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DETERMINANTS OF RESIDENTIAL REAL ESTATE PRICES: POLAND CASE STUDY

Michał Ruszuk
Krzysztof Spirzewski

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Determinants of residential real estate prices: Poland case study

Michał Ruszuk, Krzysztof Spirzewski*

University of Warsaw, Faculty of Economic Sciences
**Corresponding author: kspirzewski@wne.uw.edu.pl*

Abstract: Real estate market is important part of economy. Its influence is compounded by sectors related to real properties, such as construction, capital and rental markets. Real estate market specifics such as high capital intensity, rigidity of supply and time lags, make macroeconomic imbalance easy to emerge. Sudden changes of market conditions lead to severe consequences for the whole economy. Hence, house markets are important not only for house investors, real estate developers and financial institutions, but also for governments and central banks.
In this paper we propose to constitutes a comprehensive overview of house prices determinants. It can be perceived as residential real estate market guide, especially for polish market. In Poland house prices have been consistently increasing since 1990, when transition to a market economy had place. Statistical Pole gets wealthier from year to year, what in conjunction with a strong desire to be on his own, constitutes the powerful driving force of demand for residential real estates
The methods we used in this study are descriptive method and statistical models in addition scatter plots and Pearson's correlation coefficients between variables are presented. Empirical study are based on polish market data, published by Central Statistical Office and Centrum AMRON-SARFiN. We aggregated them for voivodeships and quarters, and concern 2010-2019 period.

Keywords: real estate market, price determinants, mortgage

JEL codes: E31, G21, K25, R31

1. Introduction

Real estate prices over the world have been increasing rapidly in recent years. This phenomenon attracts attention of house investors, real estate developers, central banks and governments. Shocks on house markets alter real estate construction, drive housing cycles[1] and generate risk for financial institutions. Hence all sides of market strongly desire the ability to predict price trends of houses. The paper present comprehensive overview of determinants of real estate prices. It can be perceived as residential real estate market guide for polish market. As polish house prices have been consistently increasing since 1990, statistical Pole gets wealthier from year to year[2], what in conjunction with a strong desire to be on his own[3], constitutes the powerful driving force of demand for residential real estates.

The aim of this paper is to examine what are the determinants of house prices in Poland. The real estate market covers not only houses, but also commercial and industrial real estates, as well as raw land. This paper analyzes only residential market as it can be perceived as most important real property market. What is more, trends and prices' behaviors on residential real estate markets differ much from these observed on non-residential. Thus, analyzing all markets at once would be a sizeable mistake.

The research hypothesis is: "The main determinants of housing prices in Poland are: personal income, demography, mortgage interest rates, cost of construction and supply of houses." To proof this thesis the descriptive method and statistical model will be used. It will be based on polish market data, published by Central Statistical Office of Poland and Centrum AMRON-SARFiN. Data will be aggregated for voivodeships and quarters, and concern 2010-2019 period. Chosen time frame is long enough to be able to draw important conclusions but excludes external factors such as COVID-19 pandemic or global financial crisis. Quarterly and voivodeships-level data provide a large enough sample for model. Additionally, more specific data is not publicly available.

The main literature used are scientific papers that verify house prices determinants empirically. The one which is base one is paper "*Is there a Bubble in the Housing Market?*" by Case & Shiller. They concern real estate markets in biggest Western countries, Central and

[1] Augustyniak, H., Łaszek, J., Olszewski , K., & Waszczuk, J., 2014. Modelling of cycles in the residential real estate market – interactions between the primary and the secondary market and multiplier effects. Kwartalnik Nauk o Przedsiębiorstwie 2/2014 (31).
[2] Wages and salaries Data. Central Statistical Office of Poland. Warsaw, July 2020.
[3] Distribution of population by tenure status, type of household and income group., 2021. Eurostat. Luxemburg, June 2021.

Eastern European countries and solely in Poland. Rest of used literature covers theoretical concepts that influence real properties.

The research paper is structured into four sections: Section 2 is a comprehensive overlook of both global and polish real estate markets. Markets will be described in detail in both qualitative and quantitative ways. Section 3 deep analysis of literature is conducted. Authors attempts to find, describe and explain the whole set of factors possibly influencing the real estate market. Sector 4 is based on a practical study. At first, dataset used for estimating is described and choice of specific variables is justified. Then, descriptive statistics of the sample are provided. Additionally, scatter plots and Pearson's correlation coefficients between variables are presented. Next section is devoted to describing a process of choosing estimation method and presenting appropriate regression. Finally, results of econometric study are presented. The final section consists of conclusions.

2. General outlook of real estate market

Real estate market is important part of economy. One of the most quickly growing industry is construction businness. It is estimated that solely this sector constituted around 6,3% of world GDP[4] in 2019. Obviously there exist plenty of other sectors, directly or indirectly related to real properties.

Maslow stated that having a shelter is one of the most important human needs.[5] The situation on real estate market affects to a greater or lesser extent, life of every person. Market condition detoriation results in change of affordability of houses for potential buyers, but also switch of situation of homeowners. This eventually proceeds to changes of consumption. Hence, real estates are important not only from point of view of construction and manufacturing industries, as well as financial and retail markets. Every central bank and government needs to monitor situation and react accordingly, creating adequate monetary and fiscal policies.

