Article

Comparative Analysis of Transaction Prices and the Values of Forest Properties in Poland

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Abstract: *Research Highlights:* In the paper, we explore systematic discrepancy between sale prices and values of forest properties in Poland. We argue that the systematic valuation bias found is partially caused by the simplified parametric appraisal methodology currently used in Poland. *Background and Objectives:* Most of the forests in Poland are state-owned, but in recent decades, the market for private forest properties has been dynamically growing. In the paper, we investigate the relations between the actual transaction prices, and the estimated value of forest properties in selected regions in Poland. We hypothesize that sale prices systematically deviate from valuations. An additional question arises regarding the determinants of forest property prices. We hypothesize that due to asymmetric information positive amenities are not fully capitalized in property prices in Poland. *Materials and Methods:* In the paper, we adopt two regression models used to investigate the valuation accuracy and bias. We test the hypothesis that valuations are unbiased estimates of transaction prices. *Results:* The results indicate that market prices for forest properties systematically differ from estimated values. *Conclusions:* Systematic deviation of forest property sales prices from market values may contribute to the imperfect information available to the market participants, especially when information is asymmetrically distributed between buyers and sellers. This may confirm the hypothesis that sellers are not fully aware of the advantages of the property being sold, and provide further explanations for large systematic differences between sales prices and valuations based on parametric valuation methods used in Poland.

Keywords: value of the forest; forest property prices; forest appraisal methodology; asymmetric information

1. Introduction

The determination of the value of forest properties is one of the important elements of the stock management process. For both historical and political reasons, the majority of forests in Poland are state-owned. Their current share in the total forest area as at the end of 2017 is 76.9% [1]. According to statutory regulations [2], trading in this part of the resource is in principle ruled out, and transactions involving the sale of forest properties from the state forest stock are extremely rare. The situation is different when it comes to privately-owned forests. Although the State Treasury has priority in purchasing forest properties under the above-mentioned provisions, this right is very rarely used and relates mainly to situations where the properties sold lie within or adjacent to compact complexes of State Forests, and improve the conditions for the harvest of timber [2]. These circumstances influence

the estimation of the value of forest properties for sales purposes and the price formation in this type of situations. Due to the aforementioned statutory requirements, when the State Forests are party to the agreement, the prices of real estate are shaped based on valuations, which links the resulting selling price with the valuation results, excluding or limiting the role of market mechanisms.

The market for private forest properties is different. With fully informed agents the prices and values should not be statistically different. Nonetheless, significant concerns arise regarding the quality of data available to market participants as well as potential asymmetric information. In this article, we explore the relations between the estimated value of forest properties and the actual transaction prices. The research question is whether the valuations are unbiased estimates of market prices in Poland. We hypothesize that valuations systematically deviate from sale prices, due to the simplified parametric appraisal methodology currently used in Poland. The answer to both these questions is not only valid for scientific research, but it may also be of vital practical importance for further works on the development of more accurate valuation methods.

The paper attempts to address the problems related to forest valuation in Poland, however, discussion on methodological pitfalls of forest appraisal can initiate further comparative research in other European countries.

Technically, there are two major approaches to valuation of forest property—income-based and sales-comparison, both having solid theoretical and behavioral underpinnings that reflect the decision-making processes on the property market. The evidence found in the literature suggests that results of forest property valuation based on income approach, and comparable sales approach may significantly differ [3].

In the case of the income-based approach, theory of valuation of forest land can be traced back to XIX Century and stems from the pioneering work of Faustmann [4]. Within this specific discounted cash flow income approach the value of the forest property is related to the value of timber volume of the forest. The assumption is that forest property is treated as an investment asset, and its value is a function of the productivity of timber. Several modifications have been made to this particular approach, as researchers investigated the role of imperfect information, changing prices [5], presence of alternative land uses [6], or climate uncertainty [7].

The second approach for the valuation of forest property is based on sales comparison. Within this framework, forests can be seen as a complex good, whose price can be decomposed into implicit prices of several salient characteristics [8,9]. There are several characteristics (amenities) that increase the utility of the forest. In contrast, there are several features (disamenities) that decrease its utility. Within the hedonic pricing model, the price is a function of property attributes if only buyers and sellers acknowledge their importance.

