From uncertainty to the efficiency of the real estate market

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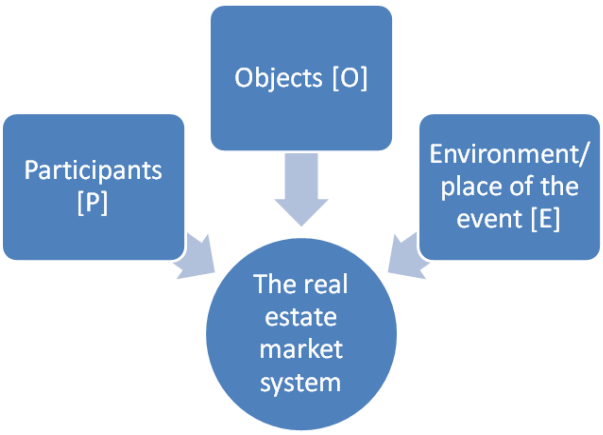
The authors (University of Warmia - Mazury in Olsztyn) have been specializing in real estate market research (REM) and its specificity for many years. The real estate market, although is informal, facilitates real estate transactions, and allows operators who are also participants of market game to read the signals of the transactions. Phenomens occurring on the property market are dynamic - are also subject of constant change and fluctuation. There are many difficulties in this market which not always are reasonable and ensued from rational circumstances. REM participants often take irrational decisions based on fragmentary information, data about the market and the objects to be traded.

Original team, composed of R. Wisniewski, Renigier - Biłozor M., Radzewicz A deals with the analysis of changes in the real estate market and tries to predict the future, according to the theories inspired by science and nature studies.

1. Real estate market system

Datum point is a discussion of the approach to the real estate market (REM) in a systemic perspective. The real market estate is regarded as an area of relations development and dependences between subjects (market participants) and objects (properties), simultaneously assuming , that it is a multidimensional space of events of different nature, where the process of transfer of rights to properties (a price formation, a number of transactions etc.) follows.

The real estate market system is understood as a set of relations and connections of its components, such as object, participants and environment - place of the event (scheme 1). The factors identified above should be regarded as necessary elements under market game achieved by objects of this game. Each of these factors is unique and personal on one hand, factors however are mutually dependent and affect each other on the other.



Scheme 1 The real estate market system
Source: Own

The participant (P) of real estate market is any person who attends in the market game (deals, transactions, creates solutions, advises, operates in the sphere of operation.) Through self activities, actor builds the market structure and creates its functioning. Investors, regardless of their knowledge, resources and skills accomplish their own (individual) investment process and are interested in achieving maximum results with minimum effort.

The subject (S) of the real estate market is: the land property (P_L), building property (P_B) and property of premises (P_P). Each of these properties is characterized by the other major features, important from the viewpoint of the managers of these entities. Other conditions will be taken into consideration for the land designated for detached houses, while others are for residential property, designated for the service. This specificity, the nature of the property and how it is used indicates the features important and totally useless to potential buyers.

Property is extracted from a particular space, in theory produces evidence of being constant in the time and place. The real estate market, as the natural location of the property, changes depending on the behavior and activities of entities, including elements of the environment. For a single property affects its direct environment (neighborhood) and milieu of the particular real estate market.

2. Uncertainty (UN) and efficiency (EF) of the real estate market

The real estate market is one of the most rapidly developing commodity markets that attract massive investments, but as an object of research, it poses numerous problems. The market can be analyzed in various categories and from various perspectives. The following determinants can be a source of uncertainty (UN) in market evaluations:

a) **market effectiveness** – the achievement of the desired structures and functions development level, the ability to maintain system processes (dynamic and informational balance), crisis survival ability (stability), the ease and possibility of processes control in the short-term, mid-term and long-term perspective, and many others;
b) **market structure, namely the configuration of market institutions and organizations** – market structure may be well developed (highly developed markets, e.g. in Great Britain), in the process of developing (emerging markets, e.g. in Poland) or weakly developed (e.g. in Belarus);
c) **market functions** – the ability to satisfy market participants' basic needs as well as reaching out changes requested by these participants;
d) **market environment** – the social and economic framework in which the RE market operates and which can be a source of crisis.

