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Real Estate Markets in Poland – Analysis of Subsystem Structure

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SUMMARY

Real estate markets (REM) may be classified as strong-form efficient, semi-strong-form efficient or weak-form efficient. Efficiency measures the 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 a function of the efficiency of individual market participants and subsystem structure.

This paper attempts to analyze the efficiency of the Polish real estate market subsystem as a feature of general market efficiency. It formulates recommendations for improving subsystem market efficiency through the choice of adequate research methods and procedures. Some chances can be application method based on the principles of the rough set theory.

Authors propose the new methodology foundation of subsystem of real estate market analysis.

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1. INTRODUCTION

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 in market evaluations:

- a) **market effectiveness** – the achievement of the desired level of development by market structures and functions, the ability to maintain system processes (dynamic and informational balance), crisis survival ability (stability), the ease and possibility of controlling processes 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), 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 and cater to changing demands;
- d) **market environment** – the social and economic framework in which the RE market operates and which can be a source of crisis.

The level of knowledge about the market and its participants is 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. Researchers analyzing the RE market should also demonstrate a sufficient level of knowledge about the mutual relationships between the subjects and objects of market transactions.

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 popular analytical methods, such as econometric models. 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.

This study attempts to prove the hypothesis that the efficiency of real estate markets is identifiable and measurable.

2. CLASSICAL THEORY OF MARKET EFFECTIVENESS AND ITS CONSEQUENCES

Any discussion concerning the efficiency of real estate market participants would be incomplete without a reference to the classical approach to market effectiveness (in particular capital markets). In line with the assumptions made by this study, efficiency determines effectiveness. This chapter discusses the rudimentary concepts of market effectiveness vs. market ineffectiveness, market equilibrium vs. market imbalance, perfect vs. imperfect markets.

According to the random walks hypothesis, developed in 1900 as the pioneer concept in the theory of capital market effectiveness (BACHELIER 1900), the expected rate of return on an asset equals zero due to the random distribution of prices. Further research (Sorin in OSBORNE'S 1964) demonstrated that the fluctuation of prices on the capital market resembles Brownian motion, i.e. the movement of particles in a fluid (GABRYŚ 2006, following OSBORNE).

According to the random walks theory, this motion does not follow a specific pattern or trend, but it is the effect of completely random changes as a result of which, the prices from the past do not support the prediction of future prices (SZYSZKA 2003). According to subsequent researchers, if prices are to reflect all available information, they should change only when new information appears. Since information enters the market in a random fashion, price changes should also have a random character (GABRYŚ, 2006).

According to FAMA (1990), *"an efficient market is defined as a market where there are large numbers of rational, profit-maximizers actively competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants. In an efficient market, competition among the many intelligent participants leads to a situation where, at any point in time, actual prices of individual securities already reflect the effects of information based both on events that have already occurred and on events which the market expects to take place in the future."*

SZYSZKA (2003) argued that if there are irrational investors on the capital market, their actions are random in character and they neutralize each other without affecting the prices. If there is a larger group of irrational investors who make similar decisions, the effects of their actions are eliminated by rational investors through arbitration.

According to pioneer researchers in the area of real estate market efficiency, a market is efficient if it fulfils the following theoretical assumptions:

- it has an indefinite number of participants who appraise the value of real estate independently in an effort to maximize the profit generated by real estate,
- a single participant is unable to change real estate prices,
- information that could affect real estate prices is generated in an uncorrelated manner,
- information instantly reaches all market participants,
- information is freely available,
- there are no transaction costs,
- all investors make instant use of the received information,
- every investor has identical expectations as regards the information's effect on real estate prices and the expected return rate,
- all market participants have identical investment horizons.

In line with the above assumptions, prices are determined as follows (cf. <http://www.naukowy.pl/...>; GROSSMAN STIGLITZ 1980):

- prices ideally reflect the value of real estate at any moment,
- prices change instantly in response to new information, and they remain stable until new information enters the market,
- higher than average profits cannot be generated in the long run,
- prices change independently.

Throughout decades, researchers came across examples demonstrating that market efficiency theory does not always work. The early 1980s were marked by several anomalies that seemed to undermine the efficiency of financial markets. Those anomalies continue to be studied, while new irregularities are surfacing. A new field of study, behavioral finance, was created to explain the phenomena that contradict the hypothesis of market effectiveness. Behavioral finance examines stock market anomalies by analyzing systematic errors made by humans when predicting the future, a fact that has also been demonstrated by psychological research.