To date, several studies assessed the impact of selected amenities and disamenities on the market prices of forest property using hedonic pricing models, mostly in the US, but also in Western Europe. Research conducted in Sweden investigated both productive and non-productive uses of the forests, and found strong evidence that the market price is affected by the share of productive forest land, and timber volume [10]. The role of productive features (land size, timber volume, and site productivity) was confirmed by Aronsson and Carlen [11]. Results of the US study suggest that the prices of forest land are also affected by such features as proximity to major roads and ski areas, and tax rates [12]. Zhang et al. found significant differences in determinants of bare forestland and pre merchantable land prices [13]. The research demonstrated that bare forestland price was determined by road access, land productivity, topographic features and population density, whereas pre-merchantable lot prices were influenced by land productivity, the age of the tree stand, as well as the possibility of other competitive uses [13].

Results from another European study indicate that the value of the forest is positively influenced by the timber stock, but negatively related to the fragmentation and size of the property [14].

A discrete choice experimental study conducted in Germany suggests that the value of the forest may be positively related to biodiversity and harvest age [15].

As wood products are heterogeneous, several papers investigated the transparency and efficiency of the market of wood products. Another study explored the price transmission mechanism between the producer and the consumer prices in the sector of forest products [16]. The efficiency of a wood fuel market and the impact of internationalization has been studied in Denmark [17]. A recent US study investigated the impact of the timber market on land-use changes. Results suggest that higher timber rents reduce transitions of forests to all other rural land uses, as well as to developed land uses [18].

Since its origins, several attempts have been made to incorporate uncertainty where buyers and sellers are not fully aware of the utility related to certain (dis)amenities, nor sometimes even the presence of them [19]. Additionally, following the seminal work of Akerlof [20], attempts have been made to reflect potential asymmetric information. With uncertainty or asymmetric information market prices are not fully affected by amenities and disamenities, because agents are either not aware or fail to assess their relative importance. Asymmetric information may arise on both sides of the market, as it may affect either sellers or buyers. Several studies are showing the significant impact of buyer and seller characteristics on forest property prices [11]. Additionally, the results of the latter study indicated suggest that land size, timber volume, and site productivity affect forest land value. Snyder et al. [21] investigated the impact of buyer characteristics on market prices for timber property, as well as controlled for terms of the agreement. They found that both buyers intentions, presence of broker/agent influenced timberland price.

Based on the literature, the most typical market situation is when sellers are better informed about the features of property. Nonetheless, in particular markets, different type of asymmetric information may be present. Examples include markets, where buyers are professionals and sellers are amateurs. Strong arguments are suggesting that this type of asymmetric information can be present on the forest property market in Poland.

In this paper, we adopt Pope's [19] theoretical model incorporating asymmetric information. We consider the special type of information asymmetry when buyers are better informed about the amenity (timber volume and its value in our case) than sellers. Figure 1 illustrates the possible impact of asymmetric information between buyers and sellers on the hedonic price function.

Figure 1. Hedonic prices with asymmetric information when sellers are better informed. Source: own elaboration based on Pope's model [19,22].

We assume that buyers are informed about timber volume. They will adjust their bids from B_1 to B_2 accordingly to timber volume increase from T_{low} to T_{high} . We also assume that sellers who are uninformed about the timber volume (and who cannot assess its value) will not adjust their offers depending on the timber volume (O_1 and O_2). In a standard case of a market with incomplete

information the hedonic equilibrium price function $P(T^+)$ will also reflect search costs and the bargaining process (error term ϵ). Following the general logic of the Pope's hedonic model with asymmetric information, if buyers are aware that the fraction of sellers is not fully informed about the value of timber in their forest properties, they will adjust their bids based on the prediction of uninformed sellers' offers (and generally underpay). As the result the hedonic price equilibrium will shift to $P(T^+) + \eta$. This theoretical model suggests that under asymmetric information, empirical estimates of the impact of the amenity like timber volume on forest land prices would under-represent the marginal value of this amenity. With asymmetric information, in equilibrium price depends on the fraction of informed sellers in the market. In line with Pope's argument [19], we argue that low searching cost and a high fraction of uninformed sellers encourage buyers to look for the uninformed seller and decrease implicit prices for timber volume to be later observed empirically on the market. The sale prices will not reflect productivity of the forest and its underlining value.

