Analysis of the Real Estate Market Dynamics as the Effect of Changes in the Road Infrastructure - Case Study in Poland

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Abstract. The paper is of analytical and research nature. The scope of the research includes a case study of the real estate market as a result of the rebuilding of a part of the road infrastructure. The purpose of the work is to determine the impact of the development of the communication system on the activity of the real estate market in two communes of the Żywiec district on the example of the section of the S1 expressway. Each type of investment carried out on the market has a positive or negative impact on the environment. The construction and development of the communication system are often a stimulant of the region because in most cases they increase its economic level. As a result of this kind of investment activities of the commune, there are changes on the local real estate markets, related to the spatial development of the region, affecting the standard of living of the population or the level of attractiveness and competitiveness of the region. These changes should also be visible in the level of transaction prices on the local real estate market. Therefore, the analysis of the number of transactions and the level of transaction prices of non-built-up agricultural and forest real estates were undertaken. The research period concerned the time from 2008 to 2015. The research area was made up of two communes in Southern Poland, located in the Malopolska voivodship. A section of the S1 road is located in these communes, the reconstruction of which is an important element of the research. Analyzes carried out allowed to answer the question of whether the development of the communication system in the analyzed communes affected the average prices per 1m² of undeveloped land. Is there a relationship between the time the transaction is made and the price? Did the year 2011 (as the date of initiation of investments) cause a systematic increase or decrease in the number of transactions concluded? On the basis of the statistical analyzes carried out, it was found in the examined case that there was no linear relationship between the time variable (T) and the price variable (P). This means that these variables are not correlated. The various values of the coefficient of variation calculated for the data of both communes indicate a large dispersion of transaction prices in the examined period. Basic statistics such as: the correlation coefficient, the coefficient of variation, standard time and price deviation, max and min values, median, kurtosis, as well as skewness were examined for the tested sample.

1. Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results. The real estate market in the Polish literature [1-4] and in the
international one [5-9] is taken into consideration in several aspects. The first one concerns the spatial category, in which the market is defined as an area with the same or similar conditions for the purchase and sale transactions. Another aspect of the market analysis includes the technical (or historical) market, which is the one on which the goods are exchanged between buyers and sellers in person. In turn, the economic market is treated as the general relationship between supply and demand. An interesting category of market classification is the so-called cybernetic market, which is considered as a set of elements and relations occurring between them, as a result of which control processes take place. In such a research object there are distinguished the subject entities (seller, buyer) and the object ones (goods and means of payment). Relations between them take the form of contractual relations as a result of which occur the aforementioned processes of controlling the flow of goods and funds according to the degree of demand. Among others, Trojanek [10] writes about it. The events that took place in Poland in the early nineties brought significant changes in the economic system. The paper analyzes the methodic of estate valuation in Poland. The author discusses types of values, aims of valuation and valuation procedures. According to Bałtowski and Miszewski [11], the transition from a centrally planned economy to a market economy was aimed at changing the system and building a free market creating the right conditions for the functioning of all business entities. These changes led to the development of the real estate market in Poland, as well as to the determination of valuation methods and techniques. Gawroński and Prus write about it [12]. From the point of view of the analysis undertaken in this article, the real estate market is understood as the whole of activities (processes) which are taken up by market participants and relations that take place between them, influencing the creation of demand and supply of real estate in a given location. The definition was specified by Mazur-Dudzińska [13]. The complexity of the real estate market has led to the specialization of market participants who are necessary for its proper functioning. According to Kucharska-Stasiak [14] - five main entities have developed on the market of purchase and sale transactions in Poland. These include: investors, lenders, developers, brokers and technical market service. From the point of view of this study, the decisive market subjects are the investors, i.e. those who decide to buy, build, rebuild or modernize the property, representing the commune of Żywiec. The emerging real estate market in Poland requires well-educated and efficient service. An important element of the development of this market is the use of a foreign experience improving the activities of the above-mentioned real estate market entities. An example is the multiple-offer system (MLS) introduced in the United States. The MLS system consists of running a joint bank of offers and mutual exchange of information about clients between real estate agents. Establishing cooperation between property offices competing for clients leads to greater cooperation and higher sales [15]. Spatial diversification of the market causes its division due to the area it concerns and distinguishes the market: local, regional, national and international. This analysis applies to the regional market, which is characterized by a range depending on the location, structure and communication network, commercial network, culture, customs and natural conditions. An important stimulus affecting the development of this type of market is a well-developed road infrastructure enabling the transport. Transport is one of the branches of the national economy, which is responsible for satisfying the needs of moving people, loads and messages [16]. Efficiently operating transport can determine the efficiency of commercial transactions among participants of trade, as Urbanyi-Popiołek writes about [17]. In turn, Rucińska [16] defines a transport as a need reported by the society or the national economy as an offer of moving people, cargoes and messages at a given time and for a given distance. Dembińska [18], however, expresses the view that identifying the sources of transport needs is related to the existence of spatial, economic, social, production, technological and cooperative factors. The transport needs, perceived in society, are related to the implementation of specific objectives and are characterized by the heterogeneity, they have a different distribution in time and space, are susceptible to changes in the environment, and also do not occur spontaneously. The object of research is the S1 expressway running through the area of the Śląskie and Małopolskie Voivodships. Ultimately, it will be about 142 km long and will connect the A1 motorway in Pyrzowice with the Slovak border in Zwardoń. Currently, in the long section, it serves as the Eastern Ring Road of the Upper Silesian
Industrial District, and it is also connected to A1 and A4 motorways as well as national roads 1,78,79,81,86 and 94. The Buczkowice-Żywiec part of the S1 expressway analyzed in the work was put into operation on 25 July 2015 and was the last stage of the road being built between the towns of Bielsko-Biała and Żywiec. The 9.5 km section of the road has enabled faster communication between these cities, as well as among the adjacent areas of the following communes: Wilkowice, Buczkowice, Łodygowice and the city of Żywiec.