The role of regulators about real estate market is crucial. The specifics of the market, such as high capital intensity, rigidity of supply and time lags, make macroeconomic imbalance easy to emerge. Sudden changes of housing prices lead to severe consequences for the whole economy. Example of such is a global financial crisis of 2007-2009. It started with excessive lending by banks in the United States, that was the main reason of shooting up of house prices

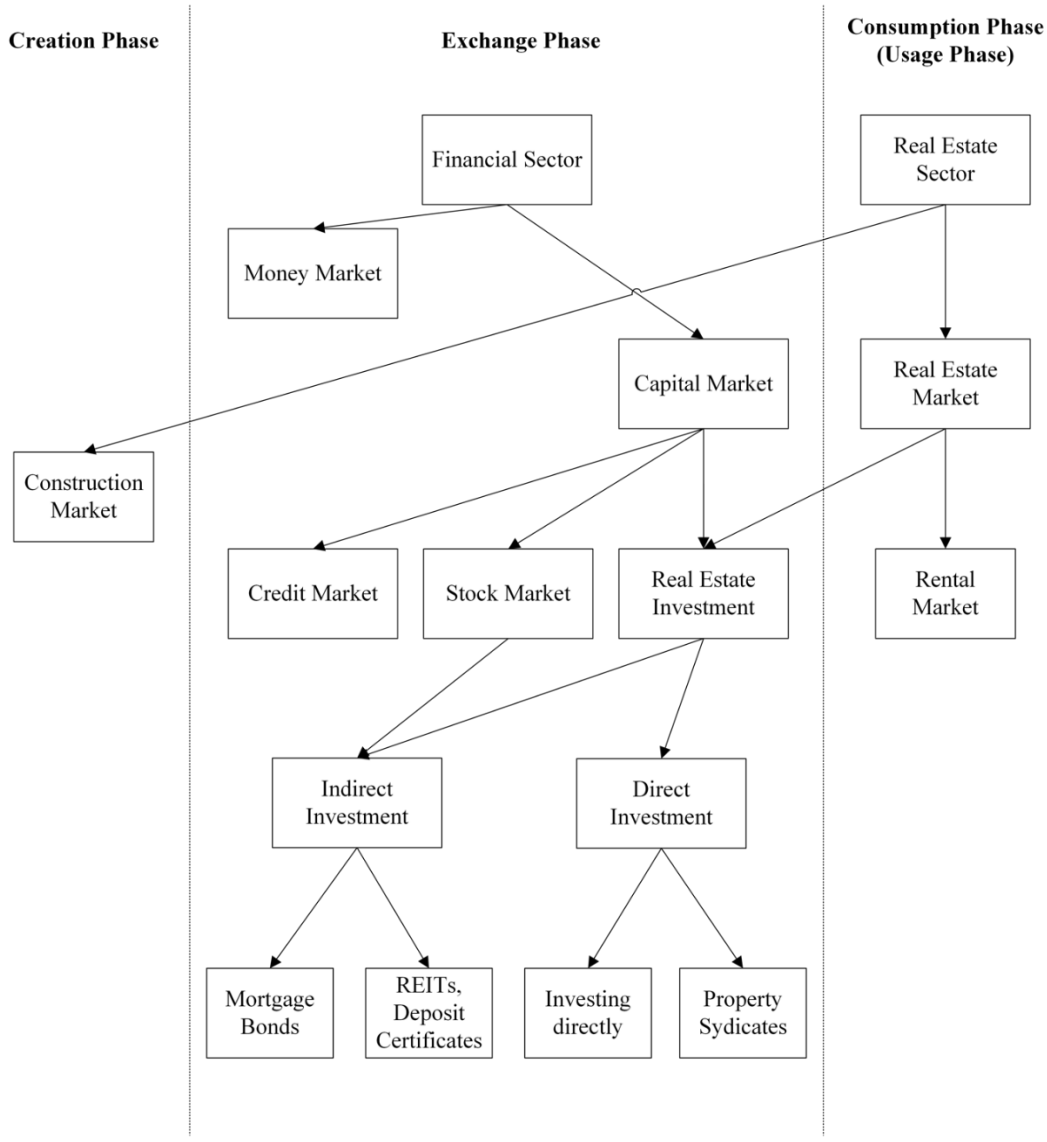
[4] Own calculations, based on:
UNECE., 2021. Share of construction in GDP. 2019. On line. Date of access: June 1 2021. https://w3.unece.org/PXWeb/en/Table?IndicatorCode=8#

[5] Maslow, A. H., 1943. A theory of human motivation. Psychological Review, 50(4), 370–396.

there. Self-perpetuating mechanism of rise of lending activities and growth of real estate prices eventually ended up with drastic declines of values of credit collaterals – real properties. As a consequence, millions of borrowers defaulted and therefore exposed big financial institutions to risk of going bankrupt. Even though governments tried to mitigate negative effects of U.S. financial crisis, it was the main cause of widespread global recession and Eurozone crisis.

One could summarize the above considerations with one sentence: real estate market is important. But what is its place in economy? As there are many interactions between housing-related market, how to organize them formally? Interesting division was presented by Kucharska – Stasiak[6]:

Graph 1. Division of real estate market and its place in economy



Source: Own study, based on: Kucharska-Stasiak E. Nieruchomość w gospodarce rynkowej. Wydawnictwo Naukowe PWN. Warszawa 2006

[6] Kucharska – Stasiak E., 2006. Nieruchomość w gospodarce rynkowej. Wydawnictwo Naukowe PWN. Warszawa

On the graph the division of real estate sector into construction market and real estate market can be seen. The first one consists of entities that construct real properties, excluding other engineering projects. Construction market includes new work, additions, alterations, maintenance, and repairs.[7] Real estate market consists of rental market and real estate investment market. Rental market is important part of real estate sector. It is also called consumption market, because includes owners' imputed rents, as well as utility payments. In 2019, rental market accounted for approximately 13% of the United States' GDP[8]. Moving further, real estate investment market positions itself between money and capital markets. It is reasonable, as all of them are characterized by strong desire of investors to achieve profits. Two types of real estate investing can be distinguished: direct and indirect. The first one is simply buying a land, building or appartment in order to obtain profit, usually by renting it or selling later for higher price. Another way to invest directly in real estate is to enter into property sydication– group of investors created to purchase and manage commercial real estates. They can be structured as corporations or limited partnerships. In the latter case, the investor is limited partner, who is liable only to the amount he invested.

