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Impact of Forest Landscape on the Price of Development Plots in the Otwock Region, Poland

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Abstract: Building plots, understood as land properties intended for development, are an important object of commercial transactions. Their prices are determined by several factors, such as location, state of development, distance from important urban centres, and proximity to green areas. It is certain that, especially with regard to building plots intended for single-family housing, the proximity of natural areas, especially forest areas, is becoming increasingly important. The Otwock region, with a forest cover of more than 30%, has numerous undeveloped lands that are or could be development plots. This article concerns an analysis of transactions involving undeveloped development land of selected communes in the Otwock region. On the basis of an analysis of prices of real estate transactions from 2011 to 2016 from four municipalities of the Otwock region and a spatial visualisation of the plots, the relationship of price (m^2) with physical characteristics (technical development, shape, area), distance from a large city (Warsaw), and distance from a railroad line stop and landscape values (landscape type, distance to the forest, number of landscape components) was determined. Statistical analyses used regression and correlation analysis. The preferences of 519 people interested in buying/selling real estate in the Otwock region were also investigated, and for this purpose, we cooperated with real estate offices and municipal offices. The results of the survey strongly indicate that forest landscapes increase the attractiveness of building plots, which in turn leads to higher prices on the market. The results of the study show that there is a relationship between the price of a property and its distance to the forest, the nature of the forest boundary, and the number of landscape elements. The forest landscape is one of the most important factors determining the attractiveness of a building plot. Proximity to a forest, especially forests under a form of protection, is an important value for prospective land plot buyers. The views of respondents varied considerably due to socio-demographic characteristics, mainly the age and education of respondents.

Keywords: forest; real estate; value; real estate transaction price

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1. Introduction

Land intended for residential development is a unique subject of market trading. The most significant interest in construction land in Poland has come as a result of intensive urbanisation processes. After the political system's transformation in the 1990s, due to the inconveniences accompanying urban areas, urban residents began to move outside the city, mainly to suburban areas, often with convenient transport links. High investment pressure and the need to meet the demand for this type of real estate caused more and more land to be allocated in planning documents for residential development [1,2]. According to the

report analysis of the status and conditions of planning work in municipalities in 2017, large agglomerations, especially Warsaw, are characterised by the greatest urban pressure and supply of land [2]. Land prices in such areas began to reach high levels. The highest average price for this type of land at the end of January 2018 was recorded in the Mazovian Voivodeship, i.e., 45.43 EUR/m^2 [3]. The price did not depend only on increased demand but also on other factors.

In addition, the designation of the land in the local plan, the use of the land, and the status of technical infrastructure facilities are important [4]. The environment and landscape are very important for the price level of land property. The property's value is influenced by the proximity of green areas, including forests, especially in urban, degraded areas. These are elements of space that can promote human well-being. Ekkel, Vries [5] emphasise the great importance of ecological lands (ecological lands) and their positive impact on air quality, stress reduction, and motivation for physical activity. Such lands improve living standards and the standard of living of city residents [6].

The impact of landscape on the value of real estate is seen as intuitive and still inconclusively verified since landscape in economic theory is treated as a public good, not an object of market trading [7].

To date, numerous studies [8–11], have established preferences for forest landscapes. Most of the existing research in this area is related to the recreational use of the forest, whereas it does not cover issues related to the attractiveness of building plots. It is therefore worth checking to what extent preferences for landscape and attractiveness of building plots are reflected in real prices of real estate. So far, in Poland there has been no such analysis. Such analyses are needed because their results provide new tools for real estate appraisers dealing with property valuation.

Lowicki [12] showed that the technical features of a plot—its development and locational features, and its location in relation to a major city—are of the greatest importance in shaping the market price of real estate. D'Acii [13]), in analysing the change in prices depending on property distance from the city centre, noted the largest price fluctuations occur in the city centre, not on its periphery, while the greatest variation in values occurs due to the presence and quality of greenery, among other factors. Chen at al. [4], as well as Belke and Keil [14], point out that in addition to the quality of infrastructure, regulations also have an impact on real estate prices. Lowicki [15] proved that as the distance between lakes and forests increases, the price of land plots decreases (by an average of EUR 0.23 per 100 m of remoteness, up to 1000 m from the forest). Noblejas et al. [16] has proven that the desire to experience beautiful open spaces is an important motivating factor in the search for real estate to live in. Parks, forested areas, other green spaces, and unique landscape increase the price of land property [17,18]. Trojanek et al. [19] proved that the price of non-residential real estate in Warsaw increases by several percentage points if there are green areas within a 100-m radius.

The zone of influence of forests is larger than that of lakes when it comes to real estate prices, at about 3 km. Melichar et al. [20] and Anderson and West [21] concluded that the greater the distance from public open areas such as a park, the lower the price of an apartment or house.

A property's value is influenced by the proximity of green areas, including forests, especially in urban, degraded areas. These are elements of space that can promote human well-being [22,23]. Quite a large number of studies have provided insight into the relationship between the presence of a forest and its features and the price of real estate. Crompton and Nicholls [24], in examining the effect of the distance of the forest from the property on real estate price, proved that people buying property are willing to pay more for it as the distance from the forest decreases. They proved that "a 1% decrease in mean distance to the forest increased house value by 6.4%". For example, Gawron [25] found that the location of a plot of land near a large forest complex increases its attractiveness. Research by Cho et al. [26] also confirms this. Kim and Johnson [27] and Mansfield et al. [28] proved that the shorter the plot distance from a forest, the higher the house price. Similar

observations were reached by Czembrowski and Kronenberg [29], who showed that as the distance from large recreational areas, including forests, increases, the price per m^2 of housing decreases. The value of real estate increases as the percentage of green space within a 500 m radius around the property increases. Zydron et al. [30] proved that the price per m^2 of undeveloped real estate for construction purposes depends on its distance from a large city and the presence of nearby forest areas. These prices decreased with distance from a large city, forest complexes, and water bodies. Osikowska and Przetacznik [31] found that landscape values significantly impact real estate prices. Additionally, a study by Hui et al. [32] showed that landscape views have a significant role in the pricing of urban real estate market. House prices tend to increase with the presence of sea and garden views. Yet, for high-level units, sea views become negatively associated with prices.

Maksymiuk [33] concluded that properties for which the closest area of green infrastructure was a forest had higher prices per m^2 compared to properties for which the closest area was a park. The results of Kolbe and Wüstemann's [34] study showed that the closer the forest and the larger the forest area within 500 m of the property, the higher the housing price. Regardless of the physical characteristics of the land in question, buyer preferences are also important in shaping the price of land. Preferences are a reflection of individual consumer tastes. They do not depend on the price of goods or the consumer's budget but the level of satisfaction, and the utility they provide [35].