As the part of the works related to the implementation of this section of the road, the terrain infrastructure networks were rebuilt, and a number of engineering devices such as overpasses, bridges and culverts were built. The question arises: how much the investment activities of the commune (analyzed in this publication), related to the improvement of road transport, influenced the development (dynamics) of the real estate market in the studied region?

2. Materials and Methods

The analysis of the investment on the S1 express road section influence on the dynamics of the real estate market in the Łodygowice and Żywiec communes was carried out on the basis of data obtained from the District Office in Żywiec, from the Real Estate Prices and Values Registry. The database initially downloaded for analysis contained 2218 transactions for both communes, recorded in 2008-2015. In the first stage of data analysis, transactions in which prices or area of real estate significantly differed from the others were eliminated from the database. Also, the transactions containing incomplete data that did not contain all the information necessary to perform the analysis were eliminated from the database. As a result of these operations, the database for the commune of Łodygowice contained 531 transactions (in commune Łodygowice and 4 villages: Łodygowice - village, Bierna, Pietrzykowice, Zarzecze), and for the commune of Żywiec (in commune Żywiec, Żywiec town and 2 villages: Moszczanica, Oczków ) - contained 927 transactions. Determination of the influence of the analyzed investment on the local real estate market was determined on the basis of the interpretation of statistical volatility of transaction prices over time and the study of changes in the number of transactions in individual time periods. The studies determined the average unit prices of undeveloped land in three time periods: before construction, during construction, and after commissioning of the S1 expressway section in the Łodygowice and Żywiec communes.

3. Results

The results of the research work are presented in Tables 1-6. The analyzes were carried out taking into account four types of real estate, using appropriate abbreviations for them: A- undeveloped forest real estate, B- undeveloped single-use agricultural real estate, C- undeveloped multi-use agricultural real estate, D- undeveloped property designated for development other than a homestead. The results were commented on in the Discussion and Conclusions section. Table 1 and 2 show rh average unit price [PLN/m²] of the not built-up land in the periods before construction (01.2008 - 12.2010), during construction (01.2011 - 07.2014) and after commissioning (08.2014 - 12.2015) of the S1 expressway, in the commune of Żywiec.

