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AN ANALYSIS OF THE INCOME AND PRICE ELASTICITY OF DEMAND FOR HOUSING IN VIEW OF PRICE DYNAMICS ON THE RESIDENTIAL PROPERTY MARKET

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Abstract

In both the global and the domestic approach, the real estate market is a multifaceted domain of study, constituting a specific and imperfect system. Researchers have to rely on increasingly advanced analytical tools to capture the structural complexity of real estate markets. Real estate prices are influenced by contradictory behaviors of market participants. This observation prompted the authors to analyze the income and price elasticity of demand for housing by calculating elasticity coefficients in view of changes in housing prices and the Veblen effect. This problem was analyzed based on a review of the literature and the results of an experiment. The results of the current study can be used to confirm the presence of the Veblen effect on the housing market based on the adopted criteria. The coefficients of price and income elasticity of demand for housing were calculated in view of the price dynamics on the real estate market to paint a more complete picture of reality and explain market processes.

Key words: *income elasticity of demand for housing, price elasticity of demand for housing, Veblen effect, luxury goods.*

JEL Classification: *D01, D12, D19, R00, R21.*

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1. Introduction

The dynamic increase in real estate prices in the long-term (multi-annual) perspective as well as present housing prices indicate that residential property is becoming less affordable and is increasingly perceived as a luxury good. During the boom on the Polish housing market in Q3 2007, the housing affordability index (expressed by the number of square meters of residential property that can be purchased at the average price by a buyer with an average income in the enterprise sector) reached 0.49 (NBP 1). The mean value of the housing affordability index was highest in 2016 (Q1) at

0.88 (NBP 1). The analyzed parameter reached 0.76 (NBP 2) in Q4 2020. Mortgage affordability, namely the number of square meters of residential property that can be purchased with a mortgage loan by a buyer with an average monthly income in the enterprise sector at the average transaction price, was estimated at 65 sq. m in 2007, 110 sq. m in 2016, and 120 sq. m in 2020 (NBP 2). Between 2007 and 2020, the average monthly income nearly doubled in Poland (from PLN 2866 in 2007 to PLN 5181 in 2019) (GUS 1). Despite the above, the housing market remains deeply unbalanced (Kucharska-Stasiak 2016; Brzezicka et al., 2018), supply does not meet demand (Surówka 2018; Szafrańska, de Lille & Kazimierczak 2019; Ulman & Ćwiek, 2020, p. 5), and the market's low informational efficiency, low transparency and liquidity contribute to market anomalies (Kołodziejczyk et al., 2019; Kobylińska & Cellmer, 2019). However, the number of cash purchases is on the rise; interest rates have hit historic lows, and the number of newly-built apartments reached a historic high in Poland in Q4 2020 (GUS 2). Therefore, the real estate market is full of contradictions, and the difference between average housing prices and the prices of "luxury" homes continues to increase (cf. Bełej, 2016).

The aim of this study was to explain the current behavior of real estate market participants by calculating elasticity coefficients based on price dynamics in a period characterized by a rapid increase in housing prices. The coefficients of income elasticity of demand for housing can be used to classify commodities into essential goods and higher-order goods. The coefficient of income elasticity of demand for higher-order goods exceeds 1, and can be higher for luxury goods. The present study explores the Veblen effect, but in a less conventional approach. In the traditional approach, the Veblen effect is identified when price and demand move in the same direction, and luxury goods are purchased as a manifestation of the buyers' material status. However, a different problem emerges on the real estate market when this relationship is reversed: rising prices turn residential property into a luxury good. On the Polish real estate market, high prices fueled speculative behaviors, but not in a conventional sense where property is purchased to obtain high future returns. Instead, market speculation was driven by the fear that property prices would continue to rise in the future, and that buyers who did not purchase an apartment in time t_0 would not be able to afford it in time t_1 (Brzezicka et al., 2018, p. 519). In this approach, the purchase and possession of property is a manifestation of the buyer's material status. These trends are influenced by changes in the perception of housing as a luxury good that is not affordable to everyone, despite the fact that housing is an essential commodity that meets the basic human need for shelter.

2. Literature review

In economic theory, perceived brand prestige drives Veblen's paradox, also known as the Veblen effect or the demonstration effect (Samuelson & Nordhaus, 2014). The Veblen effect is identified when price and demand move in the same direction, and intensifies with an increase in prices. Initially, the Veblen effect was associated with the purchase of goods for ostentatious display (Veblen, 1931). With time, this definition was expanded to include the demand for luxury goods (Begg et al., 2008) which epitomize the buyer's high material status (Corneo & Jeanne, 1997). The above applies to the wealthiest consumers who purchase Veblen goods to manifest their financial or social status. The Veblen effect occurs when the demand for a certain good increases only because its price increases (Creedy & Slottje, 1991), and it is also referred to as the snob effect. According to Bagwell and Bernheim (1996, p. 349), the Veblen effect takes place when consumers are willing to pay a higher price for a functionally equivalent good. In the traditional approach, luxury goods include rare works of art, designer clothing and items for which the income elasticity of demand exceeds 1 (the increase in demand exceeds the increase in income) (Bochańczyk-Kupka, 2014). According to Kapferer (2017), luxury goods are characterized by limited availability, uniqueness, high price, high quality, and the highest price/quality relationship on the market.