2. Materials and Methods

2.1. Data Collection

In this research, we investigated the transaction prices of forest property. We defined forest property according to the Forest Act [2] and Act on Real Estate Management [23]. The most effective use (referred to as highest and best use in real estate valuation) of forest property is timber production with accompanying functions [24]. In the research, we used transaction data on forest property in the north and the south of Poland. In the former case, forest properties sold during the study period were located in poviats (second-level unit of local government in Poland, equivalent to a county) of Świecie, Tuchola, Nakło, Sepolin, Żnin, and Chojnice. In the latter case, properties were located in the poviats of Gorlice, Nowy Sącz, Limanowa, and Tarnów in the south of the country (Figure 2).

Figure 2. Location of forest sales within the study areas. Source: own elaboration.

Due to limited market activity, we used transactions from 2012 to 2019 (see Figure 3).

Figure 3. Number of forest property sales in the study areas from 2012 to 2019. Source: own elaboration.

The selection of research areas was made due to the following factors. The Małopolskie and Kujawsko-Pomorskie voivodships are characterized by an average size of wood resources on a national scale with a significant variation in the share of private forests [1]. This circumstance made it possible to study the relationships for areas with a small and large share of private forests in the structure of forest land. An additional argument in favor of choosing the analyzed locations is also their location in the central part of the country (in the east-west system), for which timber prices are closest to average prices. This circumstance is associated with a limited impact on the studied areas of internal and external factors such as varied labor costs and wood prices, much higher in the west of the country (purchases of large quantities of wood by Germany), and lower in the east (competitive wood from Belarus and Ukraine).

The analysis covers only sale agreements concluded between natural persons and those concerning the sale of forests by municipalities by way of tenders. The real estate included in the analysis does not meet the conditions necessary for PGL LP (State Forests National Forest Holding) to purchase it, and they are, in particular, not enclaves in the state forests. The taxonomic characteristics of stands are derived from simplified forest management plans drawn up between 1993 and 2018.

To address the discrepancy between sale prices and values in the empirical part of the paper, we controlled for several characteristics of forest property. We controlled for the distance from the forest to the nearest town, defined basing on a straight line between the central points on the basis of geographical coordinates. In southern Poland Tarnów, Nowy Sącz, Rabka Zdrój, and in north Poland Chojnice, Czersk, Tuchola, Świecie, Więcbork, Nakło nad Notecią, Szubin, Barcin.

The geographic distribution of forest property sales both in northern and southern part of our study area is presented on corresponding figure (Figure 4). In addition to from the geocoded coordinates of our transactions, the figure provides the detailed information on the distribution of sale prices (in PLN/ha).

Figure 4. Spatial distribution of forest property sales within the study areas. Source: own elaboration. (left) North (Swiecie, Tuchola, Naklo, Sepolin, Znin, and Chojnice). (right) South (Gorlice, Nowy Sącz, Limanowa, and Tarnow).

The study accounted for property accessibility by road. Forest properties differed significantly regarding road accessibility. We used dummy variable road, taking the value of 1 when the property had access to an asphalt road (a hardened road with an asphalt surface) allowing for uncomplicated commuting, and significantly easing the removal of timber by heavy wheeled transport. The road variable takes the value of 0 in case of dirt or hardened dirt mountain roads, forest road, or field roads. Only 6 forest properties in our sample had road access when being sold.

During valuation process, we controlled for the age of a forest stand using the age variable. The data on age were retrieved from the forest inventory reports, prepared at the request of the local government (Forest Data Bank). When the sold forest consisted of stands of different ages, the average age was calculated as a weighted average, where the weight was the stand area and the contribution of species differing in age, according to the inventory report by tree volume. In case of the absence of an inventory, the age was assessed by the authors (three cases). Additionally, we accounted for stocking index. The stocking index (SI) variable is a measure of stand similarity to the reference stand of the same species, age and site index expressed by the ratio of the actual stand's affluence to the stand's affluence from the affluence tables and stand increment. Finally, we used a maturity variable. This categorical variable enables us to control for ripening maturity relative to the age of felling. Forest property could be classified as pole stand (junior tree stands, pole-and-stick); ripening stand (stands that reach the age of felling within 10–20 years); mature stand (stands which have reached or will reach the age of felling in less than 10 years). In our sample, there were 31 pole stands, 16 ripening stands, and 5 mature stands. The descriptive statistics of the sample are presented in the table (Table 1).