Table 1. Average unit price [PLN/m²] of not built-up land in the period before construction (01.2008 - 12.2010), during construction (01.2011 - 07.2014), and after commissioning (08.2014 - 12.2015) of the S1 expressway in the commune of Łodygowice

|          | A  | B  | C  | D  | A  | B  | C  | D  | A  | B  | C  | D  |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|
| Łodygowice | 28.77 | 41.67 | 47.82 | 9.36 | 35.58 | 58.41 | 48.38 | 5.47 | 44.76 | 49.19 | 68.00 | 6.52 |
| Bierna   | 21.88 | 49.10 | 39.48 | 7.89 | 30.87 | 40.14 | 51.35 | 5.00 | 38.63 | 61.56 | 41.50 | -   |
| Pietrzykowice | 23.77 | 32.26 | 40.76 | -   | 40.91 | 55.06 | 50.74 | 18.16 | 32.90 | 41.67 | 56.81 | -   |

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Table 2. Average unit price [PLN/m²] of not built-up land in the period before construction (01.2008-12.2010), during construction (01.2011-07.2014), and after commissioning (08.2014-12.2015) of the S1 expressway in the commune of Żywiec.

| Commune     | 01.2008-12.2010 | 01.2011-07.2014 | 08.2014-12.2015 |
|-------------|-----------------|-----------------|-----------------|
| Żywiec      | 23.41 39.60 52.40 13.65 55.55 71.11 76.82 13.41 - 67.74 94.86 - | | |
| Moszczanica | 22.87 39.07 34.96 20.00 36.91 74.00 50.54 - - 42.96 42.06 - | | |
| Oczków      | 7.60 17.38 33.61 - 11.80 15.63 30.48 - - - 48.60 - | | |
| Żywiec      | 17.96 32.02 40.32 16.82 34.75 53.58 52.61 13.41 - 55.35 61.84 - | | |

Tables 3 and 5 present the basic coefficients of prices volatility in the database of the studied communes Łodygowice (table 3) and Żywiec (table 5).

Table 3. The basic price volatility coefficients in the commune database Łodygowice.

| type of real estate | average time | average unit prices | standard time deviation | standard price deviation | correlation coefficient |
|---------------------|--------------|---------------------|-------------------------|--------------------------|-------------------------|
| A                   | 321.43       | 8.40                | 314.56                  | 4.37                     | -0.39                   |
| B                   | 9.49         | 49.79               | 9.49                    | 30.53                    | -0.04                   |
| C                   | 31.46        | 35.17               | 31.46                   | 31.55                    | 0.04                    |
| D                   | 21.55        | 46.06               | 21.55                   | 24.60                    | 0.12                    |

Tables 4 and 6 present the values of statistical functions for the set of purchase and sale transactions in the commune of Łodygowice (table 4) and in the Żywiec commune, respectively (table 6).
Table 4. Basic values of the statistical functions for the set of purchase and sale transactions in the commune of Łodygowice