In the conventional sense, the Veblen effect also applies to the real estate market, where it is manifested by an increase in demand for locations with above-standard features and amenities (environmental, infrastructural or other). Consumers have an interest in prestigious locations which become luxury goods, and the demand for top locations reflects favorably on the potential buyers' financial status. This process can contribute to the diversification of housing in various locations (cf. Tomal, 2021), and it is consistent with the residential location theory, which postulates that prestigious locations fetch higher prices, rents and return rates (Źróbek et al., 2015; Drapikovskyi et al., 2020; Tomal, 2020). The value of urban homes is driven mainly by location (which is one of the key determinants of real estate prices), the characteristic features of the local market, resource limitedness,

specificity of the real estate market, and higher demand for real estate. At the same time, due to the local character of urban housing markets (cf. Beck et al., 2012; Ling, 1992), prices are largely influenced by the local perceptions of property value and prestige. The definition of luxury goods applies not only to prestigious locations, but also to unique buildings. According to Sajnóg and Borkowski (2019), the Polish luxury residential real estate market is characterized by relatively low prices and a relatively low supply of luxury homes. Transactions involving luxury apartments generate approximately 1% of total sales on residential property markets in the largest Polish cities.

The price and income elasticity of demand for housing has been extensively investigated in the international literature. In the traditional approach, the income elasticity of demand for housing is determined by estimating the demand function independently or as part of a multi-equation model (Harmon, 1988; Rosenthal et al., 1991). Hansen, Formby and Smith (1996; 1998) relied on the Lorenz concentration curve (LC) to estimate the income elasticity of demand for housing. However, these approaches require panel studies or microdata (individual data). According to Mayo (1981), the coefficients of price elasticity of demand typically range from 0.25 to 0.7 for renters and from 0.36 to 0.87 for owners. Other researchers observed that the price elasticity of demand for single-family owner-occupied housing ranges from 0.14 to 1.5, where short-run elasticity was estimated at 0.70, and long-run elasticity – at 1.00 (Harmon 1988). A study of the Hong Kong market revealed that permanent income elasticities decreased within a range of 0.536–0.698, and that a transitory income shock exerted a significant positive impact on the demand for rental housing (Zheng et al., 2018). The income elasticity of house prices in Australia was estimated at 1.07 (Liu 2019). Despite differences in the cited results, permanent income elasticities tended to approximate 1 or less in the reviewed studies.

Recent changes in housing prices, including the prices of luxury homes, justify the interest in price and income elasticity of demand for housing. Housing prices continue to increase despite the economic shocks of the speculative bubble of 2008, the economic crisis of 2008 (Muller et al., 2010) and the Covid-19 pandemic. The influence of the Covid-19 pandemic on the housing market is complex, and local markets responded differently to this threat. In Q4 2020, prices increased in nearly all market segments, but the rate of the price increase was somewhat slowed down (NBP 2). Speculative behaviors lead to sudden price fluctuations and contradict the assumption that prices and incomes increase at a similar rate. This observation can be regarded as a vantage point for analyzing the theoretical underpinnings of the Veblen effect on the real estate market.

3. Data and Methods

3.1. Income elasticity of demand

The hypothesis postulating the presence of the Velben effect on the real estate market can be tested by analyzing the elasticity of demand for housing. As previously noted, the income elasticity of demand for luxury homes that drives the Velben effect exceeds 1, which indicates that the increase in demand exceeds the increase in incomes, and luxury homes become a manifestation of consumers' material status. The income elasticity of demand measures the responsiveness of demand (D) to changes in income (I), and it is determined by calculating the coefficient of income elasticity of demand (E_{DI}) with the use of formulas (1), (2) and (3):

$$E_{DI} = (\Delta D/D)/(\Delta I/I) \tag{1}$$

$$\frac{\Delta D}{D} = \frac{D_t - D_{t-1}}{D_{t-1}} \tag{2}$$

$$\frac{\Delta I}{I} = \frac{I_t - I_{t-1}}{I_{t-1}} \tag{3}$$

where: D – demand for housing in time t; ΔD – difference in demand for housing between time t and $t-1$; I – mean annual income in time t; ΔI – difference in mean annual income between time t and $t-1$. The study analyzed the local real estate market in the Polish city of Olsztyn. The mean gross annual income in Olsztyn expressed in Polish zloty [PLN] was determined based on the data published by *Statistics Poland* (the central statistical office in Poland). *Statistics Poland* does not track incomes on a quarterly basis. Such data are available for regions, but datasets for the analyzed period were incomplete due to changes in data hierarchy or the variables included in a given reporting period. In each analyzed period, demand was expressed by the volume of home transactions

registered in Olsztyn. The information about the number of concluded transactions was obtained from the Register of Real Estate Prices and Values kept by the Olsztyn City Office. Only apartments were analyzed in the study. The analyzed period was 2004-2016, when prices increased steadily on the studied market. The obtained information was processed to obtain a heterogeneous database for analysis. Only privately owned apartments that were traded on the market (public property sold by formal or informal tender, property sold in execution, and property sold at a discount was not included in the study) were analyzed. Apartments with a floor area of 40-60 sq. m were selected for the study. A similar approach to market segmentation had been adopted by other authors (NBP 3; Brzezicka et al., 2019). The initial database of apartments that met the above requirements was composed of 8122 transactions. Outliers were eliminated by removing 5% of transactions with the highest and the lowest prices in each analyzed quarter. The above was accomplished by creating a conditional formatting rule based on the solutions presented in the literature (Case et al., 2012; Brzezicka et al., 2020). The final database contained 7376 transactions; 746 transactions were eliminated, i.e. 9.2% of the transactions in the initial database. Transaction volumes were aggregated by summing up all transactions concluded in the analyzed periods. Transaction volume was expressed by the number of concluded transactions.