Table 1. Descriptive statistics of forest sales.

Variables	N	Mean	Std. Dev.	Min	Max
Saleprice (PLN/ha)	52	26,111.92	12,455.39	8000	87,719
Age (years)	52	59.01	16.63	22	88
Stocking index (SI)	52	0.76	0.171	0.3	1.1
Distance (km)	52	67.84	26.04	16.45	114.88

For all 52 forest property transactions in our sample, we assessed the market value at the date of a sale, using valuation techniques applied in Poland.

The value of sold forests (V) is calculated as the sum of the value of forested land (V_L) and the timber sales value (V_T). The value of forested land was calculated using the current estimated rate [25,26]. According to this method, the value of land is calculated according to the following formula:

$$V_L = \sum_{i=1}^n (N_{szi,j} \cdot P_i) \cdot C_{dr} \cdot (1 + v_1 + v_2 + v_3 + v_4 + v_5 + v_6 + v_7 + v_8 + v_9) \quad (1)$$

where V_L —the value of forested land (1 ha), NS_{zj} —estimated rate of forested land dependent of i -th group of stand type and of j -th agricultural taxing district, P_i —the area of forest property in i -th group of stand type, C_{dr} —the price of 1 m³ of timber as a weighted mean of utility wood grade encompassing its extraction and skidding costs in given forest district, v_1 —correction factor due to the stand degradation level, v_2 —correction factor due to the location of a property in the zone of harmful industrial pollution impact on the stand, v_3 —correction factor due to the location of a property in the zone of massive occurrence of primary pests, v_4 —correction factor due to the location of a property in the zone endangered or infested by secondary pests, v_5 —correction factor due to the location of the property concerning accessibility to the main road or a build-up land, v_6 —correction factor due to logging conditions, v_7 —correction factor due to the quality of an access road, v_8 —correction factor due to the vicinity of adjacent usable land, and v_9 —correction factor due to the recreational value of a property.

The value of timber stock was calculated using amended tables of forest stand value indices from the 2013 year [27], constituting an appendix to the Ordinance of the Minister of the Environment of 20 June 2002 on one-off compensation for premature felling of forest stands [28]. Given the purpose of the research and the vast area from the Beskid Mountains in the south to the Tuchola Forest, Krajna and Pomerania in the north of Poland, we decided that the selected boards (which are constructed for the valuation of wood resources according to one national measure) would be an appropriate reference point to conclude applying the comparative approach in the valuation of forests predominantly used for timber production. According to these tables, the value of timber stock is calculated according to the formula (Equation (2)):

$$V_T = B_T \cdot SI \cdot A \cdot W \quad (2)$$

where:

B_T —marketable value of forest stand as read from boards, depending on species, productivity rating and age,

SI —forest stand stocking rate (stocking index),

A —stand area,

W —average price of wood raw material in Poland, as published by the Central Statistical Office (GUS).

Additionally, as a robustness check, older tables of stands' value from 1985 were used, which are often used by property appraisers. In this case, the valuation uses current wood prices and costs of harvesting and logging from a local forest inspectorate, not general prices for the whole country (see Figure 5).

Figure 5. Spatial distribution of forest property assessed values within the study areas. Note: upper panel is based on valuation tables from 1985 and lower panel is based on valuation tables from 2013. Source: own elaboration. (left) North (Swiecie, Tuchola, Naklo, Sepolin, Znin, and Chojnice). (right) South (Gorlice, Nowy Sacz, Limanowa, and Tarnow).

Information on forest valuation features was obtained from simplified forest management plans [29]. The age of stands was calculated from the date of preparation of the forest management plan to the date of sale. For randomly selected four transactions, visual inspection was carried out, and the tree volume of forest stands was determined using a quantitative method with the help of relascopian sample areas (see Table A1 in Appendix A). The value of these stands was calculated as a sum of the value of the wood stock of particular species according to the formula of net volume multiplied by the average price of wood of a given species on the local market (reduced by felling and skidding costs).

In the sample, there are one or two-species stands with dominant pine (28 stands), with dominant fir (11), with dominant beech (9), birch (2), and mixed stands composed of several species (2). The summary statistics of different forest stands are presented in the table (Table 2).

Table 2. Descriptive statistics of forest property by dominant tree species in the stand.