The causes of anomalies on real estate markets differ from those encountered on other markets, including capital markets, due to the specific nature of real estates. The distribution of real estate prices shows an absence of linearity and the presence of anomalies that distort the classical equilibrium and affect the stability of the real estate market. If those two assumptions are not met at the stage of preliminary analysis, the above leads to the formulation of incorrect conclusions, such as the overestimated value of coefficient R^2 .

According to PETERS (1997, following PARETO), a distribution has fatter tails (suggesting the inefficiency of a market where prices do not follow random walks) when information reaches the market irregularly or when the investors' response to information is delayed. When the information flow exceeds critical values, investors respond to all information that had been previously ignored. This implies that, contrary to Newton's theory where every action produces an instant response, market participants demonstrate a non-linear response to information.

3. EFFICIENCY OF IMPERFECT REAL ESTATE MARKETS

According to KUCHARSKA –STASIAK (2005) and BRYX (2006), a perfect market has the following attributes:

- there is a large number of buyers and sellers – no participants have sufficient "market power" to set the price of a product, buyers and sellers have to be dispersed,
- product homogeneity (uniformity and full substitution) – when products are homogenous, the decision to buy a given product will be determined by the price rather than variations in the product's nature,
- perfect information (market transparency) – prices and quality of products are assumed to be known to all consumers and producers,
- utility and profit maximization – in addition to maximizing their profits, decision-makers also attempt to maximize their security or significance,
- zero entry or exit barriers – a competitive market is freely available to all participants, owners can move their capital to market segments generating higher revenues, the capital market is marked by a high degree of liquidity.

The following factors contribute to real estate market imperfections:

- a) speculation,
- b) monopolistic practices, such as the policies adopted by municipalities,
- c) large spread between prices quoted for similar real estates – the prices on local markets, in particular weakly developed markets, may differ even several-fold due to:
 - unavailability of information,
 - specific features of a transaction,
 - specific features of real estate,
 - financing method,
 - subjective evaluation of real estate's utilitarian value,
 - underestimation of prices in property deeds,
- d) low asset liquidity – real estate is difficult to sell at a price equal to its market value,
- e) sporadic market equilibrium – on the real estate market, supply and demand are usually out of balance due to:
 - market outlook,
 - fluctuations in return rates,
 - specificity of the local market,
 - the return on alternative investments,
 - situation on the construction market,
 - state policy,
 - frequent legislative changes,
- f) small number of transactions – real estate turnover is low,

- g) irrational behavior – buyers' and sellers' decisions are influenced by factors other than the price, including trends, neighborhood, tradition and advertising. Irrational behavior may result from:
 - subjective evaluation of real estate's utilitarian value,
 - unequal access to market information,
 - mutual dependencies between parties,
- h) insufficient information,
- i) differences in interpreting data.

According to the authors, the inefficiency of real estate markets results from a small number of transactions and the unavailability of vital information about the transaction and its parties. Such information is difficult to accumulate without database systems. It is also difficult to interpret without extensive analyses of functional dependencies between various attributes of real estate. The determination of the effect that real estate attributes have on a selected decision (e.g. price) may also prove problematic.

From a different perspective, the ineffectiveness of the Polish real estate market has a number of positive outcomes, including above average profits and rates of return on real estate investments. Transactions usually entail the conviction that real estate is worth more than the price paid upon acquisition and that is worth less than the price paid upon sale. High profits and high rates of return on real estate investments would be very difficult to achieve on an effective market.

The discussed attributes of a perfect market affect the efficiency of the real estate market. Each characteristic applies both on the macro (market) and micro (participants) scale. This is not to imply, however, that those attributes deliver similar effects. Their outcomes are evaluated from different perspectives.

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 use 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 **efficiency of the real estate market** is the individual participant's ability to achieve the set goals, while **market effectiveness** is level of development or goal attainment in a complex social and economic system, such as the real estate market. This paper attempts to define the factors that determine the efficiency and, consequently, the effectiveness of the real estate market.

4. ANALYSIS OF THE EFFICIENCY OF SELECTED RE MARKETS IN POLAND

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 gross monthly wages, area in square kilometers, number of real estate transactions separately for land plots and apartments, and the average price per sq. m. of apartment area. 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. The real number of transactions on a given local market (city) proved to be most problematic. It could be postulated that the level of difficulty with acquiring the relevant data was reversely proportional to city size (population and area). According to the authors, the above theory is supported by the following arguments:

- lack of data gathering systems in the public domain,
- lack of data sorting algorithms in units and departments responsible for data accumulation,
- lack of advanced systems for updating, processing and releasing data,
- the units and departments responsible for gathering public information are reluctant to create access to the data.