The purpose of the present study was to determine whether forest landscapes influence the attractiveness of building plots and whether the proximity of the forest increases the price of land property for development (building plots). The need to study such a relationship arose from the growing interest in buying building plots, especially in places located in close proximity to natural areas, including protected ones. The Otwock region was chosen as a case study because of its attractive location (not too far from Warsaw), natural areas (mostly forests), and interesting history. Forests are characteristic of the Otwock region, being generally located nearby or adjacent to the housing estates.

2. Methods

2.1. Study Area

The Otwock region is located in the central part of Poland, Mazovian Voivodeship (Figure 1).

It is a unit of territorial administration of the second grade in a three-grade scale of administrative divisions in Poland (voivodeship > region > commune). The region is subdivided into eight communes. The capital city of Warsaw borders it in the northwest. The region covers an area of 615 km^2 with a total population above 124,000 (as of 2019). In the past, the region's total area was covered by dense conifer forests. Nowadays, is characterised by a high forest cover of over 30%. The history of Otwock started in the second part of the 19th century when it started to be attractive as a leisure area with a unique microclimate. The building of a new railway line and station from Warsaw to Otwock in 1877 was the main impulse for the development of the new settlement. At the turn of the 19th and 20th centuries, more than 600 villas had been built, and during summer, about two thousand inhabitants were enjoying the forest microclimate. In 1893, the first sanatorium for pulmonary diseases was opened. The official status of Otwock as a city-spa in 1923 was the reason for its very dynamic rapid development. By 1938, Otwock had more than 20,000 inhabitants and more than 40,000 bathers. Just after the Second World War, the number of inhabitants and its structure dropped dramatically, but its characterisation as a city-spa remains these days.

Due to its favourable conditions, i.e., proximity to Warsaw, proximity to educational and cultural centres, numerous recreational values, and an efficient transportation system, it is a place to which new residents are increasingly flocking. The analysis covered communes in the Otwock region selected based on the area of protected areas and the level of forest cover, including: Józefów, Otwock, Celestynów, and Karczew.

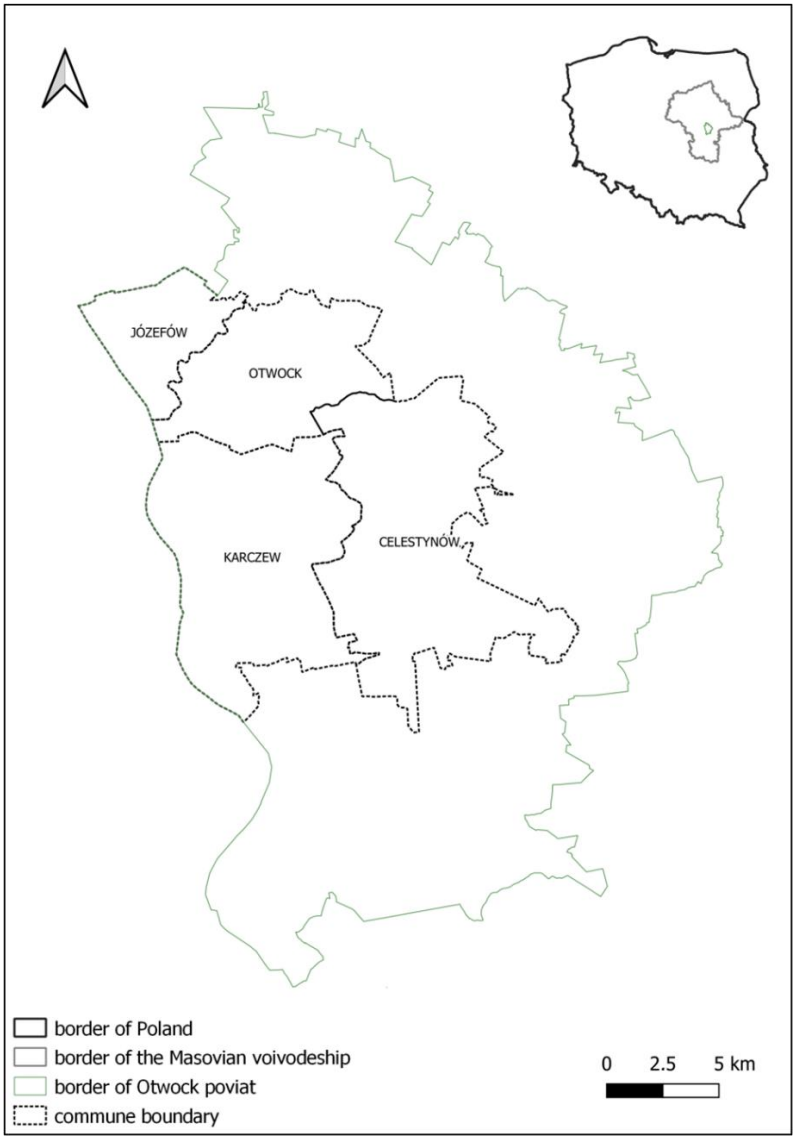


Figure 1. Location of Otwock on the map of Poland.

2.2. Data Analysis

The achievement of the purpose of the study first involved assessing the impact of individual property features on their value (Section 2.2.1), followed by a questionnaire survey on the public's preferences for forest landscapes (Section 2.2.2).

2.2.1. Land Prices and Factors Determining the Price of Real Estate

For the purpose of exploring the influence of real estate features on their prices, data were obtained from the Register of Prices and Values of Real Estate from the District Office in Otwock. The analysis included transaction prices obtained over a 5-year period from 2011 to 2016. Although the analysis was conducted in 2019, nominal real estate prices were assumed due to the fact that the level of land price changes was not subject to major fluctuations during the analysed period. The analysis of real estate prices was carried out in 2019 on the basis of data obtained from 2011 to 2016. Prices were analysed in the Polish currency, zlotys (PLN), while for the purposes of the following article, they are given in euros (EUR).

Transactions of undeveloped real estate intended for development other than homesteading were accepted for the analysis. The data included undeveloped properties that were either designated in the local plan for single-family residential purposes or for which

decisions on development conditions had been issued, as well as those that were within the range of land with a "residential function" designation in the municipality's zoning study. From the database obtained, properties were eliminated whose price was abnormally low or high in relation to the others as well as properties that were plots of land with a share in the road, being the subject of joint ownership; intended for service development; intended for areas of production facilities, warehouses and storages; plots constituting forests (without the possibility of development); plots intended for multi-family housing development; plots with an area of fewer than 400 m^2 (according to the assumptions of the local plans of the analysed municipalities too small for single-family housing development).