Indirect investments in real estates are slightly more complicated. Many types of them can be distinguished. First are the mortgage bonds, fixed income instruments that represent a loan made by an investor to bank. By creating such tools, institutions can finance their operations and new projects. On the other hand, investors buy mortgage bonds because they are undoubtedly safe, as bondholder gains bank's right to collateral. Hence, in case of delinquency or default of mortgage borrower, he has the right to sell underlying asset and retrieve invested money. Because of low risk of such investment, this kind of bond offers lower rate of return than corporate bonds.

Another type relies on investing in real estate investment trust – joint-stock companies that own and rent commercial properties. Two main types of REITs can be distinguished: funds investing in property or funds providing real estate financing. Certificate of Deposit works on a similar principle – they are used by financial institution to raise equity. Collected funds can be used to increase lending or liquidity.

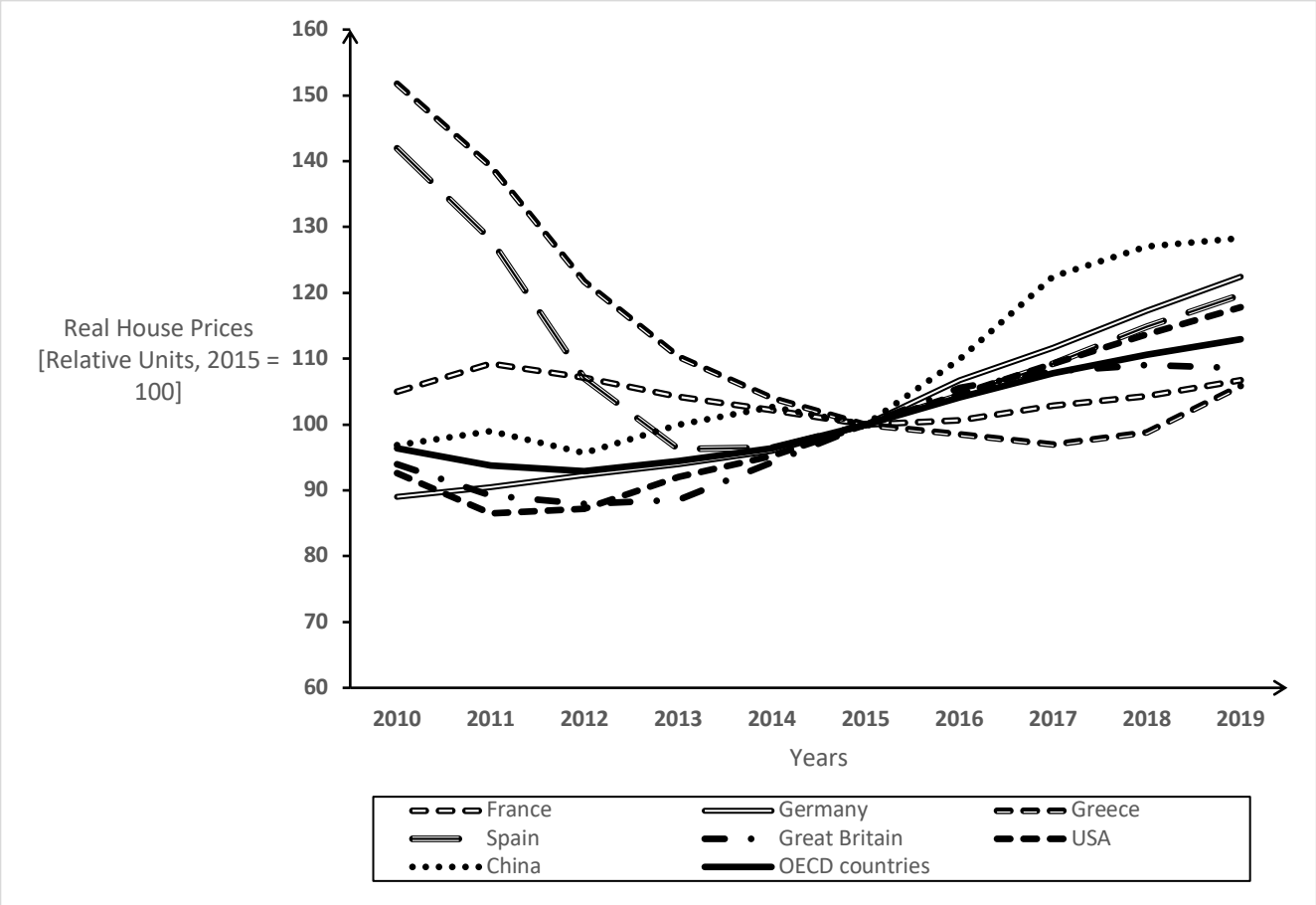
[7] The Business Research Company., 2020. Construction Global Market Opportunities and Strategies. London, July 2020.

[8] Own calculations based on:
U.S. Bureau of Economic Analysis. Personal consumption expenditures: Services: Housing and utilities [DHUTRC1Q027SBEA]. Retrieved from FRED, Federal Reserve Bank of St. Louis. On line. Date of access: June 1 2021. https://fred.stlouisfed.org/series/DHUTRC1Q027SBEA

2.1. Global real estate market

Prices of houses depend on many determinants. How house prices have been changing across time in selected coutries is an interesting topic.