3.2. Price elasticity of demand

Price elasticity of demand for housing was also analyzed to determine the presence of the Velben effect on the real estate market. Price elasticity of demand measures the responsiveness of demand (D) to a change in prices (P), and it is determined by calculating the coefficient of price elasticity of demand (E_{DP}) with the use of formulas (4), (5) and (6). Speculative bubbles on the real estate market lead to rapid price fluctuations, and price elasticity of demand describes demand sensitivity to changes in price.

$$E_{DP} = (\Delta D/D)/(\Delta P/P) \tag{4}$$

$$\frac{\Delta D}{D} = \frac{D_t - D_{t-1}}{D_{t-1}} \tag{5}$$

$$\frac{\Delta P}{P} = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{6}$$

where: P – mean quarterly price in time t; ΔP – difference in mean quarterly price between time t and time $t-1$; D – demand for housing in time t; ΔD – difference in demand for housing between time t and time $t-1$. The analysis involved the same database that was used in the calculation of the income elasticity of demand, but data were expressed on a quarterly basis to increase analytical accuracy. The analysis was narrowed down to 2004-2012, when above-average fluctuations in housing prices were noted. The demand for residential property in each examined quarter was expressed by the volume of concluded housing transactions. The literature (Kucharska-Stasiak, 2016, p. 79) distinguishes between effective demand and potential demand. Potential demand is formed by human needs, not supported by income for purchase. Effective demand, on the other hand, consists of realized needs, supported by financial capabilities. The basis for the distinction between the two types of demand is the income capacity of the buyers. Effective demand was used in the study due to the use of the number of transactions realized. Real estate prices were calculated as the arithmetic means of all transactions. Prices were expressed in Polish zloty per one square meter of apartment area [PLN/m^2].

3.3. Smoothing time series data

Raw and smoothed data were used in the analysis. The real estate market is highly heterogeneous, and the analyzed phenomena are very difficult to identify and interpret based on raw data alone. To calculate the coefficient of income elasticity of demand, annual data were smoothed with the Hodrick-Prescott filter. To calculate the coefficient of price elasticity of demand, quarterly data were smoothed using a moving average with a smoothing constant $k = 4$, and a non-linear trend was estimated (as a function of time) with a polynomial function. The Levenberg-Marquardt algorithm was applied to solve non-linear least squares problems.

The Hodrick-Prescott (HP) filter can be used to determine a smoothed component of a long-term non-linear trend by removing cyclical and random components from the time series. This was accomplished with the use of formulas (7) and (8). The time series has three main components: $y_t = \tau_t + c_t + \varepsilon_t$, where τ_t is a non-linear long-term trend, c_t is the cyclical component, and ε_t is the random component. The cyclical component is interpreted as the deviation from τ_t, and in principle, it

equals zero in the long term. Therefore, the optimization problem can be solved with the following formula (8):

$$y_t = \tau_t + c_t + \varepsilon_t \tag{7}$$

$$\min(\sum_{t=1}^{T}(y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1}[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2) \tag{8}$$

where: $c_t = y_t - \tau_t$. The first part of the equation is the sum of squared deviations $y_t - \tau_t$, and represents the cyclical component. In the second part, lambda denotes the second difference in the trend, and it measures the rate of changes in the trend. The value of lambda can differ for various types of data, and was set at $\lambda = 6.25$ for annual data.

The time series was smoothed with a moving average in equation (9), and the method of calculating the first three values in the time series was modified in equations (10), (11), (12) and (13) to prevent data loss:

$$\hat{y}_t = \frac{1}{k} \sum_{i=t-k}^{t-1} y_i \tag{9}$$

$$\hat{y}_1 = y_1 \text{ for } t = 1, i = 1 \tag{10}$$

$$\hat{y}_2 = \frac{1}{2}(y_1 + y_2) \text{ for } t \in \{1, 2\},\ i = 2 \tag{11}$$

$$\hat{y}_3 = \frac{1}{3}(y_1 + y_2 + y_3) \text{ for } t \in \{1, 2, 3\},\ i = 3 \tag{12}$$

$$\hat{y}_4 = \frac{1}{4} \sum_{i=t-k}^{t-1} y_i \text{ for } t \in \{1, 2, 3, \dots, T\},\ i \in \{4, 5, \dots, I\} \tag{13}$$

where: $\hat{y}_t$ – variable Y predicted for a moment in time or time t, $t \in \{1, 2, 3, \dots, T\}$; k – smoothing constant.

The actual and smoothed values of annual data are presented in Figure 1. The actual and smoothed values of quarterly data are presented in Figure 2. In all figures and tables, smoothed data are described as HP (Hodrick-Prescott filter), MA (moving average) and NE (nonlinear estimation). The estimated parameters of a non-linear function describing price and transaction volume trends are presented in Appendix 1.