The analysis included a total of 825 transactions of undeveloped real estate intended for residential development. The communes of Celestynów and Karczew recorded the fewest transactions, i.e., 115 and 139, respectively, while the highest number of transactions was recorded in the commune of Józefów, at 300 transactions, and in the commune of Otwock, at 271 transactions. All transactions involved a total of 1133 registered plots (Celestynów 152, Józefów 406, Otwock 352, Karczew 223).

The tool supporting the analysis was statistical research, which allowed us, among other things, to examine the relationship between price and various real estate factors. Additional supporting tools were graphical studies using a Geographical Information System (GIS). Thanks to the use of layers of land and building records and orthophotos in the Geoportal, reconnaissance was carried out in terms of the physical characteristics of the plots (shape, area, and neighbourhood). Over the course of the analysis of real estate features, the Google Maps application was used, as well as publicly available spatial information systems of the Otwock region and its individual communes. The spatial analysis of the data, obtained as a result of the calculations, was visualised using the Quantum GIS program (QGIS 2.14 Esen).

The analysis of the relationship of property price with individual features was carried out using the following steps: selection of real estate market features and forest landscape features that have a potential impact on the price of the property; adoption of an appropriate rating scale for these features; assignment of an evaluation score for features specific to each property; analysis of the significance of individual real estate market features and landscape features for the price of the property. The paper assumes, based on a review of the literature, that the factors that potentially determine the price of real estate are: distance to Warsaw, distance to a train stop, area, technical development, shape, neighbourhood, and location in the Mazovian Landscape Park (MLP) or its buffer zone. Features related to the forest landscape included: landscape type, distance to the forest, and a number of landscape components. Each of the property's market features was rated on a 3-point scale (very favourable, favourable, average), while forest landscape features were rated on a 3-point scale (distance to the forest) or based on the property's affiliation with a particular type of feature (landscape subtype), or location within the boundaries of the MLP and its buffer zone.

The features adopted for the analysis are characterised below:

"Distance to Warsaw" plots were classified by distance to Warsaw as favourably located (within 30 km) and average location (distance > 30 km). The distance was measured from the front of the plot to a point representing the centre of Warsaw using the "measure distance" tool in Geoportal.

The feature "distance to the railway station" was determined based on the distance measured from the front of the plot to the nearest railway station, according to the course of existing roads. Such distances were measured in Geoportal, using the "measure distance" tool. It was assumed that a distance of up to 1 km is very favourable. Distances from 1 km to 3 km were assessed as favourable and a distance of more than 3 km as average.

For the attribute "area", it should be noted that in the local plans in force in the communes of Celestynów, Otwock, Józefów, and Karczew, it was assumed that plots for single-family residential development have an area of 600 m^2 (for semi-detached development, 500 m^2; for terraced development, 400 m^2) to 2500 m^2. Therefore, it was

assumed that an area of 700–2000 m^2 is very favourable. A favourable rating was assigned to plots of 500–699 m^2 and 2001–3000 m^2. Plots less than 500 m^2 and more than 3000 m^2 received an average rating.

The next feature taken into account was the "plot's technical infrastructure facilities", i.e., the technical development of the plot's access to the following networks: electricity, sewage, water, and gas. However, access to the district heating network was not taken into account. In order to analyse the impact of technical utilities on the price of land plots, a layer of the basic map available in the spatial information system of each commune was used. In this study, full development of the land, i.e., access of the property to all networks, was considered a very favourable feature. Partial development (access to two or three networks) was assessed as favourable. Lack of development, or partial development (access to one network), was considered average.

An important feature of a property with a potential impact on its price is the "shape of the plot". The most adjustable property for development is a square- or rectangular-shaped plot. A regular shape allows the building to be appropriately located on the plot. Here, of course, it is necessary to exclude regular, narrow plots, the width of which limits the location of a building due to the requirements of building regulations. In the course of the analysis, regular square or rectangular plots were considered very favourable. Plots with a non-parallelogram trapezoidal shape (e.g., a non-parallel quadrilateral) were considered to have favourable conditions for construction. Irregularly shaped properties were considered average.

Another of the analysed features was the "surrounding area", i.e., the neighbourhood in which the property was situated (the type of development around the plot). In order to evaluate this feature, the spatial information system of the individual municipalities with an orthophoto layer was used. Neighbourhoods with extensive single-family housing were considered very favourable, while neighbourhoods with intensive single- or multi-family housing and non-intensive services were deemed favourable. Plots surrounded by industrial and service areas of nuisance and located far from other residential development areas were assessed as average. The type of landscape within the range of the analysed properties was determined on the basis of the landscape map prepared and the Geoportal land and building registration layer. Analysis of these two layers made it possible to assign each transaction to a given landscape subtype and code this information in an Excel summary database.

The distance to the forest was another of the analysed characteristics. There was forested land in the analysed communes. The decision to live outside of Warsaw is often dictated by lower land prices and natural and scenic values. The distance from the forest was measured from the centre of the plot to the nearest forest, along a straight line. In this respect, a forest is understood as already wooded land. Close proximity to the forest and a short distance to it (up to 20 m) were assessed as very favourable. A distance of 1 m to 100 m was considered favourable. On average, the distance from the forest was rated above 100 m.

Related to the attribute "distance to the forest" is another of the analysed attributes of space—the nature of the forest boundary. Forest boundaries that had an irregular, free-flowing course were rated as very favourable. The opposite variant—a rigidly defined tree line—was assessed as average, while the mixed variant was evaluated as favourable. The evaluation of the feature mentioned above was carried out on the basis of an orthophoto and findings from direct observations made in the field.

It was assumed that the property's price might also depend on the number of landscape components present on the plot. A significant number of landscape components can enhance a landscape's attractiveness and contribute to the perception of a chaotic, disorderly landscape. The paper did not score this feature. Instead, the relationship of the property price with the number of landscape components was examined. Landscape components include trees, shrubs, a diverse range of horizontal surfaces (grass, earth, paved surfaces,

ground cover vegetation, etc.), and infrastructure elements (fence, power pole, etc.). The number of components in a plot was determined using orthophotos.

The starting point was to characterise the variation in transaction prices and prices of 1 m^2 of land in each commune and in the entire collected dataset. The significance of differences in the average values of these characteristics for individual communes was assessed. For this purpose, the Kruskal–Wallis test was used, and if significant differences between communes were found, Dunn's multiple comparisons test was performed. The analysis of the relationship between the unit price of real estate and the size of the plot was carried out by performing regression and correlation analysis. The strength of this relationship and the directions of the relationship between the analysed characteristics were evaluated based on the value of Pearson's linear correlation coefficient. The analysis of the relationship between the unit price of a plot and the other attributes under consideration was realized using Spearman's rank correlation coefficient. Pearson's contingency coefficient C was used to analyse the significance of differences in the unit price of real estate in relation to the factors considered.