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 efficiency. 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 Efficiency of real estate markets in Poland

No.	City	Population	Unemployment rate	Gross monthly wage in PLN	Area in km ²	No. of transactions		Average price PLN/m ²	Population / No. of transactions [PO/RET]	Average wage / Average price per m ² [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
15	Łódź	742387	9.5	3159	293.25	251	2165	4666	307	0.68
16	Bydgoszcz	357650	7.3	2830	175.98	61	1235	4125	276	0.69
17	Zielona Góra	117503	7.5	3060	58.00	12	615	3446	91	0.89
18	Elk	57579	12.2	2584	21.00	72	252	2990	178	0.86
19	Elbląg	127954	16.5	2521	38.94	87	821	3894	141	0.65
20	Białystok	294685	11.6	3145	102.00	74	324	4660	740	0.67

Source: Own research based on: [http://www.stat.gov.pl/...](http://www.stat.gov.pl/); [http://www.mi.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/...](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 Elk.

Table 2 Market efficiency 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	Elk	178
8	Olsztyn	188
9	Wrocław	224
10	Gdańsk	260
11	Bydgoszcz	276
12	Działdowo	281
13	Łódź	307
14	Cracow	311
15	Poznań	403
16	Toruń	642
17	Kętrzyn	699
18	Białystok	740
19	Gołdap	1502
20	Inowrocław	2115

Source: Own research

Table 3 Market efficiency 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	Elk	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
15	Gdańsk	0.65
16	Elbląg	0.65
17	Poznań	0.63
18	Olsztyn	0.59
19	Wrocław	0.51
20	Cracow	0.47

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.

Results of analyses will tend to the construction of the time series coefficient and ranking of the subsystem efficiency in following periods of time.

5. THE USE OF THE ROUGH SET THEORY IN ANALYSES OF 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 and ineffectiveness of real estate markets:

- significant variations in the quantity of available information, subject to the type of the analyzed market (region),
- complex methods of data description (differences in the scale of attribute description) – the same attribute can be described in a variety of ways using different evaluation scales,
- significant differences between real estates (no two real estates are identical),
- various criteria for using real estate (every real estate can be used and managed in a variety of ways),
- lack of comprehensive information (due to the lack of homogenous systems for gathering real estate data which results in limited and incomplete knowledge about real estate and market prices),
- inaccurate and "fuzzy" character of real estate data (caused by stochastic factors which reflect random processes that escape the generally acknowledged cause-and-effect market relationship),
- absence of homogenous functional dependencies between real estate attributes,
- decision-making strategies represented by the value, function and method of real estate management.

According to the authors, 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

The process of managing real estate resources is problematic due to the specificity of real estate information. Owing to the complexity and diversity of data sets, the decision-making process in managing the resources of the largest property owners in Poland, such as municipalities or Polish State Railway companies, is wrought with problems. The greater the responsibility, the more difficult this process which affects not only the owner's financial performance but also the spatial, economic and social development of urban areas. The authors have concluded that the application of the rough set theory in real estate market analyses may deliver positive results (compare with Table 4). As demonstrated by Table 4, the use of the rough set theory for developing decision trees could enhance the effectiveness of the decision-making process in real estate management.

The rough set theory can also be applied in real estate appraisal on markets characterized by quantitative and qualitative defects. As demonstrated by the results of studies referenced in Table 4, market analyses can produce reliable results even when the number of transactions is small and when different attribute registration methods are applied. The procedure proposed by the authors does not require the development of complex models, preliminary analyses or the adjustment of the available data sets. In the approach based on the rough set theory, decisions are made based on "raw data" in line with the principles of Boolean logic, i.e. a given decision (real estate value) is made if given conditions (real estate attributes) are fulfilled.

The diversity and imprecision of real estate attributes, the extensiveness and complexity of the scope of data and relatively high variability over time make decision-making in real estate management a difficult process that is burdened with considerable risk. The use of the rough set theory and the valued tolerance relation in the decision-making process produces satisfactory results. Problems that cannot be tackled by statistical analyses alone may be solved with the involvement of the proposed method whose outcomes are easy to implement and interpret.

The application of the rough set theory also supports the identification of the key attributes and core characteristics of real estate based on the available data. As demonstrated by the studies referred to in Table 4, the proposed procedure can be applied to investigate the effect of real estate attributes on the analyzed decision-making problem.