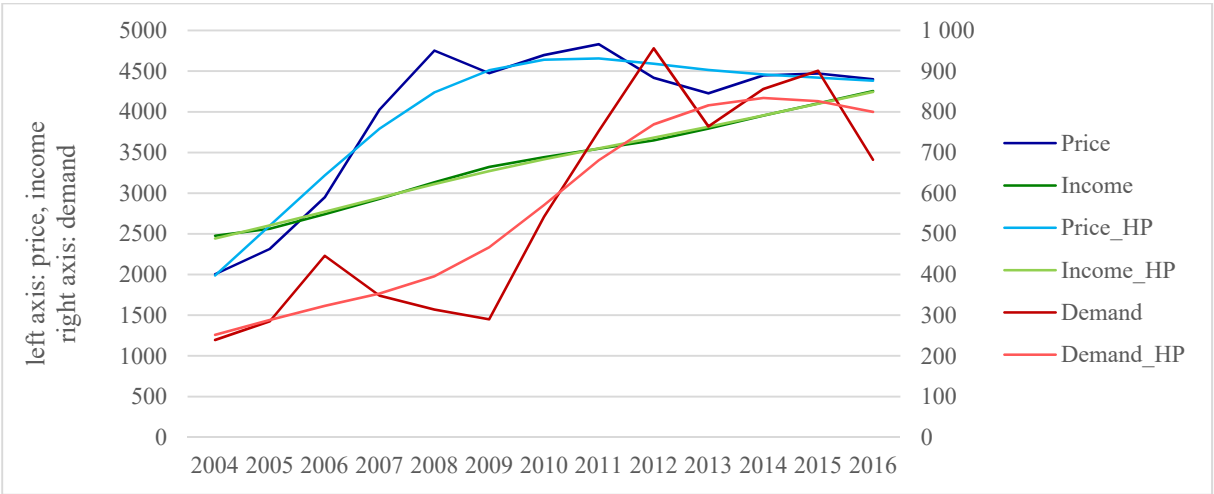

Fig. 1. Annual data: price, income and demand. *Source*: own elaboration.

4. Results

4.1. Income elasticity of demand

The income elasticity of demand was analyzed in the first step of the study. The values of D and I in the annual approach are presented in Table 1 (columns (3) and (4)). The values of the coefficient of income elasticity of demand calculated based on raw market data (column (9) and mean annual apartment prices in the analyzed period (P) (column (2)) are also presented in Table 1. In the next step, the coefficient of income elasticity of demand for housing was analyzed with the use of the values

estimated based on smoothed values. Coefficient E_{DI}' was calculated with the described method. The results are presented in Table 2 and Figure 2.

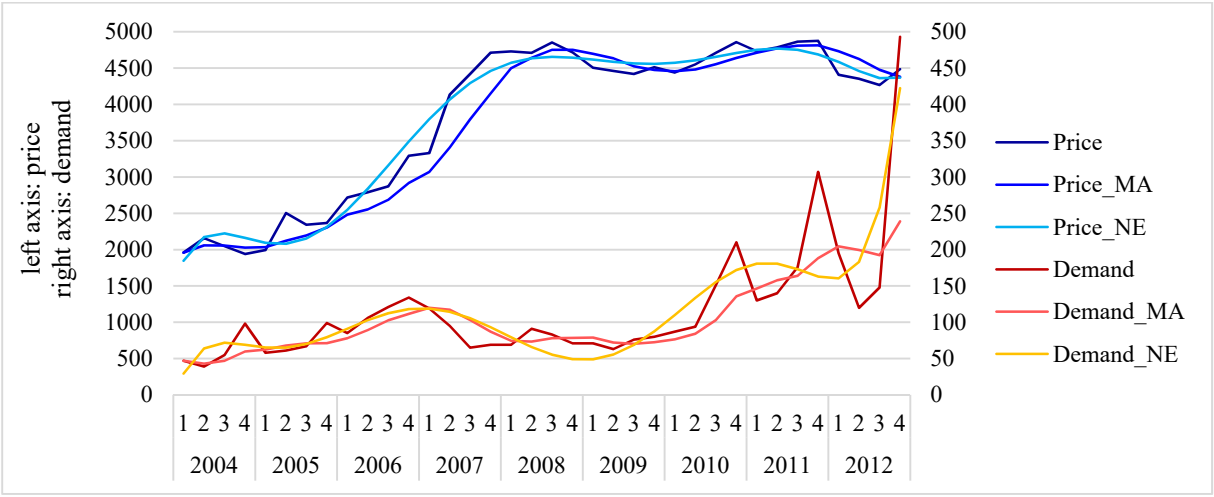

Fig. 2. Quarterly data: price and demand. *Source*: own elaboration based on Statistics Poland data.

Table 1

Income elasticity of demand for housing – actual values

Year	Price (P)	Demand (D)	Income (I)	ΔD	ΔD/D	ΔI	ΔI/I	E_{DI}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2004	2005	239	2 477					
2005	2315	285	2 563	46	0.19	86	0.03	5.57
2006	2949	446	2 742	161	0.56	179	0.07	8.11
2007	4027	348	2 931	-98	-0.22	190	0.07	-3.18
2008	4753	314	3 133	-34	-0.10	202	0.07	-1.42
2009	4475	290	3 323	-24	-0.08	190	0.06	-1.26
2010	4697	542	3 443	252	0.87	120	0.04	23.96
2011	4831	753	3 547	211	0.39	104	0.03	12.93
2012	4419	956	3 649	203	0.27	102	0.03	9.35
2013	4227	764	3 795	-192	-0.20	146	0.04	-5.02
2014	4448	856	3 954	92	0.12	159	0.04	2.87
2015	4471	901	4 104	45	0.05	150	0.04	1.39
2016	4401	682	4 255	-219	-0.24	151	0.04	-6.62

Source: own elaboration.

Table 2

Income elasticity of demand for housing – smoothed values

Year	Price (P)'	Demand (D)'	Income (I)'	Δ D'	Δ D / D'	Δ I '	Δ I / I '	E_{DI}'
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2004	1989	251.66	2443.23					
2005	2602	288.34	2604.75	36.68	0.15	161.515	0.07	**2.20**
2006	3217	322.99	2771.72	34.65	0.12	166.972	0.06	**1.87**
2007	3792	353.05	2942.92	30.06	0.09	171.199	0.06	**1.51**
2008	4240	395.65	3112.29	42.60	0.12	169.368	0.06	**2.10**
2009	4511	467.09	3271.88	71.45	0.18	159.596	0.05	**3.52**
2010	4641	570.64	3417.05	103.54	0.22	145.164	0.04	**5.00**
2011	4655	681.19	3551.25	110.55	0.19	134.208	0.04	**4.93**
2012	4592	769.09	3682.17	87.90	0.13	130.913	0.04	**3.50**
2013	4514	816.15	3816.75	47.06	0.06	134.584	0.04	**1.67**
2014	4460	834.10	3956.70	17.95	0.02	139.944	0.04	0.60

2015	4420	826.33	4100.26	-7.77	-0.01	143.559	0.04	-0.26
2016	4383	799.72	4245.32	-26.61	-0.03	145.064	0.04	-0.91

Source: own elaboration.