Ties and relations appearing on the property market should be studied and analyzed in the context of uncertainty. This uncertainty creates and conditions all processes on the real estate market. Also refers to the level of individual events, group or collective. Has an impact on the object, subject and system. In such a situation a vast knowledge of the property (structure and function), objects, and participants of the market should be collected - however, by the phenomenon of uncertainty, level of knowledge is never reached, and we won't be able to identify all the dependencies existing in this system.

Uncertainty should be treated as one of the many causal factors REM. Instability elements of the real estate market create uncertainties for the entire system. Uncertainty means that we can not (with high probability) determine the states of REM, and we can not define the conditions and circumstances of the facts creation in this system. Uncertainty is part of the price-setting factors. Value, as reflected in REM, is the result of many factors. In this context, the uncertainty (of the whole system and its individual components, the sum of these elements of uncertainty, will never be the uncertainty of the whole system though) can be understood as the cause of the REM system failures. Uncertainty manifests itself in the property market- understood as the place of transfer of rights to property, the area of relations development and relationships between participants and objects of the REM.

Human activities are among the "imperfect" with a high degree of uncertainty and most of the time are entangled in complex relationships. Participants of the real estate market describe properties (real estate objects), including accessible and possesed information. Information is understood as a category which define and imitate attributes of objects and subjects as well as relationship between them (Wisniewski, 2007).

Both entities and their activities are characterized by high uncertainty. Not all accurring between them dependencies, intuitively, we can conclude they are complex and save them in a conventional way, as a function in which we can test relations, dependencies and elements influencing and shaping the operator REM (P)

$$UN(P) = f(a_1, a_2, a_3, \ldots a_n) \qquad (1)$$

where: UN(P) – uncertainty among entities*;* $a_1, a_2, a_3, \ldots a_n$ *- following* elements that define the entity, also cursed with uncertainties.

Each element of a_1, a_2, a_3, ... refers entity and at the same time it influences the real estate market, for example: the type of entity, entity characteristics, mode of operation, characteristic factors, elements - described, collected and processed by agents or decision-making in the game market . For each factor affects the element of randomness, due to the difficulty of identification, the way of description, or even relationships which are made.

The area of the property market is designated by the land property (P_L), building property (P_B) and property of premises (P_P). REM analysis is mainly limited to studies of individual types of properties along with a description of the characteristics and attributes that affect the value, which is determined by the characteristics of the object and the relationship between themselves

Items also have a random character. Changes are made independently from the actors and the real estate market, while taking into account environmental factors and exhibit adaptive capacity. Uncertainty of items occur in the collection of various types of properties (P_L, P_B, P_P), manifested in the features of real estate, and the same applies to items that may generate uncertainty, denoted as ε. Uncertainty examines elements of the real estate market, and mutual dependencies, caused by random factors. Write to:

$$UN(S) = f[UN(P_L), UN(P_B), UN(P_P), \varepsilon] \qquad (2)$$

where: UN(S) – uncertainty of the real estate market subjects*;* $UN(P_L)$ - uncertainty into data of components and features of the real estate*;* $UN(P_B)$ - the uncertainty of the elements and features of

building properties; U*N(P_P)* - *t*he uncertainty of the elements and features of the housing properties*; ε* – qualify, the uncertainty of the property itself, for example due to their environment, evolutionary.

An important element of the real estate market, in addition to those subjects of the REM - the place of the transaction, environment of deals. The real estate market is a place of uncertainty in multidimensional space of all events.

Although location of specific properties on the market is fixed, external conditions or environment to the same properties might change. The real estate market should therefore be viewed as a whole, together with the environment (E) and the complex and often non-return relationship between the elements of this environment, and market elements. Environment can facilitate or hinder, run or pause the actions and manage them independently of the state system.

