	18	95,04	2151	10,00	129,13	686,00	...	57,35
Kielce	262	1378	226	12	116,17	2502	43,00	131,67	445,00	...	11,05
Katowice	694	1351	130	28	113,58	6815	30,00	181,95	1361,00	...	20,55
Opole	174	270	76	21	114,94	2633	11,00	165,14	899,00	...	33,13

x1 - local government's spending on housing policy in zl, x2 - total number of issued construction permits, x3 - number of issued construction permits, x4 - number of property offers per 1000 residents, x5 - ratio of replacement value per 1 m2 of property to the average price quoted on the local real estate market, x6 - number of property offers, x7 - number of developers on the local market, x8 - affordability of rental housing in m2, x9 - difference between the average prices of new and second-hand property, x10 - number of deaths (older than 50), x11 - existing residential area per 1 resident, x12 - number of residents per 1 existing apartment, x13 - number of new apartments per 1000 residents, x14 - percent of land covered by zoning.

Source: own study based on Renigier et al. (2014).

Rating scores were determined individually for supply and demand with utilization of rough set theory and Ward's cluster analysis and statistical measures. In mentioned study assumed that real estate markets are scored on a 10-point rating scale and are divided into four rating level groups: investment, development, stagnant and crisis. Except for the crisis level group which has a single score – D, there are three scores per each group: AAA/BBB/CCC, AA/BB/CC and A/B/C. Scores AAA/BBB/CCC represent the highest rating, AA/BB/CC – a medium rating, and A/B/C – the lowest rating in a given group. Plus (+) and minus (-) signs may be appended to rating symbols to indicate their relative position within each group. Numerical values were assigned to every rating score to facilitate calculations: AAA – (1), AA – (2), A – (3), BBB – (4), BB – (5), B – (6), CCC – (7), CC – (8), C – (9) and D – (10).

The result of this work was the elaboration of average rating scores that were determined for the analysed markets for demand and supply (Table 3).

Table 3. "Average rating scores" for the analyzed real estate markets

Markets	Rating of supply		Rating of demand	
Gdańsk	4.07	BBB	4.52	BB+
Olsztyn	6.00	B	5.42	BB-
Szczecin	4.86	BB	5.47	BB-
Bydgoszcz	6.07	B	5.61	B+
Białystok	5.50	BB-	5.71	B+
Poznań	4.64	BB+	4.80	BB
Warsaw	3.07	A	3.42	A-
Łódź	5.36	BB-	5.89	B
Wrocław	3.64	BBB+	4.76	BB+
Lublin	5.28	BB-	6.19	B
Kraków	4.00	BBB	4.67	BB+
Rzeszów	5.14	BB	5.42	BB-
Zielona Góra	5.71	B+	5.71	B+
Kielce	5.71	B+	6.27	B-
Katowice	5.43	BB-	5.33	BB-
Opole	6.36	B-	6.28	B-

Source: own study based on Renigier (2014).

Efficiency of presented studies depends, in a significant degree, on availability of data, data reliability and uniformity. The analysed phenomenon is very complex in its nature and requires collection of a lot of varied data. This is related to significant labour outlays, as well as the necessity of incurring significant costs.
The objective of this study is to determine an optimum set of information indispensable for preparing a rating assessment. In the presented scheme No. 1, this is a module related to the database of a rating model and data verification. In the original study (Renigier … 2014), it was not possible to verify the significance of variables on account of absence of dependent variable. Therefore, assuming the result of a rating in numerical form as a dependent variable, analysis of significance of the accepted information divided into demand and supply nature of the market was adopted.
For the purpose of finding an optimum combination of explanatory variables – combinations with greatest integral information capacity index, Hellwig's method was applied. At the beginning, the Pearson's correlation coefficient was calculated for demand and supply indices (explanatory variables) with respect to the demand rating (Table No. 4) and supply rating (Table No. 5).

Table 4. Correlation scores for real estate rating of demand

Demand variables	Correlation scores with rating of demand
average purchasing power in comparison with the national average	0,75
local government's spending per 1 resident in recent years	-0,70
difference between the national average salary and the average salary on the local market	-0,69
local government's spending on promotion	-0,34
changes in local property prices	-0,01
ratio of replacement value of 1 m2 of property and the average transaction price on the local real estate market	-0,24
number of property transactions per 1000 residents	-0,57
purchasing power on the local housing market	0,23
changes in local property prices	-0,01
ratio of replacement value of 1 m2 of property and the average transaction price on the local real estate market	-0,24

average time on the market in months	0,34
number of real estate agents on the local market	-0,79
availability of mortgages in terms of m2	-0,22
value of property transaction per 1 resident on the local market	-0,72
population density per m2	-0,45
number of marriages	-0,80
number of divorces	-0,83
net migration rate	-0,69
population growth	-0,37
age structure of potential clients (25-45 population group vs. total population in a given area)	-0,81
unemployment rate	0,70
quality of life	-0,53
number of new registered businesses per 1000 residents	-0,74

Source: own study based on Renigier 2014.