Genus of the Main Species	Age Class Years from-to	Number of Transactions	Av. Stocking Index (SI)	Av. Sale Price (P) (PLN/ha)	Av. Value (V) According to the 2013 Tables (PLN/ha)	Av. Value (V) According to the 1985 Tables (PLN/ha)
mix	21–40	1	0.80	21,496	40,870	36,536
	41–60	1	0.70	25,248	30,561	29,514
birch	61–80	2	0.60	12,704	38,527	29,820
	61–80	5	0.78	32,910	50,380	46,055
beech	81–100	4	0.80	26,910	67,586	60,078
	21–40	6	0.88	22,472	21,678	18,783
pine	41–60	18	0.80	23,481	33,332	27,904
	61–80	4	0.65	21,942	44,182	37,239
	41–60	2	0.75	31,195	64,711	60,421
fir	61–80	8	0.70	34,044	71,360	69,048
	81–100	1	0.30	33,473	42,254	36,076

The most expensive are the stands with the dominant fir in the second place beech stands, the next position is occupied by pine and mixed stands, and the cheapest are birch stands. Average sales prices of young pine stands (21–40 years old) do not differ much from the prices of older and oldest stands. The same applies to the prices of fir and beech stands. This is difficult to explain with the characteristics of the stand. As the age increases, the volume of wood increases and the share of valuable, more expensive wood species increases. Older, more valuable stands should have higher sales prices, as well as values. The expected income from the sale of wood harvested in an older stand should lead to significantly higher prices of older forests than those of young stands.

2.2. Empirical Approach to Testing Valuation Accuracy

In the paper, we investigate the relationship between property prices and assessed values. The problem is often referred to as valuation accuracy, and can be traced back to the discussion on commercial real estate appraisal [30–33] or real estate taxation [34,35]. Following McAllister [31], we explicitly distinguish valuation error from valuation bias. The former reflects the typical difference between the valuations and actual transaction prices. The latter is defined as a systematic deviation of assessed values from actual prices (undervaluation, overvaluation). The valuations can be erroneous, but not biased if they generally reflect actual market prices.

We use two standard models used to investigate the valuation accuracy and bias. We test the hypothesis that valuation (V) are unbiased estimates of transaction prices (P), thus $E(P) = V$. There are many approaches to establishing the empirical relation between values and prices, in particular, based on the decision which of these two should be a dependent variable.

Some economists suggest that assessed values should be regressed on sale prices, as in property tax equity tests proposed by Paglin-Fogarty [34] or Cheng [35]. However, most of the prior research on valuation accuracy assumes that price is a dependent variable. In a basic linear specification of valuation accuracy model is given by (Equation (3)):

$$P = \beta_0 + \beta_1 V + \varepsilon \quad (3)$$

The interpretation of regression coefficients is straightforward. Generally, valuation can be considered unbiased when the intercept $\beta_0 = 0$ and slope parameter $\beta_1 = 1$. In such a case, assessed values are in line with market prices—neither overvalued nor undervalued at any price range. The increase of property valuation by 1 PLN will be associated with an actual market price by 1 PLN.

The alternative specification is derived from a power function. After taking logarithms we arrive into the following equation (Equation (4)):

$$\ln P = \beta_0 + \beta_1 \ln V + \varepsilon \quad (4)$$

Again, property valuation can be considered proportional (and property tax equitable) when the coefficient $\beta_0 = 0$, and β_1 is equal to 1. This particular result means that 1% valuation increase results in an increase in prices by 1%.

Although some economists argue that the choice of the dependent variable should be related to underlying economic processes [30], we agree with Matysiak and Wang [32], that, from an empirical perspective, it is irrelevant whether V or P is a dependent variable. Both approaches seem to be justified when testing for valuation accuracy, and results will be analogous. Following the traditional perspective, we will assume P as a dependent variable in our empirical strategy.

3. Results

Forest transaction prices as stated declared in the notarial deeds were compared to the value calculated according to the described methodology. We calculated a ratio of the selling price (PLN/ha) to the market value (PLN/ha). The ratio was adopted as a measure of the usefulness of the transaction for forest valuation in a comparative approach. If the value of that indicator was equal to or higher than 0.8, then the transaction was considered a market transaction, based on which, the value of the property could be determined. The analysis shows that only few observations fall within this range (Figure 6).