| Year | type of real estate | average price | min | max | median | Size | coefficient of variation | skewness | kurtosis |
|------|---------------------|---------------|-----|-----|--------|------|--------------------------|----------|---------|
| 2008 | A                   | 31.17         | 10.00 | 70.00 | 30.05 | 38   | 41.26                   | 0.67     | 0.97    |
|      | B                   | 32.04         | 10.00 | 52.42 | 37.23 | 14   | 44.07                   | -0.49    | -1.17   |
|      | C                   | 41.41         | 12.50 | 120.34| 36.67 | 37   | 57.51                   | 1.61     | 2.77    |
|      | D                   | 8.00          | -     | -     | -     | -    | -                       | -        | -       |
| 2009 | B                   | 45.65         | 10.00 | 150.18| 40.00 | 31   | 61.79                   | 1.74     | 5.10    |
|      | C                   | 21.59         | 10.71 | 57.17 | 13.89 | 7    | 76.08                   | 2.20     | 5.06    |
|      | D                   | 41.93         | 12.50 | 77.19 | 37.95 | 12   | 50.24                   | 0.31     | -1.23   |
| 2010 | A                   | 44.19         | 10.50 | 93.75 | 39.72 | 34   | 62.23                   | 0.36     | -1.44   |
|      | B                   | 17.29         | 3.65  | 31.25 | 16.46 | 8    | 51.61                   | -0.06    | -0.31   |
|      | C                   | 42.80         | 10.00 | 82.37 | 46.32 | 17   | 46.36                   | -0.06    | -0.52   |
|      | D                   | 9.30          | 7.89  | 10.71 | 9.30  | 2    | 21.43                   | -        | -       |
| 2011 | B                   | 61.13         | 13.64 | 287.50| 54.03 | 42   | 78.87                   | 2.96     | 11.86   |
|      | C                   | 32.80         | 4.38  | 87.65 | 25.00 | 11   | 77.86                   | 1.10     | 0.61    |
|      | D                   | 52.38         | 11.22 | 149.25| 50.00 | 35   | 55.19                   | 1.31     | 2.85    |
| 2012 | A                   | 5.00          | -     | -     | -     | 1    | -                       | -        | -       |
|      | B                   | 52.58         | 10.00 | 100.00| 50.85 | 42   | 42.14                   | 0.34     | -0.36   |
|      | C                   | 38.75         | 7.50  | 57.46 | 44.05 | 8    | 45.31                   | -0.79    | -0.46   |
|      | D                   | 47.28         | 11.54 | 92.02 | 38.78 | 14   | 53.97                   | 0.47     | -1.02   |
| 2013 | A                   | 18.16         | -     | -     | -     | 1    | -                       | -        | -       |
|      | B                   | 56.82         | 15.94 | 100.00| 58.50 | 39   | 32.68                   | -0.09    | 0.21    |
|      | C                   | 38.65         | 6.31  | 112.36| 28.57 | 13   | 85.99                   | 1.10     | 0.42    |
|      | D                   | 38.22         | 20.00 | 57.21 | 40.00 | 5    | 37.50                   | 0.05     | -0.62   |
| 2014 | A                   | 5.47          | 5.00  | 5.93  | 5.47  | 2    | 12.06                   | -        | -       |
|      | B                   | 50.63         | 10.00 | 105.34| 45.45 | 37   | 49.70                   | 0.47     | -0.70   |
|      | C                   | 52.20         | 7.26  | 186.53| 31.40 | 16   | 105.93                  | 1.79     | 2.60    |
|      | D                   | 55.51         | 34.53 | 68.00 | 59.75 | 4    | 26.87                   | -1.34    | 1.53    |
| 2015 | A                   | 6.52          | -     | -     | -     | 1    | -                       | -        | -       |
|      | B                   | 52.90         | 10.00 | 180.25| 48.92 | 41   | 69.01                   | 1.77     | 3.90    |
|      | C                   | 2.62          | 5.81  | 75.00 | 23.38 | 15   | 77.76                   | 0.68     | -1.15   |
|      | D                   | 59.55         | 37.14 | 100.00| 41.50 | 3    | 58.95                   | 1.70     | -       |

Table 5. Basic price variability coefficients in the Żywiec commune database

| type of real estate | average time | average unit prices | standard time deviation | standard price deviation | correlation coefficient |
|--------------------|--------------|---------------------|-------------------------|--------------------------|------------------------|
| A                  | 261.88       | 14.52               | 229.20                  | 6.37                     | -0.19                  |
| B                  | 15.39        | 48.14               | 16.14                   | 51.45                    | 0.10                   |
| C                  | 51.62        | 30.27               | 44.41                   | 37.21                    | 0.15                   |
| D                  | 4.12         | 61.25               | 5.52                    | 54.17                    | 0.02                   |
Table 6. Basic values of statistical functions for the set of purchase and sale transactions in the Żywiec commune