Table 5. Correlation for supply of real estate rating

Supply variables	**Correlation scores with rating of demand**
local government's spending on housing policy in zl	-0,34
total number of issued construction permits	-0,89
number of issued construction permits	-0,73
number of property offers per 1000 residents	-0,75
ratio of replacement value per 1 m2 of property to the average price quoted on the local real estate market	-0,65
number of property offers	-0,78
number of developers on the local market	-0,81
affordability of rental housing in m2	0,45
difference between the average prices of new and second-hand property	0,55
number of deaths (older than 50)	-0,76
existing residential area per 1 resident	-0,61

number of residents per 1 existing apartment	0,62
number of new apartments per 1000 residents	-0,49
percent of land covered by zoning	-0,21

Source: own study based on Renigier 2014.

Subsequently, the matrix of correlation coefficients was determined among explanatory demand (Table No. 6) and supply (Table No. 7) variables.

Table 6. Correlation coefficients for demand

Correlation scores	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	…	x23
x1	1,00											…	
x2	-0,68	1,00										…	
x3	-0,57	0,50	1,00									…	
x4	0,55	-0,33	0,34	1,00								…	
x5	-0,23	-0,02	-0,27	-0,04	1,00							…	
x6	-0,63	0,28	0,21	-0,56	0,45	1,00						…	
x7	-0,27	0,42	0,63	0,36	0,11	0,02	1,00					…	
x8	0,55	-0,33	0,34	0,06	-0,57	-0,45	0,28	1,00				…	
x9	-0,23	-0,02	-0,27	-0,04	1,00	0,45	0,11	-0,57	1,00			…	
x10	-0,63	0,28	0,21	-0,56	0,45	1,00	0,02	-0,45	0,45	1,00		…	
x11	0,27	-0,14	-0,20	0,01	-0,20	-0,19	-0,20	0,12	-0,20	-0,19	1,00	…	
x12	-0,69	0,74	0,50	0,10	0,00	0,33	0,22	-0,38	0,00	0,33	-0,21	…	
x13	0,01	0,08	0,74	0,07	-0,42	-0,08	0,43	0,77	-0,42	-0,08	-0,01	…	
x14	-0,45	0,59	0,49	0,31	-0,07	0,13	0,52	-0,10	-0,07	0,13	-0,36	…	
x15	-0,40	0,54	0,11	0,16	-0,10	0,11	0,04	-0,43	-0,10	0,11	0,38	…	
x16	-0,72	0,70	0,46	0,20	-0,01	0,26	0,18	-0,45	-0,01	0,26	0,00	…	
x17	-0,71	0,69	0,52	0,18	-0,11	0,26	0,20	-0,37	-0,11	0,26	-0,08	…	
x18	-0,51	0,76	0,38	0,20	-0,04	0,35	0,25	-0,31	-0,04	0,35	-0,22	…	
x19	-0,45	0,44	0,15	0,12	0,40	0,45	0,34	-0,39	0,40	0,45	-0,48	…	
x20	-0,71	0,73	0,52	0,17	-0,09	0,26	0,21	-0,37	-0,09	0,26	-0,01	…	
x21	0,58	-0,59	-0,70	-0,21	0,03	-0,14	-0,49	-0,03	0,03	-0,14	0,46	…	
x22	-0,35	0,18	0,57	0,06	-0,38	-0,06	0,48	0,21	-0,38	-0,06	-0,39	…	
x23	-0,63	0,54	0,44	0,18	0,38	0,38	0,37	-0,35	0,38	0,38	-0,38	…	1,00

x1 - average purchasing power in comparison with the national average, x2 - local government's spending per 1 resident in recent years, x3 - difference between the national average

salary and the average salary on the local market, x4 - local government's spending on promotion, x5 - changes in local property prices, x6 - ratio of replacement value of 1 m2 of property and the average transaction price on the local real estate market, x7 - number of property transactions per 1000 residents, x8 - purchasing power on the local housing market, x9 - changes in local property prices, x10 - ratio of replacement value of 1 m2 of property and the average transaction price on the local real estate market, x11 - average time on the market in months, x12 - number of real estate agents on the local market, x13 - availability of mortgages in terms of m2, x14 - value of property transaction per 1 resident on the local market, x15 - population density per m2, x16 - number of marriages, x17 - number of divorces, x18 - net migration rate, x19 - population growth, x20 - age structure of potential clients (25-45 population group vs. total population in a given area), x21 - unemployment rate, x22 - quality of life, x23 - number of new registered businesses per 1000 residents.