In order to assess the impact of forest landscape features on the price of real estate, it was necessary to analyse the number of transactions, taking into account their location in each commune. Taking these data into account made it possible to distinguish between areas with the highest and lowest number of transactions, which can also be reflected in the price. When determining the average price of real estate for each precinct in the analysed commune, a relationship was sought between the transaction price and the considered features of the forest landscape.

2.2.2. The Questionnaire Surveys

In order to further emphasise the importance of the forest landscape in shaping the transaction price of the analysed properties, the preferences of people interested in buying/selling real estate in the Otwock region were surveyed in September–October 2018 among residents of the Otwock region and people vacationing in the Mazovian Landscape Park. For this purpose, a diagnostic survey method was used. The research technique was a questionnaire. The survey questionnaire was posted on the "webankieta" platform. The webankieta.pl platform was chosen from among other available ones due to the rather wide spectrum of possibilities for presenting graphic drawings and photographs. The link to the questionnaire was made available to 15 real estate offices and was also posted on the websites of the commune offices of Celestynów, Józefów, Karczew, and Otwock. Reaching the widest possible audience was also ensured by placing advertisements in the local press. The survey questionnaire consisted of three parts. The first part (formal and informational) contained data on the survey, i.e., the title of the survey, information relating to the purpose of the survey, and the location and the dates of the start and end of the survey. The second part (metrics) concerned the socio-demographic characteristics of the respondents, such as gender and age (a division into three age categories was used: 18–34 years of age; 35–54 years of age; over 54 years of age), level of education (two categories of education were included: elementary (or high school) and higher education), and respondents' place of residence (three categories for place of residence were adopted: rural/rural; city with up to 100,000 residents; city with over 100,000 residents). The third part was a set of seven questions that dealt with aspects such as factors determining the attractiveness of a building plot, factors determining the attractiveness of a landscape, and factors determining the attractiveness of a forest landscape. The survey covered a group of 519 people. The obtained survey material was subjected to statistical analyses to determine whether the respondents' preferences depended on their gender, age, education, and place of residence.

The responses were automatically coded and then saved as a report in a text data file as an Excel summary report and as so-called raw data. The use of the web survey eliminated the problem of respondents not answering all of the questions since moving on to the next question required answering the previous question. On the basis of the

automatically generated report and as a result of the technical work of preparing the file for statistical analysis, it was possible to build result tables and conduct statistical tests. All statistical analyses, performed in the Statistica v. 13.0 package (Dell Inc., Round Rock, TX, USA, 2016) at a significance level of 0.05, included an assessment of the independence of non-measurable characteristics carried out using the chi-square test, in which observed values obtained from the study were compared with expected (theoretical) values. The contingency coefficient (C) was used to assess the strength of the relationship between the two qualitative variables.

The following questions were selected from the survey to examine the impact of forest landscape on the price of real estate. The first was: What features of a building plot do you think determine its price attractiveness? (provision of utilities; shape; access to a public road; area; distance to Warsaw; ability to commute to Warsaw by public transportation; access to administrative and educational services; surroundings and landscape; the presence of tall trees on the plot; distance to the forest). This question was answered with a Likert scale taking into account five degrees of acceptance of the view from total acceptance to total rejection: /strongly yes; yes; I have no opinion; no; definitely no/. On the basis of the question posed, the formation of views on certain real estate features was examined in relation to the age and gender of respondents and their place of residence.

The second question was: At what distance to the forest would you like to live? Answers included: up to 20 m; from 20 to 100 m; from 100 to 500 m; over 500 m. For this question, respondents could mark only one answer.

3. Results

3.1. Results of the Conducted Analysis of Real Estate Transaction Prices

A total of 490 properties were analysed. Below in the table is a summary of real estate transaction data for selected communes of the Otwock region from 2011 to 2016. Table 1 indicates the average price and the minimum and maximum prices of real estate in each commune.

Table 1. Transaction data in the surveyed communes of the Otwock region from 2011 to 2016, including the average price, maximum price, and minimum price.

Commune	Number of Transactions Analysed	Average Price of Property (EUR/m^2)	Minimum Price (EUR/m^2)	Maximum Price (EUR/m^2)	Median (EUR/m^2)	Standard Deviation (EUR/m^2)
Józefów	180	76.08	13.70	137.18	73.14	24.12
Otwock	152	45.04	8.49	98.02	44.78	18.95
Karczew	67	18.59	5.83	42.27	14.59	10.39
Celestynów	91	21.95	3.61	49.49	19.69	10.44

The spatial distribution of data on the number of transactions and average prices in each of the analysed communes is presented in Figure 2. The highest transaction prices were recorded in the commune of Józefów, followed by Otwock, Celestynów, and Karczew.

The largest share of real estate in the selected municipalities of the Otwock region was in the range of suburban and settlement landscapes "forest-settlement landscape with villa character" (136 properties), urban landscape "villages with contemporary character" (86 properties), rural landscape "with a predominance of ribbon-shaped complexes of small arable fields, meadows and pastures" (63 properties), and forest landscape "with a predominance of boric habitats" (58 properties). A summary of properties' average unit prices and the number of transactions in each commune within and outside the forest landscape range (plots in the forest settlement landscape range with a villa character are also included in this group) is presented in Table 2.