| Year | type of real estate | average price | min | max | median | Size | coefficient of variation | skewness | kurtosis |
|------|---------------------|---------------|-----|-----|--------|------|--------------------------|----------|---------|
| 2008 | A                    | 17.43         | 7.24 | 27.62 | 17.43  | 2    | 82.66                    | -        | -       |
|      | B                    | 19.36         | 9.19 | 46.88 | 19.38  | 24   | 45.28                    | 1.57     | 3.41    |
|      | C                    | 19.38         | 4.88 | 52.00 | 10.32  | 4    | 113.08                   | 1.91     | 3.71    |
|      | D                    | 46.66         | 10.24 | 262.45 | 30.56  | 149  | 95.54                    | 3.13     | 13.11   |
|      | A                    | 20.00         | -    | -    | -     | 1    | -                        | -        | -       |
| 2009 | B                    | 50.01         | 10.00 | 234.00 | 31.00  | 29   | 108.63                   | 2.37     | 5.58    |
|      | C                    | 19.70         | 5.65 | 96.36 | 7.60   | 8    | 158.72                   | 2.73     | 7.55    |
|      | D                    | 47.37         | 10.52 | 210.41 | 39.88  | 116  | 70.66                    | 2.21     | 6.71    |
|      | A                    | 9.86          | 9.72 | 9.99 | 9.86   | 2    | -                        | -        | -       |
| 2010 | B                    | 37.91         | 10.00 | 110.90 | 21.02  | 32   | 82.52                    | 0.97     | -0.46   |
|      | C                    | 24.56         | 7.09 | 96.73 | 11.39  | 10   | 111.67                   | 2.41     | 6.25    |
|      | D                    | 58.75         | 10.00 | 276.38 | 43.65  | 112  | 70.66                    | 2.21     | 6.71    |
|      | A                    | 13.85         | -    | -    | -     | 1    | -                        | -        | -       |
| 2011 | B                    | 54.61         | 10.99 | 197.69 | 35.00  | 19   | 91.43                    | 2.25     | 5.31    |
|      | C                    | 26.01         | 12.11 | 39.91 | 26.01  | 2    | 75.59                    | -        | -       |
|      | D                    | 60.76         | 10.00 | 249.19 | 45.00  | 81   | 74.07                    | 1.71     | 3.52    |
|      | A                    | -             | -    | -    | -     | -    | -                        | -        | -       |
| 2012 | B                    | 64.01         | 10.00 | 191.78 | 44.66  | 19   | 91.28                    | 0.85     | -0.40   |
|      | C                    | 50.38         | 4.86 | 156.86 | 21.59  | 8    | 117.88                   | 1.17     | -0.14   |
|      | D                    | 67.45         | 10.84 | 256.96 | 59.86  | 96   | 67.28                    | 1.68     | 4.17    |
|      | A                    | 16.39         | -    | -    | -     | 1    | -                        | -        | -       |
| 2013 | B                    | 47.98         | 10.00 | 203.90 | 16.79  | 20   | 131.0748                 | 1.92     | 2.32    |
|      | C                    | 47.89         | 34.75 | 71.43 | 37.50  | 3    | 42.66                    | 1.70     | -       |
|      | D                    | 85.26         | 15.00 | 294.99 | 64.24  | 57   | 74.95                    | 1.56     | 2.36    |
|      | A                    | 12.94         | 10.00 | 15.87 | 12.94  | 2    | 0.00                     | -        | -       |
| 2014 | B                    | 61.13         | 13.44 | 216.67 | 30.77  | 15   | 104.91                   | 1.68     | 1.90    |
|      | C                    | -             | -    | -    | -     | -    | -                        | -        | -       |
|      | D                    | 91.11         | 10.84 | 268.74 | 70.00  | 39   | 80.30                    | 1.08     | 0.20    |
|      | A                    | -             | -    | -    | -     | -    | -                        | -        | -       |
| 2015 | B                    | 60.16         | 10.00 | 311.85 | 44.55  | 29   | 100.76                   | 2.82     | 10.33   |
|      | C                    | -             | -    | -    | -     | -    | -                        | -        | -       |
|      | D                    | 82.43         | 15.45 | 462.96 | 56.50  | 46   | 110.09                   | 2.91     | 8.716212 |