Behavior of the real estate market may fluctuate due to changing of internal and external conditions, causing a change of individual components. Changes as well as environment is a multi-dimensional surface where uncertainty occurs. Surrounding of the property market and real estate economy determines the economic, spatial, socio-economic or otherwise environment. Even the smallest change can cause random changes in other components of the system, completely changing the relationships and dependencies occurring in the market. The uncertainty of the environment, external and internal, write:

$$UN(E) = f(E_E, E_I, \varepsilon) \qquad (3)$$

where: (E_E) external environment such as legislation (act), economic indicators for the region / country*; (E_I)* - internal environment such as local municipal law, the unemployment rate, the value of $1m^{2;}$ *ε* – the error generated by the elements of the environment to the entire system.

Uncertainty exists in the property market and may be revealed in the way of its description, causing loss of important (from the forecasted value of properties point of view), information on system structure changes. The uncertainty is therefore a condition (long term) accompanying of the real estate functioning (Wisniewski, 2007). The real estate market is characterized by limited predictability and of the multi-dimensionality behavior of elements . Uncertainty, in shorter periods of time may be measurable and known as risk.

The uncertainty of the real estate market is associated primarily with the entities that are responsible for creating REM, its description and identification. Private and institutional investors become market participants, as a result of social interaction and market conditions, they take the final decision to disclose the real estate market. The activities of the entity are burdened with uncertainty, although they concern properties (the subject). An important role is played by the relationship between subject and object, which becomes the cause of a specific effect, occurring in the real estate market. Market participants describe all the occurring events, relationships, objects - choose properties, define its features and attributes, and finally determined value of the properties becomes a carrier of information for other entities.

Evaluation of the effects of various actors (participants) real estate market is known as "efficiency", which is not used to assess the market as a whole. Evaluating the level of achievement of the goals planned for the entire system of RN use the term "efficiency". Efficiency is an expression of ability to achieve the objectives of the entire system rather than in individual cases.

The effectiveness of the market will be called in this work, "efficiency" and effectiveness of individual market players will be called the "efficiency and effectiveness of market operators. " For REM, the two concepts are closely linked and essential to a better understanding of processes occurring in this system.

The efficiency of the real estate market is the individual participant's ability to achieve the set of goals, while market effectiveness is a level of development or goal attainment in a complex social and economic system, such as the real estate market.

The effectiveness of the real estate market is the process of achieving a certain level of development (the target) by the complex socio-economic system, which is the market. In the maintain - effectiveness of REM is an ability of achiving a specific objective of the system development while making maximum usage of available information, as well as maximilization of the efficiency of various participants in this market. The effectiveness of REM is a general level of efficiency of the entire system, which consists of: actors, structure (organizational, informational, technical, etc.), functions, procedures, tasks, etc. Efficiency is an expression of all the causative factors of individual and collective levels. This means not only proper work and functioning of the REM, but also reflects the state of development of the whole sector of the economy, which is the real estate sector. The effectiveness of REM is a synergistic emanation of way of thinking, acting and functioning of the participants in this market.

Effectiveness of REM shows and defines**:**

– entities knowledge of the system processes REM**,**

– REM players information level

– entities knowledge about the structures and functions of the system**,**

– level of processing and aggregation of information in the system,

– state of general knowledge, industry expertise and accumulated in the system of REM

– skills and abilities of each player in the field of planning**,** operation and functioning of the real estate market**.**

The efficiency of the real estate market is inseparable from the efficiency of its participants who are the market's driving force and the final decision-makers. In broad terms, the efficiency of market participants is determined by their ability to achieve specific goals through the maximum usage of the available information. Efficiency is measured in terms of the outcomes of their actions, and it is determined by the relationship between the borne outlays and the achieved results, but on the real estate market, those goals are not always optimal from the economic point of view.