The lack or unavailability of data poses one of the greatest obstacles hindering the exploration of real estate market information. Table 4 cites a quick and simplified procedure for supplementing the missing information in data sets used for market analyses. It is based on the principles of the rough set theory aided by the valued tolerance relation. This solution is particularly suitable for markets that are weak-form efficient as regards information availability.

6. CONCLUSIONS

The efficiency of real estate markets is a problem that escapes an easy definition and a crucial factor that determines the selection of appropriate procedures and methods for market analysis. This paper identifies factors that influence the overall efficiency of real estate markets and, consequently, the entire market system in Poland. Weak-form efficiency of a real estate market could generate positive outcomes, such as above average profits. Market inefficiency, however, always produces negative consequences which lead to the selection of inadequate analytical methods, unreliable results and misguided decisions due to the type, availability and quality of information on the real estate market.

The venture point for every analysis of real market efficiency is the selection of adequate research methods that account for the market's specific attributes and produce results applicable to other local markets. Owing to their individual character, local markets require suitable analytical tools, such as the proposed method based the rough set theory.

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. More specific information in published article "Analysis of real estate markets with the use of the rough set theory"(RENIGIER-BIŁOZOR, 2011).

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BIOGRAPHICAL NOTES

Małgorzata Renigier-Biłozor was born in Lidzbark Warmiński (Poland) on 4 June 1977. In 2000 she graduated as a MSc in the faculty of Geodesy and Space Management at the University of Warmia and Mazury in Olsztyn. During 2001 she began doctorate studies at the Department of Real Estate Management and Regional Development at University in Olsztyn. In 2004 she defended her PhD dissertation entitled: “Application of the methods of the residual analysis from statistical models in real estate management” with distinction, and She was given the title of PhD in technical sciences in discipline for Geodesy and Cartography.

In 2005 she was employed as an assistant of professor in Department of Real Estate Management and Regional Development at the University in Olsztyn. Her major fields of research interest are as follows: Systems of Real Estate Management, Value Forecasting, Nonlinear Analysis in Modelling of Real Estate Value, Influence Analysis of Stochastic Factors on the Real Estate Value, Application of Artificial Intelligence in the Real Estate Management (especially application of the rough set theory). For the topic of developing mass-appraisal methods, her a few articles are given below.

In 2006 she received the prize of the minister of the building and the transportation for PHD dissertation. She also in 2006 has become a member of the board of Scientific Society of Real

Estate. From 2004 to 2007 she has been a co-author of the programme of the concerning creation of the management system of real estates sources owned by Local Government of the committee of scientific research. From 2009-2012 she is a chief of the project entitled: "The elaboration of the decision making system with the utilization of rough set theories on real estate market".

Below a few of my articles:

- ✓ The residual from statistical models in valuation and management of real estate. Annual conference The European Real Estate Society – ERES. Dublin. 2005
- ✓ Application of the stochastic theories in marking of attractiveness niches on the real estate market. Monograph red. Prof. T. Skotarczaka . „Changes on real estate market on peripheries of great cities”. Wyd. Studia z prawa i gospodarki nieruchomościami, NR 01, str154 -161. Szczecin 2005r.
- ✓ Analysis of the residual as the source for diagnosing stochastic factors which influence the value of a real estate. Annual conference The European Real Estate Society – ERES. Weimar. 2006
- ✓ Residuals analysis for constructing 'more real' property value. 30 October 2006 seminar . 'Advances in mass appraisal methods', Technische Universiteit Delft .
- ✓ The system- management communal of „bank of real estate" ” condition of the development of small cities Annual conference in Łodz 2005r – Small cities - implements and conditionings of the development. – Warszawa, 2006,
- ✓ Application of data analysis by rough set method to management real estate resources. Article published in conference material XIV Scientific Conference TNN „Real estate as the object to finance and the management”. Elbląg 2006
- ✓ The problems of the rough set theory in real estate management”. Publikacja w „Studiach i Materiałach Towarzystwa Naukowego Nieruchomości” 16 (1) . Olsztyn. 2008. str. 79
- ✓ „Application of the rough set theory to mass appraisal of real estate on small markets”. ACTA SCIENTIARUM POLONORUM, Administratio Locorum 7 (3) 2008 , str 35
- ✓ “Residuals Analysis for Constructing ‘More Real’ Property Value”. Monografia pt. “Mass Appraisal Methods. An international perspective for property valuers” –Wydawnictwo Blackwell Publishing. Oxford. RICS Research 2008, str.148 – rozdział w monografii
- ✓ “ The significance of real estate attributes in the process of determining land function with the use of the rough set theory” (współautor A. Biłozor) – publikacja w „Studiach i Materiałach Towarzystwa Naukowego Nieruchomości” . Olsztyn. 2009
- ✓ „The procedure of determination of the significance of impacts of real estate attributes using the theory of approximated sets”. Przegląd Geodezyjny 2009
- ✓ Alternative procedure determining balance coefficients of land attributes in the process of determining land function. Acta Scientiarum Polonorum, Administratio Locorum 8 (3), 2009 (współautor A. Biłozor)
- ✓ Supplementing incomplete databases on the real estate market with the use of the rough set theory Acta Scientiarum Polonorum, Administratio Locorum 8 (3), 2010
- ✓ Analysis of real estate markets with the use of the rough set theory, wyd. „Studia i Materiały Towarzystwa Naukowego Nieruchomości” . Vol. Nr , 2011