The significant element of analysis of the real estate market dynamics as the effect of changes in the road infrastructure was the study of the relation between time and the number of transactions. The researches were carried out in three time periods - before the construction of the S1 expressway section begins (01. 2008 - 12. 2010), under the construction (01. 2011 - 07. 2014) and after the completion of the "Buczkowice-Żywiec" road section (08 2014 - 12.12. 2015). The results of these analyses are presented in Figures 1 and 2.
4. Discussion

Construction of the "Bielsko-Biała-Żywiec" section of the S1 expressway connected two cities and shortened the travel time between them, and reduced the intensity of traffic on Żywiecka Street. The location of the fragment of the S1 road in the communes also resulted in a better connection of the city with the center of the Silesian Voivodship (Katowice), and also with other neighboring towns. The development of the transport system in the Żywiec district, in the Łodygowice and Żywiec communes, had a slight impact on the local market of the undeveloped forest real estates (A), agricultural real estates (B), single use and multi-use properties (C), as well as the real estates designated for the development other than homestead (D). Basing on the analysis results, we can only notice a periodic and non-linear increase in the value of not built-up land in both communes in 2008-2015. With the exception of the undeveloped forest land (A) which is characterized by a decrease in the value of the

**Figure 1.** Number of real estate purchase and sale transactions in the Łodygowice commune in the years 2008-2015

**Figure 2.** Number of real estate purchase and sale transactions in the Żywiec commune in the years 2008-2015
land. The reason for obtaining this result may be an insufficient number of transactions in the database. Table 7 presents the results of the analysis of percentage values of the increase or decrease in the average prices of not built-up land in the analyzed communes.

Table 7. The percentage of the increase or decrease in the average prices of the not built-up land in the municipalities of Łodygowice and Żywiec in the years 2008-2015

|            | A       | B       | C       | D       |
|------------|---------|---------|---------|---------|
| Commune of | **Łodygowice** |         |         |         |
| Price decrease | 3.9% |         |         |         |
| Price increase  | 3.3% |         |         |         |
| Price increase  | 3.9% |         |         |         |
| Price increase  | 3.1% |         |         |         |
| Commune of | **Żywiec** |         |         |         |
| Price decrease | 9.1% |         |         |         |
| Price increase  | 4.4% |         |         |         |
| Price increase  | 14.8% |         |         |         |
| Price increase  | 6.2%  |         |         |         |

5. Conclusions
The analysis of the basic statistical functions did not show a linear relationship between the time variable and the price variable. This means that these variables are not correlated. What is more, the diversified value of the coefficient of variation calculated for the data of both communes indicates a large dispersion of the transaction prices in the analyzed period. Moreover, the research has shown that only the villages of the Łodygowice commune, through which the S1 expressway section passes, are characterized by a definite predominance of the number of transactions concluded in relation to the rest of the studied area. This is due to the sale of these properties for the implementation of the public goal, which is the road. The analysis of the extract from the Real Estate Prices and Values Registry of the communes of Łodygowice and Żywiec also allowed the identification of the main groups of buyers and sellers. The research showed that the vast majority of transactions in the audited period were concluded between individuals. Other transactions were concluded between the State Treasury, local government units or other entities with the legal personality.

The analysis of changes in the average real estate prices of selected real estate groups within the investigated communes will be made available to the communes. The results of this analysis may be used by the commune authorities, entrepreneurs, developers, investors and other legal or natural people who would like to obtain information about the expected land prices. Such information may help, for example, in choosing the location of further investments or conducting financial negotiations. Furthermore, the results of the analysis can be used as a material that is the basis for the creation of the specialist expertise, reports or opinions related to the non-built-up properties market. The dynamics of the real estate market is observed, especially in the period before the planned investment begins. This problem is noticeable due to the increase in the number of transactions in the Żywiec commune during this period. The graphic analysis of this issue is presented in Figure 2. In relation to the second surveyed commune (Łodygowice), no similar market activity was noticed before the commencement of reconstruction of the S1 road. Graphical analysis of this issue is presented in Figure 1.

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