Source: own study based on Renigier. 2014.

Table 7. Correlation coefficients for supply

Correlation scores	x1	x2	x3	x4	x5	x6	x7	x8	x9	...	x14
x1	1,00									…	
x2	0,19	1,00								…	
x3	0,13	0,77	1,00							…	
x4	0,06	0,83	0,46	1,00						…	
x5	0,00	0,57	0,41	0,35	1,00					…	
x6	0,11	0,97	0,72	0,83	0,47	1,00				…	
x7	0,10	0,92	0,85	0,72	0,60	0,92	1,00			…	
x8	-0,08	-0,57	-0,51	-0,36	-0,25	-0,48	-0,54	1,00		…	
x9	0,11	-0,57	-0,49	-0,39	-0,60	-0,57	-0,67	0,61	1,00	…	
x10	0,16	0,90	0,81	0,69	0,37	0,92	0,84	-0,39	-0,41	…	
x11	0,50	0,67	0,59	0,38	0,32	0,60	0,53	-0,23	-0,03	…	
x12	-0,53	-0,71	-0,54	-0,49	-0,25	-0,68	-0,53	0,29	0,08	…	
x13	0,04	0,22	0,26	0,17	0,52	0,15	0,33	-0,27	-0,64	…	
x14	0,11	0,05	-0,37	0,26	0,08	0,02	-0,16	0,00	-0,13	…	1,00

x1 - local government's spending on housing policy in zl, x2 - total number of issued construction permits, x3 - number of issued construction permits, x4 - number of property offers per 1000 residents, x5 - ratio of replacement value per 1 m2 of property to the average price quoted on the local real estate market, x6 - number of property offers, x7 - number of developers on the local market, x8 - affordability of rental housing in m2, x9 - difference between the average prices of new and second-hand property, x10 - number of deaths (older than 50), x11 - existing residential area per 1 resident, x12 - number of residents per 1 existing apartment, x13 - number of new apartments per 1000 residents, x14 - percent of land covered by zoning

Source: own study based on Renigier. 2014.

On this basis, individual indices of information capacity were determined for each combination according to the following formula:

$$h_{kj} = \frac{r_j^2}{1 + \sum_{\substack{i=1 \\ i \neq j}}^{m} |r_{ij}|} \tag{1}$$

rj - correlation between *Y* and *Xj*
rij - correlation between *Xi* and *Xj*
k- number of combinations, $k = 1, 2, \ldots, l$
j- variable number of combinations $j = 1, 2, \ldots, m$
Finally, integral information capacity indices should be determined for each combination according to the following formula:

$$H_k = \sum_{j=1}^{m} h_{kj}, \quad k = 1, 2, \ldots, l \tag{2}$$

The optimal set of information indicates from combination of variables with the highest *Hk.*
The authors modified the classical assumptions of this theory and conducted the sensitivity analysis in order to increase the efficiency of the analysis and to estimate the time saved. In this analysis the influence of every variable on the result of the integral information capacity (Hi) was verified. The total integral information capacity (Ht) (with all variables) was compared with individual integral information capacity (Hi) (after deleting each variable) respectively. These deleted variables with individual indicators bigger then the total indicator were removed (bold font - table No. 8 and 9). The analysis indicated that the remaining variables constituted the combination of optimal set with the highest integral information capacity (Ho) (table No.8 and 9).