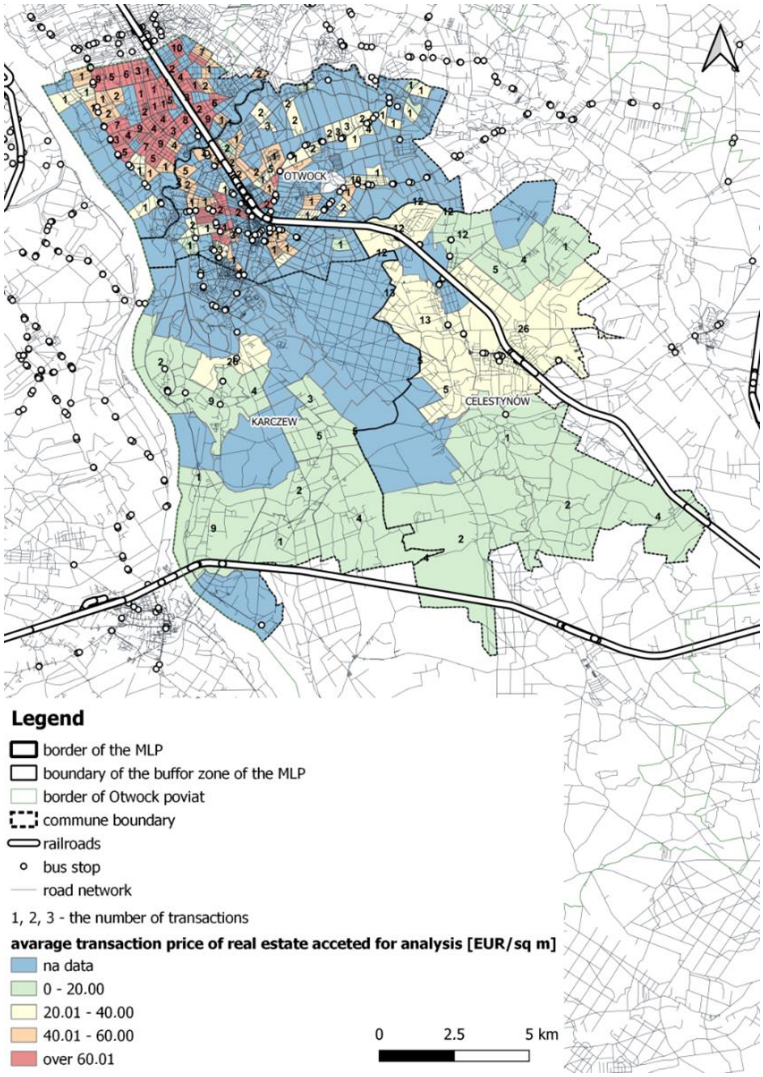


Figure 2. Number of real estate transactions in the analysed communes of the Otwock province in 2011–2016.

Table 2. Evolution of average property prices and number of transactions in relation to the landscape.

Commune	Type of Landscape			
	Forest Landscape		Another Type of Landscape	
	Average Price of Property (EUR/m^2)	Number of Observations	Average Price of Property (EUR/m^2)	Number of Observations
Celestynów	22.49	12	21.71	79
Józefów	75.78	140	76.56	40
Otwock	42.08	55	46.45	97
Karczew	16.67	3	18.30	64
Total	38.97	210	40.76	280

As can be seen from Table 2, only within Józefów was there a significant prevalence of properties located within the forest landscape range in the market. A relatively large share of these types of plots was also visible in Otwock. In the other two communes, plots located in landscapes other than forest areas definitely prevailed.

The results of the significance analysis of the differences in the average price per m^2 of a plot in the analysed communes depending on location in the forest landscape range, conducted using the Kruskal–Wallis test, showed that there were no statistically significant

differences between the price of a plot and its location in a given landscape type. On the other hand, the statistical analysis showed that the landscape characteristics considered (distance to the forest, nature of the forest boundary, number of landscape components) significantly impacted the property's price (Table 3). The statistically significant differences are marked in bold.

Table 3. Values of Spearman's rank correlation coefficients between unit real estate price and ratings of selected real estate characteristics—distance to forest, etc.—in selected communes of the Otwock region in 2011–2016.

Commune	Landscape-Related Features		
	Distance to Forest	**Forest Boundary (Forest Edge Contour)**	**Number of Landscape Components**
Celestynów	0.0845	−0.0387	−0.0313
Józefów	−0.0778	−0.0221	0.0255
Otwock	−0.1835	−0.0123	0.1798
Karczew	−0.1672	0.2903	−0.0513
Total	0.3803	−0.2199	−0.3390

Research on the impact of the role of the forest landscape in the formation of real estate transaction prices showed that there was a dependence of the unit price of real estate on the feature related to the distance of the plot to the forest. Each plot of land was classified into one of three groups based on its location in relation to the forest: average values, favourable, and very favourable (Table 4).

Table 4. Average values of the unit price of real estate and the number of observations in the feature evaluation classes related to the plot's distance to the forest.

Commune	Distance to Forest Assessment					
	Average		**Advantageous**		**Very Advantageous**	
	Average Price of Property (EUR/m^2)	**Number of Observations**	**Average Price of Property (EUR/m^2)**	**Number of Observations**	**Average Price of Property (EUR/m^2)**	**Number of Observations**
Celestynów	19.34	21	23.21	29	22.05	41
Józefów	55.76	4	84.04	27	74.52	149
Otwock	52.01	36	44.54	49	40.93	67
Karczew	19.18	56	13.71	9	23.79	2
Total	36.57	117	41.38	114	40.53	259

As can be seen from Table 4, the Karczew commune was dominated by plots with an average location in relation to the forest, while in the communes of Celestynów and Otwock, a similar share of plots both favourably and very favourably located in relation to the forest was noticeable. In Józefów, on the other hand, the majority of plots were very favourably located in relation to the forest (close proximity).

3.2. Results of the Questionnaire Surveys

According to the respondents, the attractiveness of a building plot is first associated with its provision of utilities, followed by its surroundings, i.e., the landscape. Respondents further indicated the importance of, in the following order: the shape of the plot and access to a public road, the area of the plot, and the ease of access to Warsaw by public transportation and access to administrative services. The presence of tall trees on the plot was scored slightly higher than the distance to Warsaw and the distance to the forest (Figure 3).

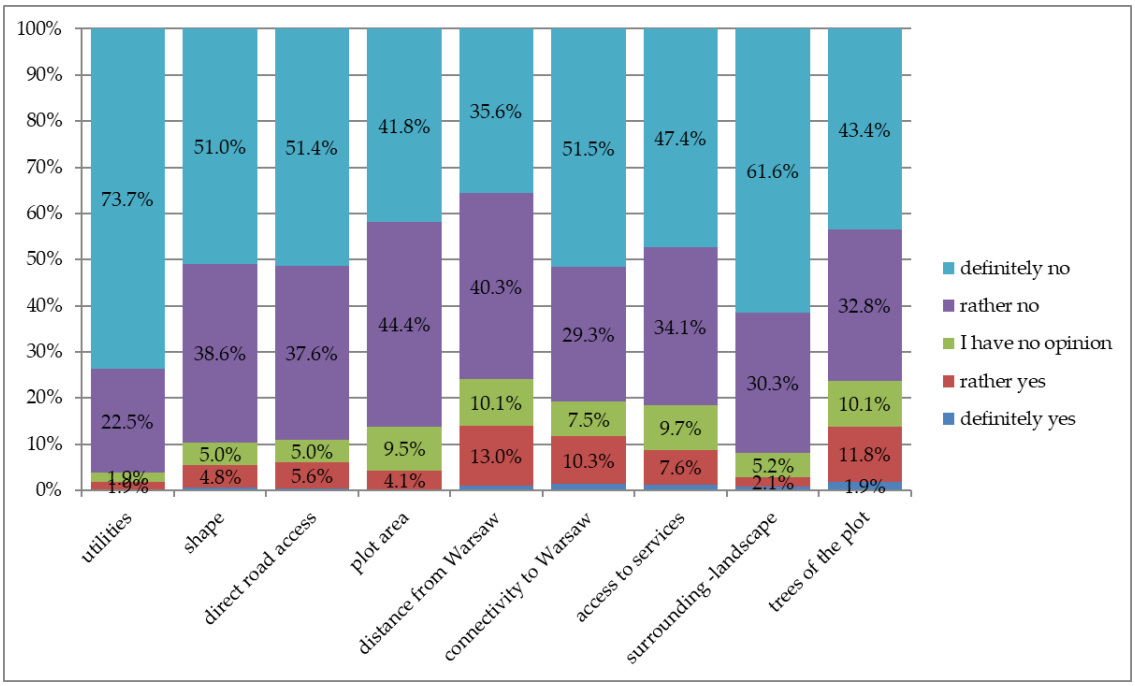


Figure 3. Respondents' view of the attractiveness of a building plot in the Otwock region.