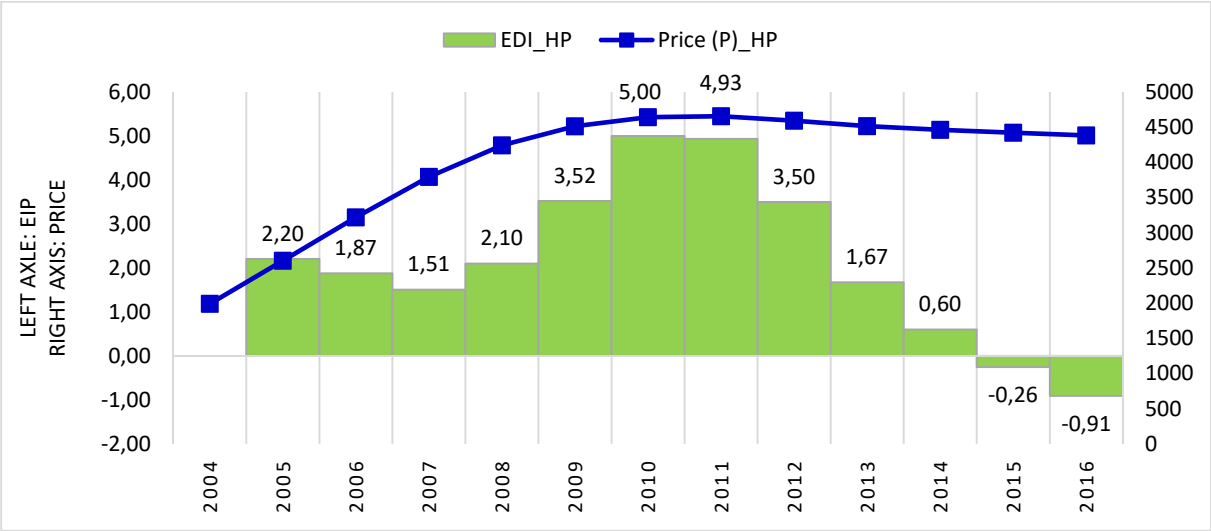

Fig. 3. Coefficient of income elasticity of demand (E_{DI}) and real estate price (P). *Source*: own elaboration.

An analysis of raw data revealed that the coefficient of income elasticity of demand for housing exceeded 1 in 2005-2006 and 2010-2012. In 2005-2006, E_{DI} ranged from 5 to 8, and it peaked (> 20) in 2010. The calculated coefficient assumed negative values in 2007-2009. These results are difficult to interpret because high coefficients of price elasticity of demand are generally expected in periods of rapid price growth. The greatest increase in real estate prices fueled by speculative demand was observed in 2007. The year 2008 marked the beginning of the correction of housing prices; prices began to adjust to changes in the market, and increased again in 2009 (to make up for the losses). After the speculative bubble of 2007-2008, the demand for real estate decreased, and a stable trend was observed over a period of one year (E_{DI} was negative until 2009). As the market gradually emerged from the global financial crisis, the demand for housing increased rapidly in 2010-2011. An analysis of the data smoothed with the HP filter demonstrated that the coefficients of price elasticity of demand exceeded 1, and, interestingly, that they increased with a rise in housing prices. The observed changes in E_{DI} resulted from dynamic changes in demand, i.e. the volume of concluded transactions. In this case, demand was highly elastic, and the relative change in demand was higher than the relative change in income (E_{DI} > 1) (columns (6) and (8) in Tables 1 and 2). The correlation coefficient denoting the relationship between changes in demand (ΔD/D) and the elasticity coefficient (E_{DI}) reached 0.962. Therefore, the trajectory of E_{DI} closely followed the trajectory of ΔD/D. Changes in income (ΔI/I) were less strongly correlated with changes in demand (ΔD/D), and the value of the correlation coefficient between these variables was determined at -0.238. The rate of changes in income was lower than the rate of changes in demand. This correlation was even stronger when cyclical and random variations were eliminated from the dataset. The value of E_{DI}' exceeded 1 in 2005-2013, peaking in 2010 at E_{DI}' =5. In this case, the value of the correlation coefficient for the relationship between E_{DI}' and ΔD/D reached 0.967.

Two partial conclusions can be drawn from the analysis of income elasticity of demand. The analysis confirmed the presence of the Veblen effect on the studied market, where the coefficient of income elasticity of demand exceeded 1. This observation suggests that the analyzed market was subjected to the Veblen effect based on the adopted criteria. However, the results were affected by considerable fluctuations in demand and the applied price aggregates (annual prices). The second conclusion is that the coefficient of income elasticity of demand calculated based on actual market data was more affected by the rate of changes in demand than the rate of changes in income.

4.2. Price elasticity of demand

The coefficients of price elasticity of demand for housing were calculated in the next step of the analysis. The results of the calculations based on actual data were highly labile, and did not support observations of change trends (increase/decrease) in E_{DP} over several time periods. The analyzed data were too heterogeneous, and the difference between the highest and the lowest value of E_{DP} (range) reached 438. The results for the data smoothed with a moving average are presented in Table 3, and the results for the data obtained by non-linear estimation are presented in Table 4. In Table 4, data are not presented for the first four quarters and the last four quarters because this smoothing method produces the greatest errors at the beginning and end of the time series.