The results of the exploratory analysis suggest that assessed values are generally significantly higher than actual sale prices. The sale prices ranged from PLN 8000 to PLN 87,719 per hectare. The average sale price was PLN 26,112, and the median was PLN 25,000. There was considerable variance in prices (standard deviation was PLN 12,455). The assessed values differed accordingly to valuation assumptions. When 1985 timber values tables were used, the assessed values ranged from PLN 11,899 to PLN 99,530, the mean was 39,798 and, again, the results were fairly dispersed (standard deviation was PLN 20,306). When updated 2013 timber value tables were used, the assessed values ranged from PLN 13,514 to PLN 101,204. The mean was PLN 44,416 and median was PLN 40,978.

On average, the price/value ratio was 0.66 for a methodology based on 2013 tables and 0.76 for updated 1985 tables. Additionally, we observe that price-to-value ratios do not follow the normal distribution.

(a)

(b)

Figure 6. Distribution of price-to-value ratios by valuation methodology (a) upper panel ratios are based 2013 valuation tables; (b) lower panel ratios are based on 1985 valuation tables.

In the next step, we formally test whether assessed values are in line with sale price drawing from the vast literature on valuation equity in the context of property taxation, as can be seen from the scatter plots (Figure 7).

Figure 7. Correlation between sale prices and assessed values by valuation methodology: (a) upper panel results are based 2013 valuation tables; (b) lower panel results are based on 1985 valuation tables.

Following exploratory analysis, we tested for valuation accuracy and bias. We regressed sale prices on assessed values using standard procedures. We apply three robustness checks. First, we compared the results for two variants of forest valuation (using different methodological assumptions)— V_{2013} and V_{1985} (see methods and data). Second, we compared the results of the estimation with the results based on a sub-sample of observation (excluding one outlier observation with sale price significantly higher than other transactions). Third, we included year controls (year fixed-effects: 0–1 dummy variables), to account for changing market conditions that could affect the findings (ModA3 and ModB3). The results are presented in a Table 3.

The results show that constant (β_0) is significantly different from 0 in all specifications, thus, valuation inequity is present. The regression coefficient ranges from 0.133 to 0.224 (thus, differing from 1) providing additional support in favor of the presence of significant valuation bias related to forest properties in the sample. The results show that the price-to-value rate is higher for lower-valued properties. The latter finding suggests that the assessed values tend to better match the actual sale price for cheaper forest properties.

Table 3. Valuation accuracy test 1 (dependent variable is sale price in PLN/ha).

Variables	Valuation (2013 Tables)			Valuation (1985 Tables)		
	ModA1	ModA2	ModA3	ModB1	ModB2	ModB3
Valuation	0.218 ** (2.704)	0.145 * (2.427)	0.133 (1.801)	0.224 ** (2.776)	0.150 * (2.490)	0.149 * (2.040)
Constant	16,407.087 *** (4.163)	18,509.055 *** (6.392)	13,063.291 * (2.425)	17,190.639 *** (4.775)	19,031.296 *** (7.193)	12,608.484 * (2.413)
Specification:						
No outliers	No	Yes	Yes	No	Yes	Yes
Year controls	No	No	Yes	No	No	Yes
R-squared	0.128	0.107	0.166	0.134	0.112	0.183
N	52	51	51	52	51	51

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

To check whether the results hold for a different specification of a model, we also tested different form of regression equation to assess property valuation accuracy. In this specification, we regressed the natural logarithm of property sale prices on corresponding valuation assessment. In parallel with the previously discussed procedure, we ran the regression for two variants of forest valuations and compared results from a full sample to a trimmed sample. We also used specifications with year fixed effects (ModC3 and ModD3). The results are presented in a table (Table 4).

Table 4. Valuation accuracy test 2 (dependent variable is the natural logarithm of the sale price in PLN/ha).