Taking into account socio-demographic characteristics, views on the landscape environment as a factor determining the attractiveness of the plot varied with the age of the respondents. It was found that the respondents' belief in the importance of this feature increased with age. In the group of respondents older than 54, the percentage stating that the surroundings definitely affect the attractiveness of the plot was 72.5%, compared to 61.6% among respondents aged 35 to 54 and 56.3% among younger respondents (Figure 4).

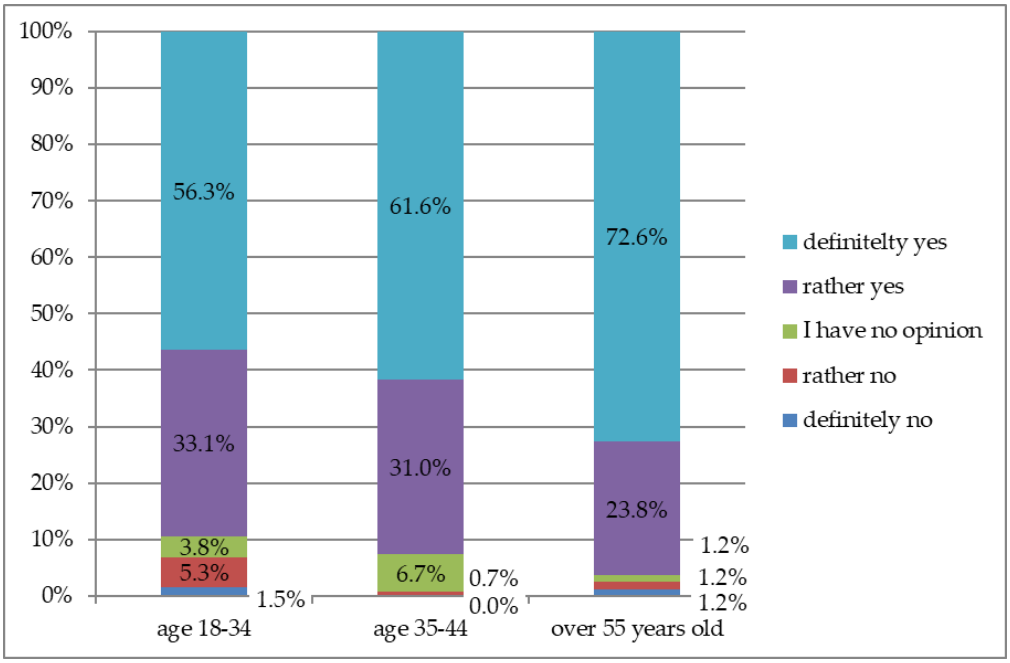


Figure 4. Formation of views on the importance of surroundings, i.e., landscape, for the attractiveness of building plots in relation to the age of respondents.

Respondents' views on the importance of the distance from the forest for the attractiveness of the plot varied according to the respondents' age and place of residence. The belief that this factor significantly affects the price attractiveness of a plot increased with age. In the group of respondents aged 18–34, the percentage believing this was 63.5%. In the group of respondents aged 35–54, this percentage was 70.6%, while in the group of older respondents, it was 86.8% (Figure 5).

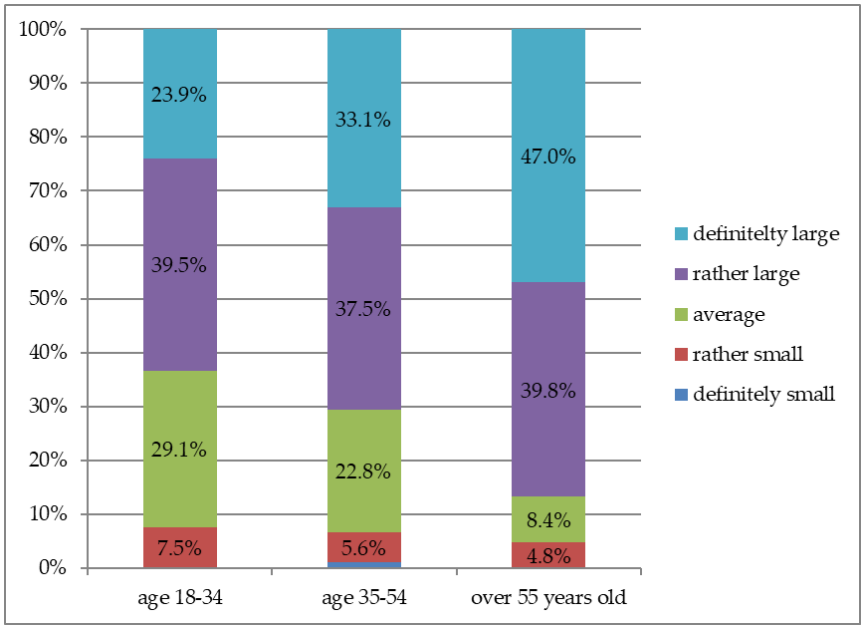


Figure 5. The formation of views on the relationship between the price attractiveness of the plot and the distance to the forest, taking into account the age of the respondents.

With the urbanisation of spaces, the respondents' belief that this factor is quite important (rather important and definitely important) for the attractiveness of the plot increased. In the group of rural/settlement residents, the percentage of those believing this was a total of 65.6%, while in the group of respondents from cities with up to 100,000 residents, it was 69.7%, and in the group of respondents from larger cities, it was 84.9% (Figure 6).