Graph 2. Real House Prices in 8 chosen areas in 2010-2019 period



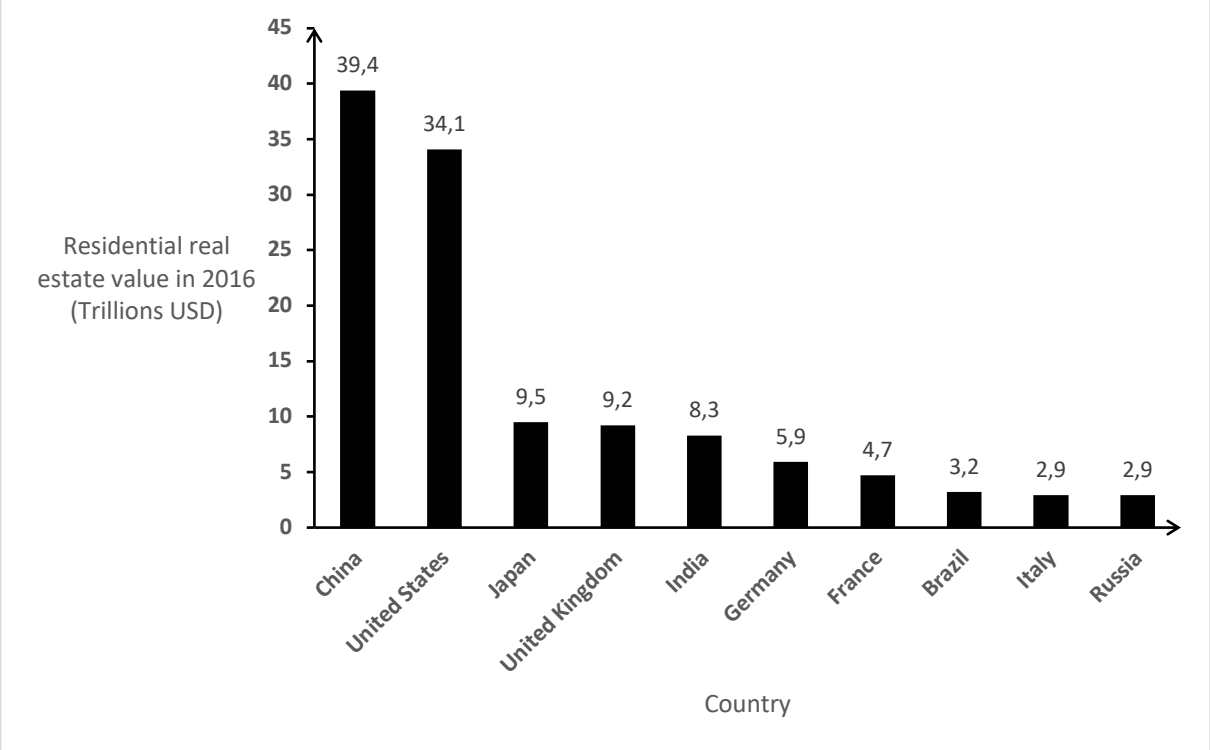
Source: Own study, based on: OECD Data. Housing prices Indicator. 2021 On line. Date of access: June 1 2021 https://data.oecd.org/price/housing-prices.htm

Graph 2 depicts changes in house prices expressed in real terms (meaning adjusted for inflation), taking 2015 as a base year. In Spain and Greece plunging of relative prices before 2015 can be observed. In other countries prices have been climbing steadily in that period, excluding France. After base year, 2015, growing trend continued, except for Greece. In this country values from 2015 could be observed until after 4 years. The most important remark is illustrated by the shape of black line. In 2010 – 2019 period there occurred a moderate, stable upward trend of average house prices among OECD countries[9].

[9] Organisation for Economic Co-operation and Development, comprising 37 member countries.

Another interesting question is about the *biggest players* on global real estate market. Graph 3 shows the top 10 countries by residential real estate value:

Graph 3. Top 10 countries by residential real estate value in 2016



Source: Own study, based on: Tostevin P. The 10 most valuable real estate markets in the world. The Savills Blog. On line. Date of access: June 1 2021. https://www.savills.com/blog/article/219340/international-property/the-10-most-valuable-real-estate-markets-in-the-world.aspx