Variables	Valuation (2013 Tables)			Valuation (1985 Tables)		
	ModC1	ModC2	ModC3	ModD1	ModD2	ModD3
Valuation	0.427 ** (3.145)	0.426 ** (2.820)	0.372 * (2.506)	0.462 ** (3.240)	0.457 ** (2.884)	0.424 ** (2.724)
Constant	6.300 *** (4.601)	6.312 *** (4.156)	7.115 *** (4.891)	5.823 *** (4.054)	5.870 *** (3.684)	6.552 *** (4.287)
Specification:						
No outliers	No	Yes	Yes	No	Yes	Yes
Year controls	No	No	Yes	No	No	Yes
R-squared	0.165	0.140	0.391	0.174	0.145	0.392
N	52	51	51	52	51	51

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Based on the estimation result, we observe that regression coefficient β_1 is lower than 1 and statistically significant, and ranges from 0.372 to 0.462. The estimates suggest that properties are overvalued, thus, actual prices are significantly below assessed values. Additionally, we observe that the constant β_0 is statistically different from 0. This suggests that the relation between prices and values differs between low-priced and high-priced properties. Valuations are generally more in line with actual prices when the property is less valuable (smaller, and relatively less complex).

The sale price higher than the calculated value occurred for two reasons, the attractive location of the forest property or the young age of the stand (low volume of the stand). One forest was located between holiday resorts on Lake Czorsztyn, and the other near a large SPA center. In the group of young stands whose age was less than 40 years, in six cases out of nine, the sale price was 10–90% higher than the calculated value. This can be explained by the underestimation of the value of the forest land itself, and the relatively small impact of the low-density young stand on the overall value of the entire property. Sellers have access to information on prices of agricultural land, which are disproportionately higher than the value of forest land calculated according to the method applicable in Poland. The valuation accuracy test performed in this paper has several limitations. Matysiak and Wang [32] argue that simple measures of valuation accuracy, which do not account for changing

market conditions and property characteristics, can lead to erroneous results due to specification bias. Unfortunately, despite having an information on salient features of forests, we did not account for the properties' attributes, mainly due to relatively small sample size. Simple test results suggest that valuation accuracy and bias may vary significantly depending on maturity of forest stands (see Figure A1 in Appendix A). We also have not investigated the impact of market cycle on forest property appraisal accuracy and bias. Provided detailed data is available, a more robust estimation procedure would require specification tests and controlling for the market cycle.

4. Discussion

The observed substantial disproportion between forest property prices and estimated values is significant, therefore, it is necessary to analyze the underlying reasons. On the one hand, individual and subjective assessment of forest property buyers differs from those performed by professional valuers. Market participants do not seem to take into account the salient characteristics of forest property related to forest productivity (maturity, stocking index, age of the tree stands), or even to property general location and accessibility. This could suggest the presence of asymmetric information on the market. The prices of wood in private agroforestry farms are rarely examined, due to difficult access to data, but the studies carried out in this respect indicate that the prices of raw material are much lower than in the State Forests. The investment perspective is also different in these cases. These circumstances may be one of the significant reasons for the observed disproportion. Interestingly, these disproportions concern both forest properties located in southern and northern Poland, despite their different size and stand composition (GUS). A closer look at the group of forest buyers throws some light on the reasons for the discrepancies between forest sales prices and forest value. In principle, buyers are limited to neighbors and small local wood processing companies. Both parties use their knowledge of the forest owner's situation and dictate the terms of purchase, and, in many cases, have a clear information advantage. The group of forest sellers is dominated by people who have emigrated from their hometown or village. Not intending to return to it, they gradually dispose of their farms by selling the forests at a price below its value (based on our records, we estimate that the problem concerns about 10–20% of the forest sales).

On the other hand, the valuation methods used in the study may not be sufficiently robust. When analyzing social and economic conditions, one should pay attention to the fact that the problems of private forests are closely related to the principles of the policy on shaping the agricultural system and agricultural management implemented in the country. The second reason for the differences considered may be errors in the appraisal method used. In this respect, it should be noted that this method uses the relationship between the prices of the various product ranges and the cost of their harvesting, and the projected national forest value, while the factual sales prices are local. Zygmunt et al. [36,37] and Gaca [38] noted that the value determined using the value indicator tables is overestimated, compared to the value determined using the stock survey method. Their research covered pine stands in central Poland, the value calculated employing the tables was higher than the reference value by about 20% in pole stands and 10% in ripening stands. In the mature stands, the difference was insignificant. We argue that the application of traditional parametric appraisal methods is not appropriate in the case of privately-owned forest properties, especially the small ones (less than 50 ha). As shown in this study, in most cases, it leads to highly overestimating the value of forest properties in comparison to their actual sales prices. The relationships between sales prices and the estimated value of the real estate have long been understudied in Poland [39], and the issue requires further discussion in the case of the emerging forest property market.