The relationship between efficiency participants and effectiveness of real estate market :

$$E_R = \vec{\delta}\left(S_{P1}, S_{P2}, \ldots S_{Pn}\right) \qquad (4)$$

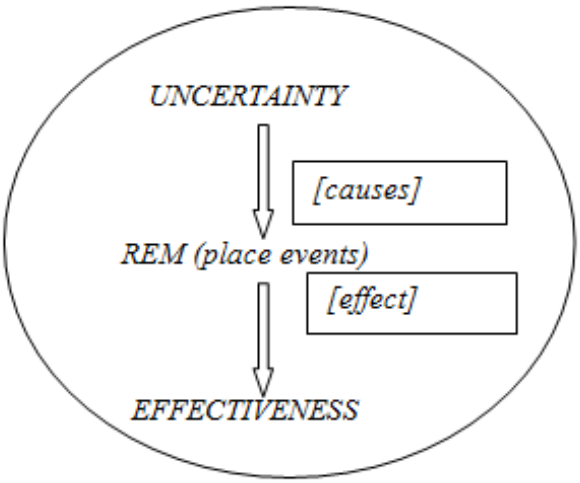
where: E_R - real estate market efficiency*;* S_{Pi} - efficiency of the participants *(P_1, P_2, … P_n) real estate market;* $\vec{\delta}$ - function transforming the individual efficiency into the real estate market efficiency.

The presented relations (4) shows that the efficiency of the real estate market is a function of efficiency of all participants in the market, and efficiency of each operator determines the overall effectiveness of REM.

Efficiency is a measure of real estate market. The real estate market is characterized by low efficiency, which is due to inadequate access to information for both the entities, objects, and the

market itself. The more restricted access to information, the more market is inefficient, which means an increase of the probability of uncertainty appearance in the REM. REM efficiency becomes the measure of the entire system functioning, which is due to the interaction of all elements of the real estate market. This means that the better and more efficient entities and objects are functioning in a particular area are the more efficient system we deal with.

Issues of uncertainty and efficiency are closely linked. Increase one of these issues (eg uncertainty), causes an automatic decrease of another(eg, efficiency) - the trend of behavior is always the opposite. Uncertainty includes these factors and phenomena that are the result of identification difficulties, technical (data collection), computational and interpretative as well as others which are regarded as important. These difficulties are the cause of inefficiencies in the real estate market (scheme 2).



Scheme 2 Uncertainty and efficiency of the real estate market
Source: Own

3. Analysis of the effectiveness of selected REM in Poland

The authors went into the matter of the effectiveness of real estate markets using the method based on rough sets theory. The theory of real estate markets, based on rough sets, was used to develop methodology for a simplified classification performance. This theory was chosen for the analysis of real estate markets because of the possibility of its application for specific data, fuzzy, vague and varied quantitatively and qualitatively. The result of the study is a verification of the potential and actual performance of the analyzed real estate markets.

Data from various real estate markets in Poland for 2008-2010 are presented in Table 1 with reference to population statistics. The analyzed data constitute a benchmark for measuring the size and efficiency of real estate markets in selected Polish cities, and it accounts for: population, unemployment rate, average monthly gross wages, area in square kilometers, number of real estate transactions separately for land plots and apartments, and the average price per sq. m. of an apartment. The data have been used to analyze real estate market efficiency. At this stage of the analysis, the choice of data was dictated by the ease of acquisition and the availability of the relevant information.

If the efficiency of Polish real estate markets were to be evaluated based on the criterion of data

availability, the majority of Polish cities would receive low or very low marks. Access to information is an important, yet not the only factor determining market effectiveness. Two indicators were computed based on the assumption that the acquired data are credible:

1. PO/RET – population per 1 real estate transaction,
2. HA/GW – housing area in square meters that can be purchased with an average gross monthly wage.