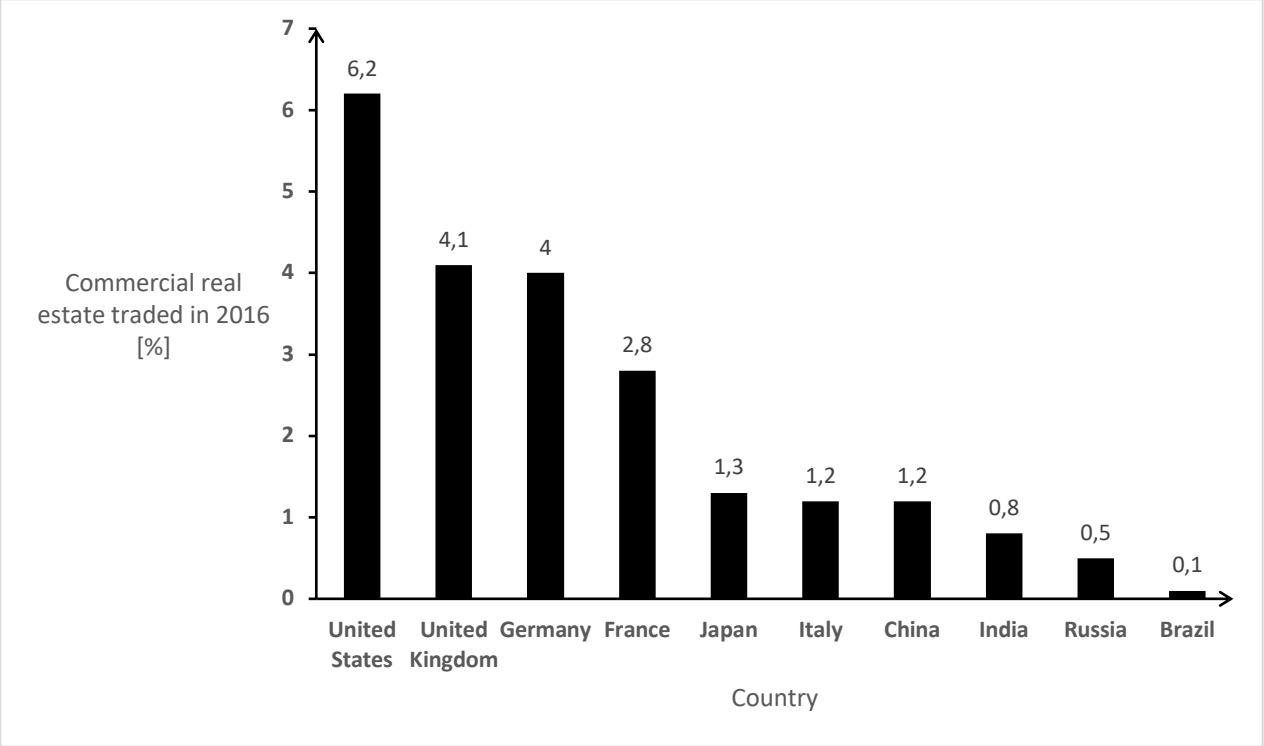
Market of China alone is worth 23.4% of all global residential real estate value[10]. The U.S. is just behind, with market share lower by 3 percentage points. In next 8 countries, residential real properties are worth 46,6 trillion american dollars in total, which constitutes 27.7% of global market. Interestingly, rest of the world consitutes merely 28% of global real estate market.

Another important market characteristic is its liquiditity. Some investors may put emphasis on this matter, as it makes the investment more likely to sell in shorter period of time on investor's demand. Lack of liquidity on the market can result in serious problems for him, including default. Obviously, professional investors choose commercial properties much more

[10] Assuming global residential real estate market is worth 168.5 trillions USD, according to Savills World Research: Tostevin P., 2021. The 10 most valuable real estate markets in the world. The Savills Blog. On line. Date of access: June 1 2021. https://www.savills.com/blog/article/219340/international-property/the-10-most-valuable-real-estate-markets-in-the-world.aspx

often than residential real estate. Therefore, graph 4 shows percentage of commercial real estate traded in 2016.

Graph 4. Percentage of commercial real estate traded in 2016



Source: Own study, based on: Tostevin P. The 10 most valuable real estate markets in the world. The Savills Blog. On line. Date of access: June 1 2021. https://www.savills.com/blog/article/219340/international-property/the-10-most-valuable-real-estate-markets-in-the-world.aspx

As can be seen, United States market is the most investible. Liquid markets, as in United Kingdom, Germany and France, attract more international investors. On the other hand, although size of Chinese market is tremendous, it is illiquid and thus can be percieved as non-attractive for international investors. The lowest rates are observable in India, Russia and Brazil, which means poor economic climate in these countries.

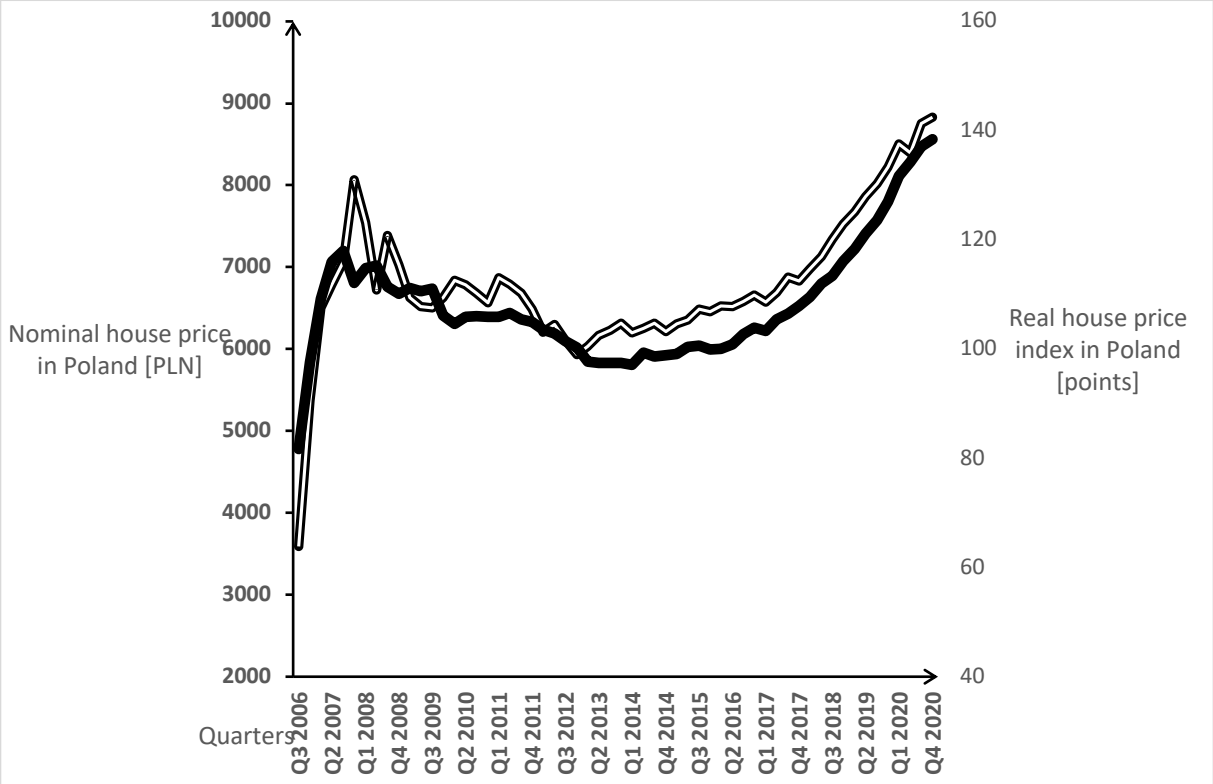
From mentioned above statistics it can be concluded that global leader in terms of real properties is the United States. It has the biggest real property market worldwide, with remarkable levels of liquidity. Additionally, real estate related transactions represents big share of U.S. gross domestic product. Therefore, there is no surprise that the whole american economy reacts strongly to any changes of conditions on real estate market. This conjecture can be proven by existing literature. The economic downturn, in pair with crisis on real estate market can lead