Generally, the authors see the reasons for the observed differences in the described socio-economic conditions, rather than in the irregularities of the applied valuation methods. A separate issue is the problem of mapping the taxonomic features of sold stands in simplified forest management plans, according to the status recorded a few or sometimes even over 20 years before the transaction date. In half of the analyzed cases, the updated description reflected the current state of the forest at the

date of sale, verified by the inventory made for this publication. In one-quarter of cases, the current forest condition was much better, and in one-quarter worse than that described in the simplified management plan. In some cases, forest owners could have cut down trees, significantly reducing the value of the property. This would be in line with the general tendency for people leaving their homeland to gradually dispose of their forests, the first step being to sell thick wood followed by the sale of 'land with bushes'. A similar situation occurred on a much larger scale in the interwar period, e.g., in the Vilnius Province. At that time, huge areas of land covered with clearings were purchased by the State Forests from private owners [40]. It is interesting to note, however, that, in contrast to the 1990s, i.e., to the beginning of the economic transformation period, when entire areas of private forests were cut down, the last decade has not seen such radical tree stand felling, which is also indicated in the documentation kept by the authorities supervising forest management in private forests.

5. Conclusions

In the paper, we explored the relationship between transaction prices and assessed values of forest properties in selected regions in Poland. Using valuation accuracy models, we tested the hypothesis that forest property valuations are unbiased estimates of transaction prices. The results show that market prices systematically differ from estimated values. We argue that this systematic valuation bias is partially caused by the current valuation methodology applied in Poland. We found that, in general, forest properties are overvalued, as the appraisal methodology seems to overestimate the potential income from the forest and underestimate the costs to be incurred for forest management performed under the law, e.g., for obligatory afforestation of clearings within 5 years from the date of felling.

This may confirm the hypothesis that sellers are not fully aware of the advantages of the property being sold (timber volume, wood price, and related profitability), and provide further explanations for large systematic differences between sales prices and valuations based on a parametric valuation method used in Poland.

The results are based on the property sales in selected regions in Poland. To make further generalizations, it seems appropriate to carry out further research in other regions of the country. Additional challenges are related to data availability issues. Future research should account for the history of forest management, as well as the condition of forest stands at the date of a sale. Further research is needed to address the role of sales conditions in forest property transactions, as we did not account for that, due to data limitations.

The research findings have several policy implications. In certain cases where the value of the forest is assessed, i.e., compensation for losses or due to compulsory purchase, invalid methodology resulting in an overestimation of the value forest properties will lead to unjust enrichment of property owners and welfare losses. To conclude, the forest property valuation accuracy is of considerable social importance, in particular in the case of possible forest real estate expropriation and related fair compensation.

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Appendix A

The visual inspection confirms the available data for three stands, only one stand has a lower forestation rate than the simplified management plan. In two stands the forestation index is even

higher than the management plan, and yet the sales price is much lower than the value calculated from the low forestation index.

Table A1. Visual inspection results.

Sale Date	City /Region	Age	Species	Share		Stocking Index		Sale Price (PLN/ha)	Value According to the Tables [PLN/ha]		Price/Value Ratio	
				FM	I	FM	I		V2013	V1985	V2013	V1985
2016 Sept.	Ołpiny south Poland	76	fir	5	6	0.62	0.67	33,299	55,239	53,064	0.60	0.63
		72	pine	3	3							
		64	spruce	1	1							
		86	oak	1	-							
2017 Jan.	Rychwałd south Poland	84	beech	8	5	0.7	0.53	30,172	66,161	55,281	0.46	0.55
		84	hornbeam	2	3							
		na	alder	-	2							
2017 June	Czermna south Poland	81	beech	9	8	0.7	1	20,000	47,821	39,462	0.42	0.51
		69	pine	1	1							
			fir	-	1							
2017 April	Filipowice south Poland	74	pine	9	9	0.39	0.58	19,531	37,608	31,629	0.52	0.62
		74	fir	1	1							

FM—Forest management plan; I—visual inspection (measurement on relascope sample plots).

Figure A1. Correlation between sale prices and values by stand maturity (a) left panel results are based on 1985 valuation tables. (b) right panel results are based 2013 valuation tables.

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