Table 3

Price elasticity of demand for housing – moving average

Quarter (LP)	Price (P)	Demand (D)	ΔD	$\Delta D/D$	ΔP	$\Delta P/P$	E_{DP}
(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)
Q1 2004	1960	47		-		-	-
Q2 2004	2059	43	-4	-8.51%	99	5.04%	-2
Q3 2004	2056	47	4	9.30%	-4	-0.18%	-52
Q4 2004	2027	60	12.75	27.13%	-29	-1.40%	-19
Q1 2005	2035	63	2.75	4.60%	9	0.42%	11
Q2 2005	2122	68	5.5	8.80%	86	4.24%	2
Q3 2005	2196	71	3	4.41%	74	3.48%	1
Q4 2005	2302	71	0.25	0.35%	107	4.86%	0
Q1 2006	2483	78	6.75	9.47%	181	7.84%	1
Q2 2006	2554	89	11.25	14.42%	72	2.88%	5
Q3 2006	2687	103	13.5	15.13%	132	5.18%	3
Q4 2006	2918	112	8.75	8.52%	231	8.61%	1
Q1 2007	3071	120	8.5	7.62%	153	5.25%	1
Q2 2007	3407	117	-2.75	-2.29%	336	10.96%	0
Q3 2007	3794	103	-14	-11.94%	387	11.35%	-1
Q4 2007	4149	87	-16.25	-15.74%	355	9.36%	-2
Q1 2008	4499	75	-12.5	-14.37%	350	8.43%	-2
Q2 2008	4643	74	-1	-1.34%	144	3.19%	0
Q3 2008	4751	78	4.5	6.12%	109	2.34%	3
Q4 2008	4752	79	0.5	0.64%	1	0.02%	41
Q1 2009	4696	79	0.5	0.64%	-56	-1.18%	-1
Q2 2009	4634	72	-7	-8.86%	-62	-1.32%	7
Q3 2009	4525	70	-1.75	-2.43%	-109	-2.35%	1
Q4 2009	4474	73	2.25	3.20%	-51	-1.13%	-3
Q1 2010	4457	77	4	5.52%	-17	-0.37%	-15
Q2 2010	4480	84	7.75	10.13%	22	0.50%	20
Q3 2010	4553	103	18.75	22.26%	73	1.63%	14
Q4 2010	4640	136	32.5	31.55%	87	1.91%	17
Q1 2011	4713	146	10.75	7.93%	73	1.58%	5
Q2 2011	4772	158	11.5	7.86%	59	1.24%	6
Q3 2011	4810	164	6.25	3.96%	38	0.80%	5
Q4 2011	4814	188	24.25	14.79%	4	0.08%	183
Q1 2012	4733	205	16.25	8.63%	-81	-1.68%	-5
Q2 2012	4625	200	-5	-2.44%	-108	-2.28%	1
Q3 2012	4476	193	-7	-3.51%	-149	-3.23%	1
Q4 2012	4378	239	46.5	24.16%	-97	-2.17%	-11

Source: own elaboration.

Table 4

Price elasticity of demand for housing – moving average

Quarter (LP)	Price (P)	Demand (D)	ΔD	$\Delta D/D$	ΔP	$\Delta P/P$	E_{DP}
(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)
Q1 2005	2094	65	-4	-5.51%	-68	-3.14%	2
Q2 2005	2081	65	0	-0.21%	-13	-0.60%	0
Q3 2005	2152	70	5	7.60%	71	3.41%	2
Q4 2005	2311	79	9	13.26%	159	7.39%	2
Q1 2006	2547	91	12	14.77%	236	10.20%	1
Q2 2006	2839	103	12	12.94%	292	11.45%	1
Q3 2006	3161	112	10	9.35%	322	11.35%	1
Q4 2006	3488	118	6	5.07%	327	10.35%	0
Q1 2007	3797	119	1	0.63%	309	8.86%	0
Q2 2007	4069	114	-4	-3.72%	273	7.18%	-1
Q3 2007	4293	105	-9	-7.86%	224	5.49%	-1
Q4 2007	4461	93	-12	-11.68%	168	3.92%	-3
Q1 2008	4574	79	-14	-14.87%	112	2.52%	-6
Q2 2008	4635	66	-13	-16.78%	61	1.34%	-13
Q3 2008	4655	55	-11	-16.16%	20	0.42%	-38
Q4 2008	4644	49	-6	-11.07%	-10	-0.22%	50
Q1 2009	4617	49	0	-0.35%	-27	-0.58%	1
Q2 2009	4587	56	7	13.32%	-30	-0.66%	-20
Q3 2009	4565	69	13	23.66%	-22	-0.49%	-49
Q4 2009	4559	88	19	27.32%	-6	-0.13%	-207
Q1 2010	4573	110	23	25.74%	14	0.32%	81
Q2 2010	4607	134	24	21.48%	34	0.75%	29
Q3 2010	4656	155	22	16.19%	48	1.05%	15
Q4 2010	4708	172	17	10.63%	52	1.13%	9
Q1 2011	4751	181	9	5.14%	43	0.91%	6
Q2 2011	4770	181	0	-0.01%	19	0.40%	0
Q3 2011	4752	173	-8	-4.20%	-18	-0.39%	11
Q4 2011	4688	163	-10	-5.86%	-63	-1.33%	4

Source: own elaboration.