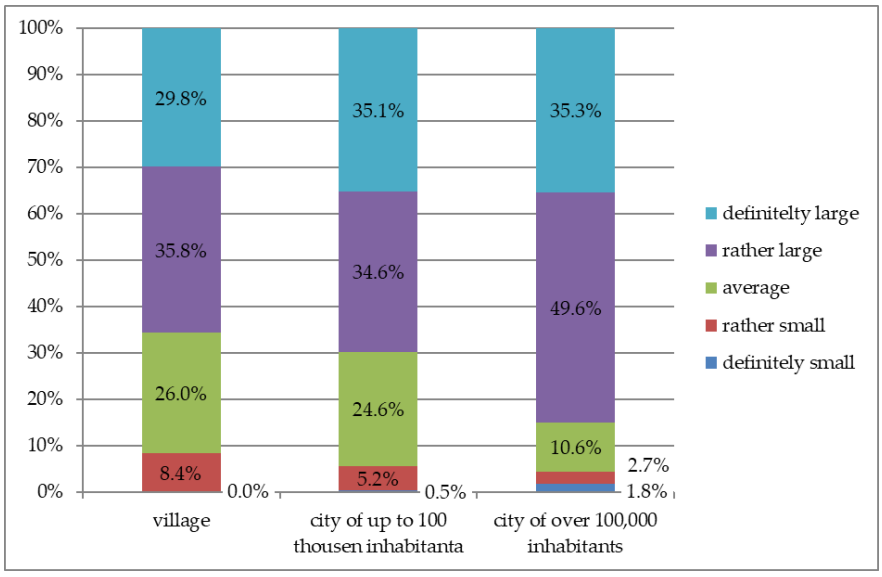


Figure 6. Formation of views on the relationship between the price attractiveness of the plot and the distance to the forest, taking into account the place of residence of respondents.

The survey shows that 46.2% of respondents would like to live within 20 m of the forest, 36.2% would be happy to live between 20 and 100 m from the forest, 12.1% would like to live between 100 and 500 m away, and 5.5% of respondents would like to live more than 500 m away. Respondents' views on this aspect differed based on their gender and age. In the male group, the percentage of those interested in living in very close proximity to the forest (up to 20 m) was significantly higher (53.5%) than in the female group (37.3%) (Figure 7).

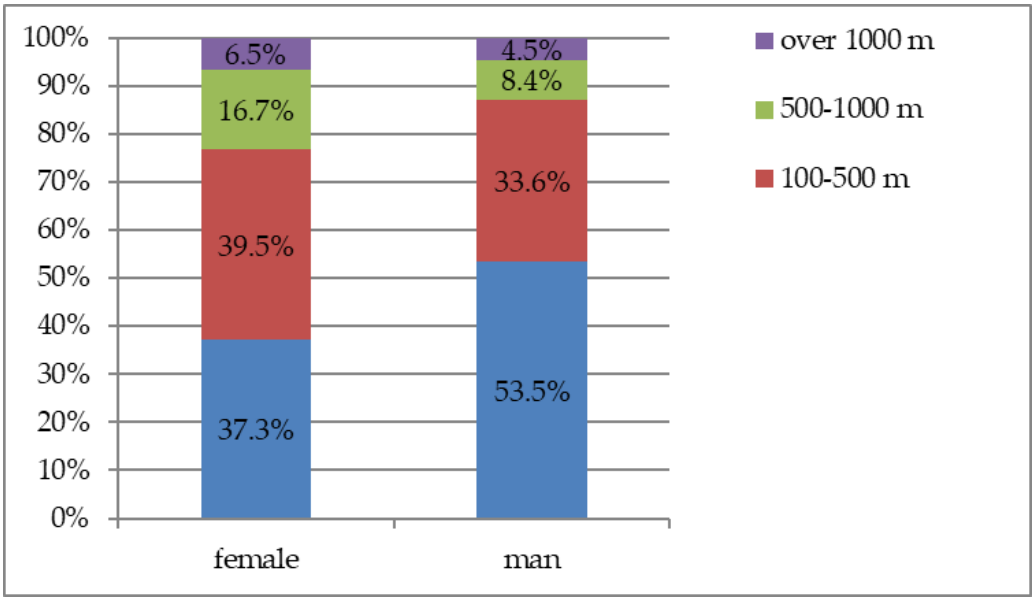


Figure 7. Opinions on the declared distance of residence to the forest, by gender of respondents.

The older the respondents, the higher the percentage of those willing to live in close proximity to the forest, up to 20 m. In the group of 18–34-years-old respondents, the percentage of those who valued this was 34.3%, while in the group of those 35–54-years-old, this percentage was 46.3%, and among older respondents, it was 65% (Figure 8).

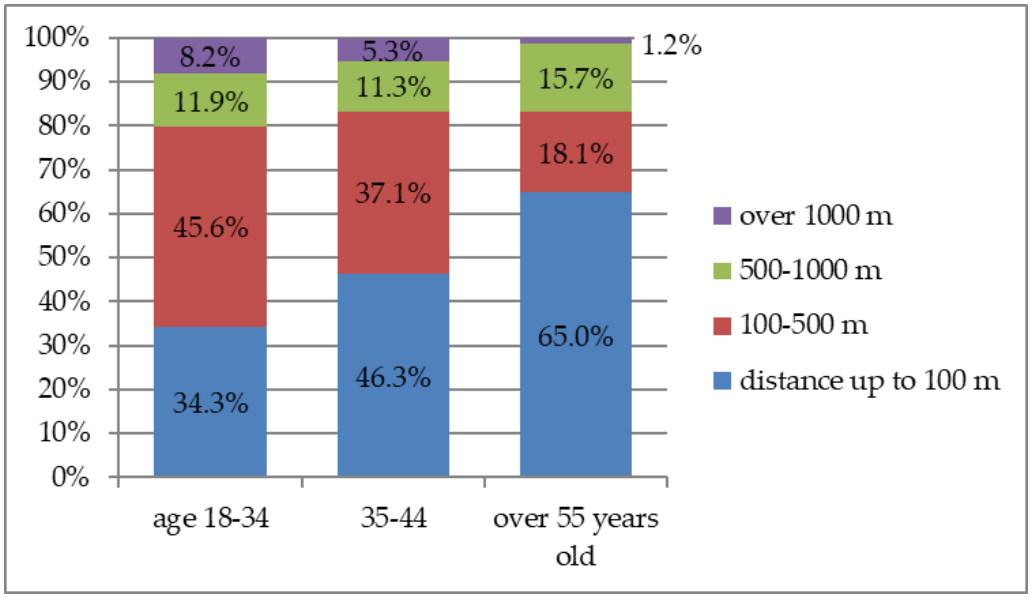


Figure 8. Views on the declared distance of residence to the forest, taking into account the age of respondents.

4. Discussion

The real estate market survey was based on an analysis of transaction prices over a five-year period. It seems that the adoption of such a period of time is sufficient to be able to state with confidence that the analysis carried out and the results obtained are not subject to error due to the unstable market situation. From a review of the available literature [20,26,36], it was clear that the analysis of transaction data cannot be based on a single calendar year and that it is necessary to analyse transactions over a longer time frame. From the Real Estate Prices and Values Register dataset from the Otwock Regional Office, plots of land intended exclusively for single-family residential development were carefully selected, accounting for 73% of all transactions. The study results are therefore relevant only to this type of plot. So are the findings from the works of Zydron [37], Zydron and Walkowiak [38], and Zydron and others [30]. Meanwhile, many other studies providing insight into the relationship between real estate price and space attributes included agricultural plots [15], recreational plots [39], properties with agricultural and forestry uses [40], apartments [20,27–29,33,34,41], or single-family homes [26,42].