to significant deepening of recession[11]. Eventually, the financial sector is strongly conditioned by real estate sector.

2.2. Polish real estate market

This section is devoted to characterize in detail real property market in Poland. First, examination of changes of prices of residential real properties in 2006-2020 period will be conducted.

Graph 5. Nominal and real prices of residential real estate in Poland in period 2006-2020



Source: Own study, based on:
Nominal house prices: Narodowy Bank Polski House Prices Database. On line. Date of access: June 1 2021. https://www.nbp.pl/homen.aspx?f=/en/publikacje/inne/real_estate_market_q.html
Real house prices: European Central Bank Residential Property Prices Database. On line. Date of access: June 1 2021.
https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=429.RESR.A.PL._T.N._TR.TVAL.4D0.TB.N.IX

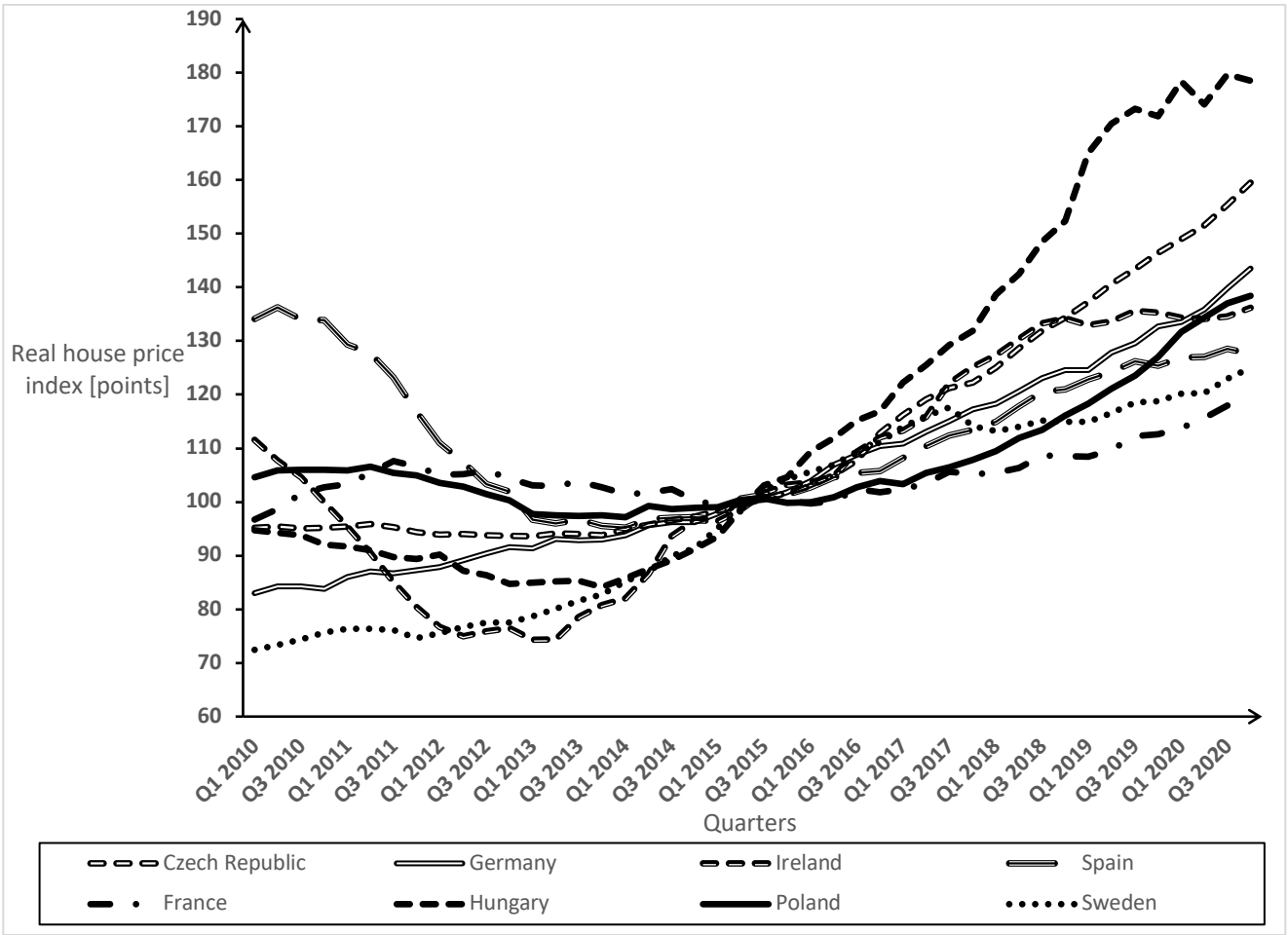
Double line represents house prices in nominal terms. These can be read from left horizontal axis. Black line depicts real house prices index, where value equal to 100 is fixed for 2015. Real values can be seen to the right of chart. Prices shot up between third quarter of 2006

[11] Agnello L., 2009. Schuknecht L. Booms and Bust in Housing Markets: Determinants and Implications. ECB Working Paper Series. No 1071.

and end of 2007 can be seen. As expected, lower volatily could be observed in terms of real values. On the turn of 2007 and 2008 the highest values of nominal prices were achieved. Since then, both nominal and real house prices followed a moderate decreasing trend until second quarter of 2013, when they started to go in opposite direction. Interesting change could be observable in 2017, when increasing trend became significantly stronger. Such a state of things led to solid increase of prices. At the end of 2020, average house price was 8830 PLN per 1 sqm. It consitutes 38 percent more than in 2015, adjusted for inflation.