The calculations involving the moving average also produced highly varied data. Interesting results were obtained for data described as a function of time. In this case, the coefficient of price elasticity of demand was influenced by certain trends. Two discontinuity points in the values of the coefficient of price elasticity of demand were observed at the inflection point on the price and demand curve. The coefficients, the actual price and the smoothed price are presented in Figure 4. Price and demand dynamics are presented in Figure 5. The discontinuity points in the values of the coefficient of price elasticity of demand are marked with a red dashed line in the figures and in Table 4. Two discontinuity points were identified in 2004-2012. Q3/Q4 2008 was the first discontinuity point, and 4Q2009/1Q2010 was the second discontinuity point. Prices increased gradually and the calculated coefficients decreased up to the first discontinuity point. The first discontinuity point coincides with a change in the direction of the price trend – demand visibly decreased and prices were adjusted at the end of 2008. The coefficients decreased between the two discontinuity points and beginning from the second discontinuity point. The data presented in Figure 5 indicate that the first discontinuity point is linked with the local minimum of the demand function, whereas the second discontinuity point is related to the local maximum of the demand function. In the future, the results of this study will be validated with the use of other analytical methods or on a different market.

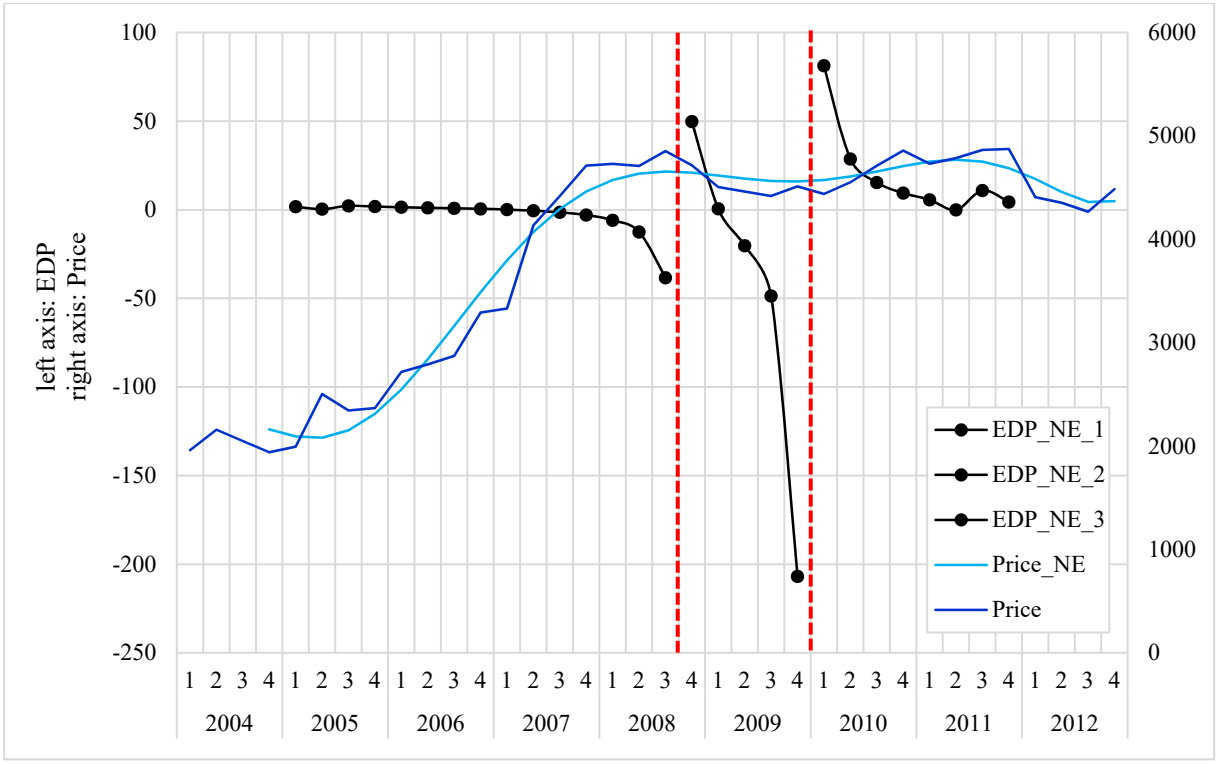

Fig. 4. Coefficients of price elasticity of demand (E_{DI}), real estate prices (P) and discontinuity points. *Source*: own elaboration.