When taking into account respondents' preferences for building plots, it was found that "provision of the plot with utilities" was highly valued, as well as its "surroundings-landscape". The development of the plot, especially full provision of utilities (water, sewerage, electricity, and gas), facilitates the investment process, speeds up the procedures for obtaining the relevant permits in the construction process, and reduces investment costs. The highest values of the average unit price for each commune were attributed to fully developed plots. Additionally, Lowicki [12] believes that the price of a plot is highly correlated with its technical development. Zydroń et al. [30] found that access to a sewage system had the biggest influence on the price of 1 sq. m. of an undeveloped plot. The high position of "surroundings-landscape" among the factors determining the attractiveness of the plot, according to the respondents, is probably related to the fact that the Otwock region, and especially its northern part—including Józefów and Otwock—is an alternative for residents of the capital who are thirsty for silence, peace and quiet, contact with nature, and greenery.

In many parts of Poland, not just Warsaw, people are escaping from the cities to settle in suburban areas. This mass phenomenon, known as the "urban exodus", has been of interest to urban planners and sociologists for years. The COVID-19 pandemic further accelerated the speed of this phenomenon. In Poland, this process has become pronounced over the past several years. According to the newspaper *Rzeczpospolita*, during the decade 2002–2012, the population of Poland's 908 cities declined by almost 300,000 people, of whom as many as 241,000 moved to the countryside [43]. Additionally, data on the socio-demographic structure of the Otwock region indicate greater interest in settling in the area. The district is characterised by a positive migration balance of +3.4. Out of a total population of 111,706 people, the difference in inflow and outflow of the population is 502 people [44]. According to the survey, the belief that the attractiveness of a plot of land is determined by its "surroundings-landscape" increased with the age of respondents. Numerous studies [45,46] indicate that people's age differentiates their views on the perception of space. A study by Yang and Kang [46] found that tolerance for sounds associated with human activities decreases with age, meaning that older people seek a different type of scenery for recreation than younger people.

Therefore, the environment, i.e., landscape, and quality of space are more important for this social group than for the younger part of the population. When considering the relationship between the transaction price of a plot of land and the so-called environment (neighbourhood), it was found that this feature is less important than factors such as: "distance to Warsaw" or "distance to the nearest railway station". This may be related to the difference at the level of the questionnaire, the analysis of real estate prices, and understanding of the concept of "plot surroundings". In the survey questionnaire, the question "What features of a building plot, in your opinion, determine its attractiveness?" included the answer "surroundings–landscape". The analysis of the results made it pos-

sible to determine to what extent the landscape/aesthetic qualities of an area affect the attractiveness of building plots. In the case of the analysis of transaction prices, the surroundings were considered through the prism of neighbourhoods with different types of development (single-family, multi-family, services, industry, etc.), which determines the landscape in the surroundings of the plot but does not fully reflect the aesthetic qualities of the space. Hence, the comparison of survey results with trends in real estate prices did not quite work in this case. The results of the survey respondents' preferences show that the other factors, e.g., "shape", "area of the plot", and "access to a public road", have less influence on the attractiveness of a building plot. Older respondents perceived "landscape" factors ("environment-landscape", "distance to the forest", or "presence of tall trees") as significantly influencing the attractiveness of a plot, while younger respondents were convinced that attractiveness is determined more by the technical features of a plot (including its area or access to a public road). The attribute "distance to the forest" was not ranked among the most desirable attributes of a building plot either because the Otwock region is characterised by high forest cover. With increasing age, the share of respondents who declared a desire to live in very close proximity to the forest increased. In addition, for urban residents, the attractiveness of a plot is more related to close proximity to a forest, or the presence of trees, than for rural residents, who have daily contact with nature.

Based on an analysis of real estate transaction prices, it was found that among landscape-related elements, "distance to the forest" had the most significant impact on the price of building plots. Additionally, the results of studies by Tyrvainen and Miettinen [44], Kim and others [29], and Kolbe and Wustemann [36] show that this feature determined the price of real estate. In all the analysed communes, except for Karczew, plots in a very favourable location in relation to the forest (up to 20 m from the forest) were the most popular on the real estate market, as evidenced by the number of completed transactions. In the commune of Karczew, the highest value of the average unit price was attributed to plots located close to the forest, up to 20 m away, which may be related to the fact that the forest cover of the municipality of Karczew is the lowest of all communes; the forest is "scarcer", and hence its close proximity may affect the price of real estate. In the municipality of Otwock, the average unit price of real estate assumed the highest value for plots located more than 100 m from the forest. This commune is characterised by a much higher forest cover (37.6%), so there is not as much construction pressure on plots directly adjacent to the forest; hence, the average unit price is not the highest here. In the communes of Celestynów and Józefów, the highest average unit prices were attributed to properties located at a distance of 20–100 m from the forest. Plots having direct contact with the forest are cheaper due to the fact that the construction of a house on this type of plot involves a number of difficulties and additional costs.

5. Conclusions

Forest landscapes are one of the most important factors determining the attractiveness of a building plot. Preferences for the building plot and landscape, including forest landscape, varied due to the socio-demographic characteristics of the respondents, including primarily age and education.

The price of a building plot within the analysed communes of the Otwock region depends primarily on the area, technical development, and the distance to the nearest railway station and the distance to Warsaw. Features relating to the landscape, e.g., the distance to the forest, the contour of the forest fringe, or the number of landscape components, had a more pronounced effect on the price of a m^2 of land than the shape of the plot.

The results of our research indicate that the concept of ecotones, which is important for the proper functioning of forest ecosystems, is also important for the market value of plots. By forming forest edges and avoiding geometric borders, it is possible to increase the unit price of plots in the vicinity of the forest. In addition, our results show how interest in settlement in the forest edge zone is growing. Increased social pressure on forests is associated with the need to expand recreational infrastructure in forest areas and the need

to shape the forest interior in a way that is more conducive to social rather than economic functions. The results are also important for real estate appraisers, as they provide a tool for valuing properties in the vicinity of forests. Finally, the results should be of interest to spatial planners, who, when planning the development of forest-adjacent areas, should be aware not only of the high value of the area, but above all, of the expected effects on forest ecosystems and forest management.

According to the average exchange rate of the National Bank of Poland on 12 December 2022, 1 PLN = EUR 0.2069.

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