Authors believes it could be worth to collate prices on polish market with other national markets. To examine it, please look at graph 6.

Graph 6. Real prices of residential real properties in eight chosen countries in period 2010-2020



Source: Own study, based on: Eurostat. House price index – quarterly data. 2021 On line. Date of access: June 1 2021. https://data.oecd.org/price/housing-prices.htm

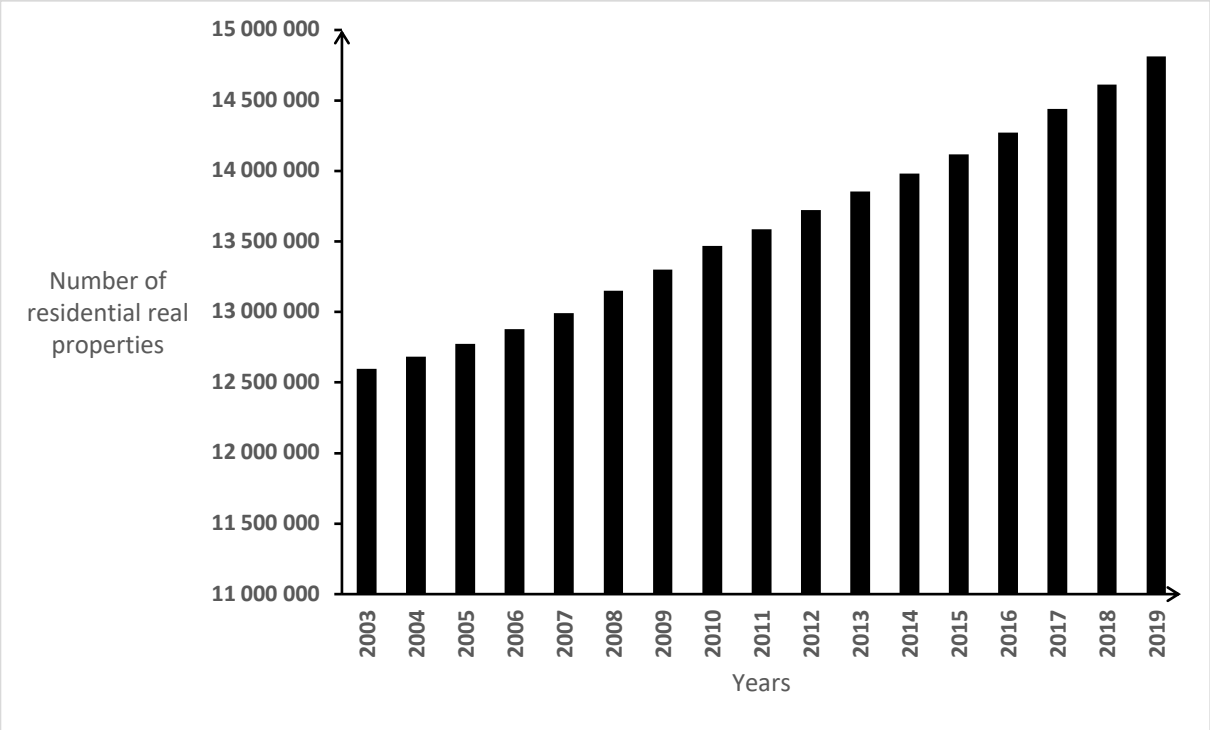
On the graph there is a comparison of real prices of houses in eight chosen european countries, including Poland. With the bare eye important conclusions can be drawn. First, the

general trends were similar. Until 2015, levels of prices of real estates were generally rising, exluding Hungary and Spain. Polish real prices were quite stable as compared to other countries.

Second, after 2015 all prices started to increase on unprecented scale. The leader was Hungary – with increases almost as large as 80 percent, comparing to 2015. More rapid increases were noted in Poland after 2017, as stated above. However, it can be observed they are relatively not tremendous. In comparison with other countries Poland is in middle-sector if it comes to price increases in 2015-2020 period.

Having learned about changes of prices of immoveables, quantitive changes present on polish market can be described. First important statistics represents overall number of housing resources in Poland.