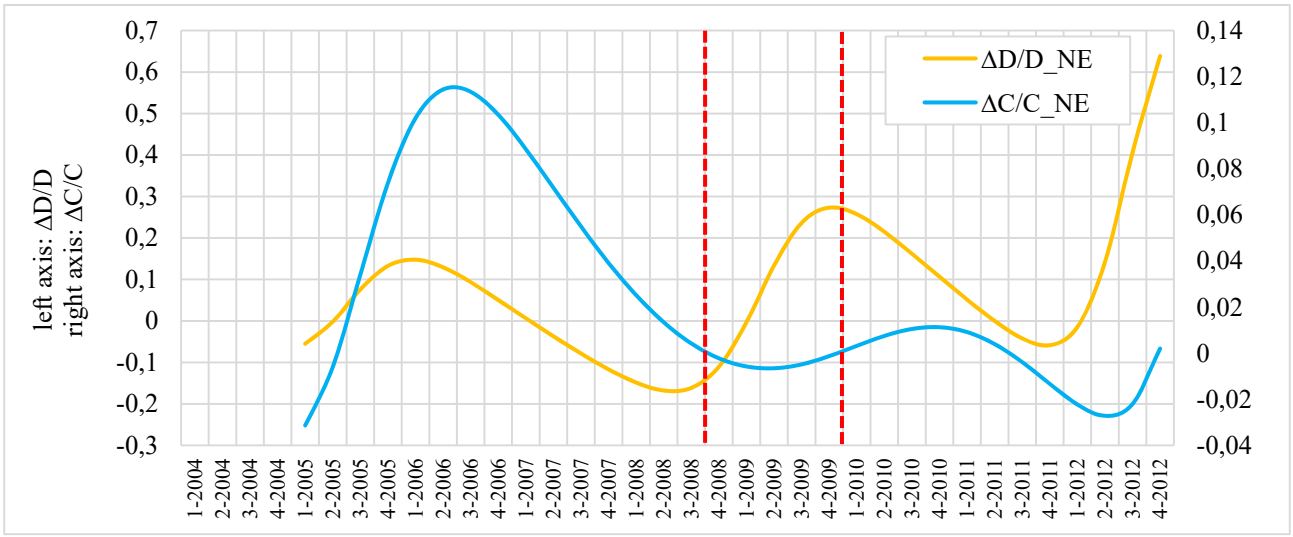

Fig. 5. Price and demand dynamics and discontinuity points. *Source*: own elaboration.

5. Discussion

Discontinuities in the elasticity of demand for housing are not a new phenomenon. The demand for housing is characterized by high intensity, low substitution, low responsiveness to price changes, considerable differences between potential and effective demand, and low elasticity (Kucharska-Stasiak, 2006, pp. 60-61; 2016, p. 6). According to many authors, supply is less elastic than demand (Kucharska-Stasiak, 2016, p. 6) due to the specificity of the housing development process. Supply responds slowly to short-term changes in price because it is influenced by the development process, business cycles, availability of resources and consumer spending. Supply is more elastic and cyclical in the long term (Kucharska-Stasiak, 2006, pp. 60-61). Prices and demand increase in the same direction in periods of rapid price growth (Brzezicka et al., 2018). The price elasticity of demand is not

observed under such conditions, which, according to Masiukiewicz and Dec (2013), can be attributed to a compensation effect. When the price of an apartment, including mortgage costs, is lower than the anticipated future price, the rate of return on the purchased property will be high. Discontinuities in the price elasticity of demand are also caused by price bubbles. One of the definitions of a price bubble is related to the elasticity of demand. Masiukiewicz and Dec (2013, p. 402) define a price bubble as an increase in price dynamics that is unrelated to the fundamental value of assets and the associated disruptions in the elasticity of demand. According to Fernández-Kranz and Hon (2006), real estate bubbles are caused by transitory shocks to the demand for real estate investments; therefore, the benchmark for a long-term equilibrium in house prices is related to the long-term equilibrium relationship between house prices and incomes. Łaszek, Augustyniak and Widłak (2009) argued that high income elasticity of demand (> 1) was one of the main demand-side factors responsible for the speculative bubble in 2006-2008. In a broader context, discontinuities in real estate prices were also observed due to changes in market trajectory rather than subsequent adjustments over the business cycle (Bełej 2011, 2012).

6. Summary and Conclusions

The aim of the study was to analyze the income and price elasticity of demand for housing by calculating elasticity coefficients based on real estate price dynamics. The income and price elasticity of demand was evaluated to explain the behavior of market participants, and the analysis revealed the complexity of the studied phenomenon. The coefficient of income elasticity of demand exceeded 1 when smoothed data were used in calculations. When smoothed data were applied to calculate the coefficients of price elasticity of demand, two discontinuity points corresponding to breakthrough events on the local market were identified. The specificity of local real estate markets can be attributed to diverse phenomena, including demand, supply, random events as well as behavioral factors. Categorical conclusions are difficult to formulate due to the complex structure of the real estate market. Further research is needed to validate the present findings with the use of other methods for calculating elasticity coefficients or on a different local market.

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Appendix 1

Model: demand=a1*(lp^7)+a2*(lp^6)+a3*(lp^5)+a4*(lp^4)+a5*(lp^3)+a6*(lp^2)+a7*lp+a8 Dependent variable: demand						
-	Score	SEM	T df = 28	p	Lower confidence limit	Upper confidence limit
a1	0.000004	0.0000	0.00	0.00	0.000	0.0000
a2	-0.000501	0.0002	0.00	0.00	-0.001	-0.0001
a3	0.023851	0.0092	0.00	0.00	0.005	0.0428
a4	-0.563881	0.2448	0.00	0.00	-1.065	-0.0624
a5	6.935659	3.5003	0.00	0.00	-0.234	14.1057
a6	-42.866995	26.1096	0.00	0.00	-96.350	10.6161
a7	122.407180	89.4413	0.00	0.00	-60.805	305.6193
a8	-56.675060	101.0733	0.00	0.00	-263.714	150.3643

Model: price=a1*(lp^7)+a2*(lp^6)+a3*(lp^5)+a4*(lp^4)+a5*(lp^3)+a6*(lp^2)+a7*lp+a8 Dependent variable: price						
-	Score	SEM	T df = 28	p	Lower confidence interval	Upper confidence interval
a1	0.000022	0.0000	0.00	0.00	0.000	0.000
a2	-0.003028	0.0008	0.00	0.00	-0.005	-0.001
a3	0.163659	0.0392	0.00	0.00	0.083	0.244
a4	-4.424085	1.0388	0.00	0.00	-6.552	-2.296
a5	61.717945	14.8524	0.00	0.00	31.294	92.142
a6	-410.806999	110.7876	0.00	0.00	-637.745	-183.869
a7	1186.809374	379.5139	0.00	0.00	409.410	1964.208
a8	1014.596214	428.8692	0.00	0.00	136.097	1893.095