Table 1 Effectiveness of real estate markets in Poland

						No. of transactions			Population / No. of transactions [*PO/RET*]	Average wage / Average price per m2 [HA/GW]
						Land plots	Apartments			
1	Olsztyn	176457	4.5	2830	88.33	224	717	4765	188	0.59
2	Słupsk	97331	9.2	2667	43.15	91	816	3783	107	0.70
3	Suwałki	69448	13.4	3645	66.00	270	124	4433	176	0.82
4	Ciechanów	45270	5.7	2994	32.51	131	182	2503	145	1.20
5	Wrocław	632162	5.0	3415	292.82	159	2661	6740	224	0.51
6	Działdowo	21644	6.6	2546	11.47	17	60	2401	281	1.06
7	Inowrocław	76137	20.4	2789	30.42	11	25	3443	2115	0.81
8	Gdańsk	456591	5.1	4053	261.68	26	1728	6215	260	0.65
9	Cracow	755000	4.6	3424	326.00	127	2298	7260	311	0.47
10	Koszalin	106987	4.7	2932	98.33	258	805	4112	101	0.71
11	Kętrzyn	27942	27.5	2423	10.35	9	31	2345	698	1.03
12	Toruń	193115	8.3	3175	115.75	49	252	4666	642	0.68
13	Gołdap	13514	5.7	2361	17.20	4	5	2432	1501	0.97
14	Poznań	554221	3.3	3669	261.85	83	1292	5800	403	0.63
…	…	…	…	….	……	…..	…..	……	….	…..

Source: Own research based on: http://www.stat.gov.pl/…; http://www.mi.gov.pl/…; www.money.pl; www.egospodarka.pl, www.gratka.pl, www.oferty.net.pl, http://www.stat.gov.pl/… information given by municipal housing departments

The two indicators can be used to perform a simplified classification of the efficiency of selected real estate markets in Poland. The first indicator, PO/RET, indicates the size of the local population per 1 real estate transaction, and the higher its value the lower the efficiency of the local market. The second indicator, HA/GW, is a price to income ratio that measures the affordability of real estate, and the higher its value, the higher the efficiency of the real estate market. The value of the second indicator illustrates the correlation between real estate prices and incomes on the local market. Real estate markets are ranked according to the adopted indicators in Tables 2 and 3. An analysis of Table 2 data indicates that a given market's place in the ranking is not determined by the size of the city, its population or the unemployment rate. The ranking is topped by medium-sized cities with a population nearing 100,000 – Zielona Góra, Koszalin and Słupsk. Table 3 suggests a certain trend, namely that real estate prices are more affordable in smaller cities, in this case – Ciechanów, Działdowo and Kętrzyn. An analysis of both tables shows a certain analogy as regards similar positions occupied by Bydgoszcz, Łódź, Suwałki and Ełk.

Table 2 Market effectiveness in terms of population size per one RE transaction

No.	Real estate market	Population / No. of transactions [*PO/RET*]
1	Zielona Góra	91
2	Koszalin	101
3	Słupsk	107
4	Elbląg	141
5	Ciechanów	145
6	Suwałki	176
7	Ełk	178
8	Olsztyn	188
9	Wrocław	224
10	Gdańsk	260
11	Bydgoszcz	276
12	Działdowo	281
13	Łódź	307
14	Cracow	311
….	……	…..

Source: Own research

Table 3 Market effectiveness in terms of real estate affordability – the number of square meters that can be purchased with average monthly wages

No..	Real estate market	Average wage / Average price per m^2 of housing area [*HA/GW*]
1	Ciechanów	1.20
2	Działdowo	1.06
3	Kętrzyn	1.03
4	Gołdap	0.97
5	Zielona Góra	0.89
6	Ełk	0.86
7	Suwałki	0.82
8	Inowrocław	0.81
9	Koszalin	0.71
10	Słupsk	0.71
11	Bydgoszcz	0.69
12	Toruń	0.68
13	Łódź	0.68
14	Białystok	0.67
….	……	…….