Table 8. Indices of integral information capacity for supply

	Sets of variables combinations	Indicate of integral information capacity (H)
(Ht)	C1= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14	0,8365
Hi (x1)	C2 = x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13,x14	0,8191
Hi(x2)	C3 =x1,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14	0,8307
Hi(x3)	C4 =x1,x2,x4, x5, x6, x7, x8, x9, x10, x11, x12, x 13, x14	**0,8381**

Hi(x4)	C5 =x1,x2,x3, x5, x6, x7, x8, x9, x10, x11, x12, x 13, x14	0,8142
Hi(x5)	C6 =x1,x2,x3, x4, x6, x7, x8, x9, x10, x11, x12, x13, x14	0,8113
Hi(x6)	C7 =x1,x2,x3, x4, x5, x7, x8, x9, x10, x11, x12, x13,x14	**0,8404**
Hi(x7)	C8 =x1,x2,x3, x4, x5, x6, x8, x9, x10, x11, x12, x13, x14	**0,8416**
Hi(x8)	C9 =x1,x2,x3, x4, x5, x6, x7, x9, x10, x11, x12, x 13, x14	**0,8458**
Hi(x9)	C10 =X1,X2,x3, x4, x5, x6, x7, x8, x10, x11, x12, x13, x14	**0,8452**
Hi(x10)	C11 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x11, x12,x13, x14	**0,8368**
Hi(x11)	C12 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x12, x13, x14	0,8313
Hi(x12)	C13 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x13, x14	**0,8415**
Hi(x13)	C14 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x14	0,809
Hi(x14)	C15 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x 13	**0,8411**
Ho	C16 =x1,x2, x4, x5, x11, x13	0,8948

Source: own study

Table 9. Indices of integral information capacity for demand

	Sets of variables combinations	integral information capacity (H)
(Ht)	C1= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,8053
Hi (x1)	C2 = x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,8028
Hi(x2)	C3 =x1,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	**0,8064**
Hi(x3)	C4 =x1,x2,x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,7978
Hi(x4)	C5 =x1,x2,x3, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,7981
Hi(x5)	C6 =x1,x2,x3, x4, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	**0,8197**
Hi(x6)	C7 =x1,x2,x3, x4, x5, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	**0,8226**
Hi(x7)	C8 =x1,x2,x3, x4, x5, x6, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,7893
Hi(x8)	C9 =x1,x2,x3, x4, x5, x6, x7, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	**0,8274**
Hi(x9)	C10 =x1,x2,x3, x4, x5, x6, x7, x8, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	**0,8197**
Hi(x10)	C11 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	**0,8226**
Hi(x11)	C12 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,8050
Hi(x12)	C13 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,7971
Hi(x13)	C14 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12,	**0,8145**

	x14, x15,x16,x17,x18,x19,x20,x21,x22,x23	
Hi(x14)	C15 =x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x15,x16,x17,x18,x19,x20,x21,x22,x23	0,7834
Hi(x15)	C16= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14,x16,x17,x18,x19,x20,x21,x22,x23	**0,8097**
Hi(x16)	C17= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,,x17,x18,x19,x20,x21,x22,x23	0,7918
Hi(x17)	C18= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x18,x19,x20,x21,x22,x23	0,7916
Hi(x18)	C19= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x19,x20,x21,x22,x23	0,8030
Hi(x19)	C20= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x20,x21,x22,x23	**0,8123**
Hi(x20)	C21= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x21,x22,x23	0,7939
Hi(x21)	C22= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20, x22,x23	0,7893
Hi(x22)	C23= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x23	0,7841
Hi(x23)	C24= x1,x2,x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, x14, x15,x16,x17,x18,x19,x20,x21,x22	0,7941
Ho	C25 = x1,x3, x4, x7, x11, x12, x14,x16,x17, x18, x20,x21,x22,x23	0,9359

Source: own study

Conclusions

The authors prepared analyses of verification of variables that were used to develop the real estate market ratings. To this purpose Hellwig's method of integral capacity of information was applied. The mentioned method enables to choose the optimal combination of variables with the highest information capacity integral indicators. The results lead to obtain the necessary set of features that constitute essential information which describes the situation on the local real estate market.

The conducted analyses indicate that the most optimal set of indicators for demand rating comprises: *average purchasing power in comparison with the national average, difference between the national average salary and the average salary on the local market, local government's spending on promotion, number of property transactions per 1000 residents, average time on the market in months, number of real estate agents on the local market, value of property transaction per 1 resident on the local market, number of marriages, number of divorces, net migration rate, age structure of potential clients (25-45 population group vs. total population in a given area), quality of life, number of new registered businesses per 1000 residents* and for supply rating: *local government's spending on housing policy in zl, total number of issued construction permits, number*

of property offers per 1000 residents, ratio of replacement value per 1 m2 of property to the average price quoted on the local real estate market, existing residential area per 1 resident, number of new apartments per 1000 residents.

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