- ✓ The efficiency of selected real estate markets in Poland *Acta Scientiarum Polonorum, Oeconomia* 10 (1), 2011 (współautor R. Wisniewski)

Radosław Wiśniewski was born in Lubień Kujawski (Poland) on 3 August 1972. In 1997 he graduated as a MSc in the faculty of Geodesy and Land Management at the University of Warmia and Mazury in Olsztyn. In 1999 he defended his PhD dissertation entitled: “Use of artificial intelligence in mass appraisal” with distinction, and he was given the title of PhD in technical sciences in discipline for geodesy and cartography. In 2010 he was given the title of professor in economic sciences in discipline for economy.

In 2000 he was employed as an assistant of professor in Department of Real Estate Management and Regional Development at the University in Olsztyn. His major fields of research interest are as follows: Real Estate Management, Application of Artificial Intelligence in the Real Estate Market (especially application of artificial neural networks), Systems of Real Estate Management, Value Forecasting and Systems Theory. For the topic of developing artificial intelligence in the real estate market methods, his a few articles are given below.

In 2003 he was become a member of The Council of The Polish Scientific Society of Real Estate, from 2006 he is a Secretary of The Council. From 2006 he is a Secretary of Editorial Council of The Polish Real Estate Scientific Society. From 2004 to 2007 he was a chief of the project entitled: “Programme of the concerning creation of the management system of real estates sources owned by Local Government of the committee of scientific research”. From 2009-2012 he is a co-author of the project entitled: “The elaboration of the decision making system with the utilization of rough set theories on real estate market”. From 2005 he is a Vice Dean of The Faculty of Geodesy and Land Management at the University of Warmia and Mazury in Olsztyn. In 2010 he received the Bronze Cross of Merit for science and organization work.

Below a few of my articles:

- ✓ WIŚNIEWSKI R., ŻRÓBEK R. 2003. Long-term land use in Poland – principles of transformation, payment and appraisal process. *International Journal of Strategic Property Management* vol. 7, No 4, str. 162-171.
- ✓ WIŚNIEWSKI R. 2006. Evaluation of Quality and Generalization Processes in Neural Network Sets Used to Forecast the Value of Space. *The Electronic Journal of Agricultural Universities* vol. 9, nr 2, Wrocław.
- ✓ WIŚNIEWSKI R. 2007. Efficient real estate market. *Journal of The Polish Real Estate Scientific Society*, vol. XV, nr 1-2, p. 103-113.
- ✓ WIŚNIEWSKI R. 2008. Some aspects of use ANN in mass appraisal of real estates in Poland. *Argumenta Oeconomica* nr 2 (21).
- ✓ WIŚNIEWSKI R. 2008. Efficient real estate market in Poland. *Poznan University of Economics Review* nr 1 vol. 8 str. 55-77.
- ✓ WIŚNIEWSKI R. 2009. Time Series of Residential Property Prices in Poland - Identification of Nonstationarity Type. W: Value in the process of real estate management and land administration, red. Sobczak A., Żróbek R. Wydawnictwo TNN, Olsztyn, str. 67-90. (6 pkt.).

- ✓ WIŚNIEWSKI R. 2009. Ekonometryczne modelowanie wykorzystania zasobów nieruchomości. Acta Scientiarum Polonorum. Administratio Locorum. Wydawnictwo UWM w Olsztynie, 8(2) str. 41-55 –. (4 pkt.).
- ✓ WIŚNIEWSKI R. 2010. Identification of Nonstationarity Type in Time Series of Land Property Prices in Poland. Journal of The Polish Real Estate Scientific Society, vol. XVIII, nr 1, p. 33-47 (4 pkt.).

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