Source: Own research

The above analysis is only a preliminary attempt at determining the efficiency of real estate markets subsystem in Poland, and its main aim is to indicate the direction of research initiated by the authors. The area of research will be expanded in successive papers to include a comparison of data relating to real estate transactions and market offers, market classification and an efficiency ranking of the examined real estate markets based on other indicators presented in Table 1.

4. The use of the Rough Set Theory in analyses od real estate market efficiency.

This study addresses a common problem encountered during advanced analyses of real estates, namely the choice and use of analytical and research methods that account for the specific nature of real estate data. As suggested in the preceding parts of this paper, the following factors contribute to the inefficiency

According to the authors ((Renigier-Biłozor M., Wiśniewski R, 2011), popular analytical methods (mostly statistical) are relatively ineffective in weak-form efficient real estate markets. The preferred methods and procedures should account for the following defects in real estate data: absence of data, small number of transactions, significant variations in attribute coding, non-linear correlations between the analyzed data and the type of the underlying market. The applied methods should support market analysis at the potential (theoretical) and actual (applied) level. The below solutions (Table 4) that rely on the rough set theory may offer an effective alternative to popular analytical methods. References to detailed studies are indicated in parentheses.

Table 4 The use of the rough set theory (RST) for improving real estate market efficiency

RST-based methods for analyzing the real estate market		
General problem	**Detailed problem**	**Solution**
Selection of methods for managing and using buildings and apartments (RENIGIER, 2006)	Analysis of the real estate market using various methods for registering real estate attributes without data loss (RENIGIER, 2008)	Option of analyzing data sets without the risk of data loss when quantitative attributes are replaced with qualitative attributes
Real estate appraisal on markets characterized by limited resource availability (RENIGIER, 2008)	Real estate appraisal involving limited data sets (RENIGIER, 2008)	Real estate appraisal based on expert data sets, with high confidence in results
Selection of functions assigned to land on ineffective real estate markets (RENIGIER-BIŁOZOR, BIŁOZOR 2009 a, b, c	Determining the significance of real estate attributes without the use of statistical methods (RENIGIER-BIŁOZOR, BIŁOZOR 2009a, 2009b)	Reliable verification of the significance of attributes adopted based on a limited data set
	Determining weighing factors for real estate prices (RENIGIER-BIŁOZOR, BIŁOZOR 2009c)	Determining the significance of attributes without the use of statistical tests
Real estate appraisal based on limited market data (RENIGIER-BIŁOZOR, 2010)	Supplementing the missing real estate attributes (RENIGIER-BIŁOZOR, 2010)	Determining the value of the missing real estate attributes based on the analyzed data set

Source: own research

5. Conclusions

The processes occurring in the real estate market have extremely complexed structure, related to both the difficulty of unequivocal records of changes in the REM identification and the determination of the effects that may occur. Difficulties in defining the causes are associated with uncertainty and the effects of the effectiveness of the real estate market.

Uncertainty has a huge impact on the system of the real estate market. It can not be fully measured (measurable would be a risk),however, it is known that it has an impact on the entire set of elements present in the space of the RN. These elements are not tightly- closed group - summarizing- that set can be concerend as open and going under constant changes, to adapt the system to the new situation. Situations "uncertain" are by definition specific to the housing market, which is an open system.

The level of knowledge about the market and its participants is a a factor that determines the efficiency of the RE 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.

The above data (from real estate market) were used to develop a method for a simplified classification of the efficiency of real estate markets, based on the rough set theory. The rough set theory was chosen for the analysis of real estate markets since it accounts for the specific nature of real estate data which are highly specific, fuzzy, inaccurate and diverse, both quantitatively and qualitatively. The results of the study support the verification of the potential and actual efficiency of the analyzed real estate markets.

It indicates the practical aspect of the applicability of rough set theory to describe the uncertain knowledge, imprecise reasoning and modeling of approximation. In this article for research purposes was adopted and defined the factors that affect the overall performance of selected real estate markets and, consequently, the entire market system in Poland.

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