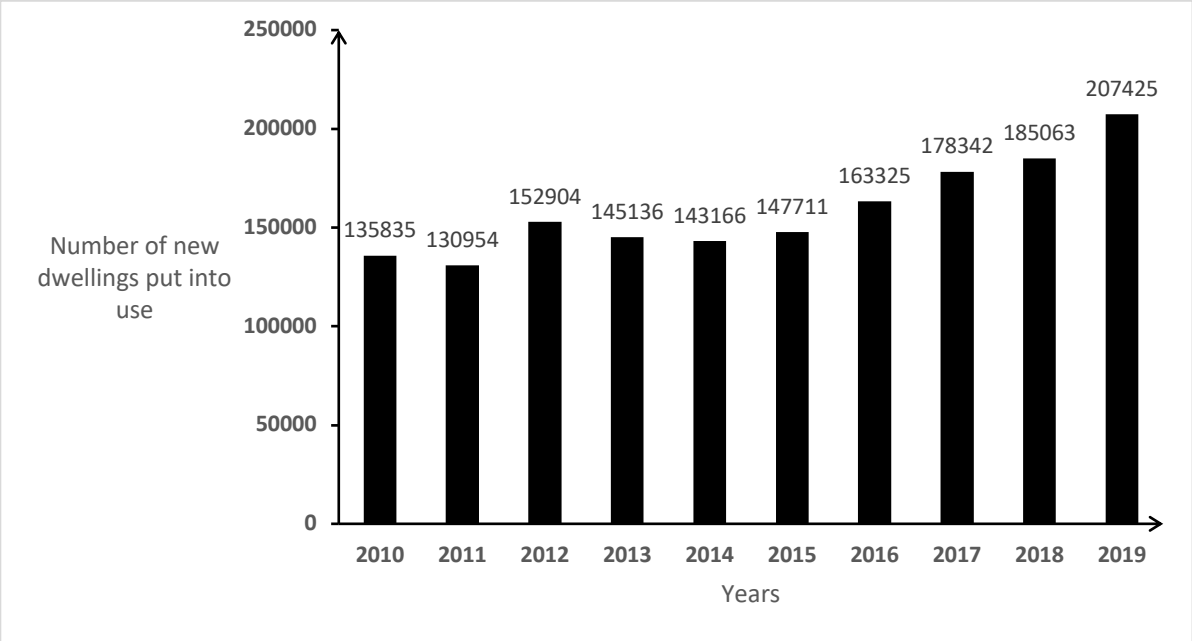
Graph 7. Overall number of residential real properties in Poland in period 2003-2019



Source: Own study, based on: GUS. Housing construction in the period I-XII. 2003-2019.

Number of houses in Poland was systematically rising for the whole analyzed period. Additionally, it seems like in most recent years more and more real properties were putting into use. It denotes rising power of real estate sector. Graph 8 can be used to check it in details.

Graph 8. Number of new residential real properties in specific year in Poland in 2010-2019 period



Source: Own study, based on: GUS. Housing construction in the period I-XII. 2003-2019.

It can be observed that, indeed, rising number of new dwellings have been put into use since 2015. All-time maximum was reached in 2019, when more than 207 thousands of new houses were made ready to use. The average size of polish apartments correlates with growing number of new dwellings. The specific values can be observed in table 1.

Table 1. Average useful floor area of a dwelling and of a dwelling per 1 person in Poland in 2004-2019 period

No.	Name of parameter	Values of the parameters of asessment [square meters] in years															
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1.	Average useful floor area of a dwelling	69	69,3	69,5	69,8	70,2	71	72,3	72,6	72,8	73,1	73,4	73,6	73,8	74	74,2	74,4
2.	Average useful floor area of a dwelling per 1 person	22,9	23,2	23,5	23,8	24,2	25	25,3	25,6	25,9	26,3	26,7	27	27,4	27,8	28,2	28,7

Source: Own study, based on: GUS. Housing Economy and Municipal Infrastructure: Dwelling Stocks Indicators. 2004-2019.

During the whole analyzed presented period, both average size of house and average floor area per person have been increasing. Average house got bigger by 5.4 sqm. Statistics about floor area per 1 person improved even to a greater extent. It changed from almost 23 sqm in 2004 to almost 29 in 2019. One should not be too optimistic, however. It is possible that main reason is miserably low level of population growth in Poland[12].

3. Determinants of house prices

Modern economics states that the price of goods traded on the free market self-regulate. It is a very intuitive process – as can be read in freshmens' textbook from Microeconomics, "*Prices adjust until the amount that people demand of something is equal to the amount that is supplied."*[13] Obviously, in the case of this paper, *something* is residential real estate. The concept is really simple, but as usual in economic sciences, it will be very much developed and become more complicated in further parts of the paper.

Continuing, the final (equilibrium) price adjusts to equal demand and supply. Therefore the role of this section is obtained: investigate the determinants of demand and supply and therefore discover the possible reasons for changes in house prices. In next section empirical verification will be conducted. Two groups of factors that can have an impact on both housing demand and supply can be distinguished: a group of internal factors and a group of external factors. All factors that describe the individual, specific good as location, area, state of the building, standard of interior design etc. are perceived as internal and are not in the interest of this paper. The authors focuses solely on external factors, which can be defined as the broad scope of macroeconomic, demographical, financial and other factors. This section aims to find and describe possible determinants of house prices based on existing literature.

House price determinants are spitted into two categories. In the first part all non-financial determinants will be described then analysis of financial factors is going to be conducted.

3.1. Non-financial determinants of house prices

Income, housing stock and demography factors can be considered as the most probable drivers of house prices (Muellbauer and Murphy, 2008). Mentioned determinants are included in the

[12] Nawrocka E., 2011. Obszary wzajemnego oddziaływania rynku mieszkaniowego i gospodarki rynkowej. Prace i Materiały Wydziału Zarządzania Uniwersytetu Gdańskiego. 4/8: 167-176.
[13] Varian H. R., 2014. Intermediate Microeconomics: a Modern Approach. Norton & Company. New York

vast majority of econometrics studies trying to forecast house prices (Brown et al., 1997; Wei and Cao, 2017; Bork and Møller, 2015, Palacin and Shelburne, 2005). Income impact is usually analyzed as first.

Income

The first chosen elaboration concerning the relationship between personal income and house prices is the paper written in 2003 by Karl E. Case and Robert J. Shiller. The authors tried to find the justification for house price bubble theories, which were then frequently raised by American media. It was done by analyzing the steadiness of the relationship between home prices and determinants of prices, with a focus on income. For this purpose, the quarterly data covering all U.S. states for the 1985 – 2002 period was collected and analyzed. The findings were as following: for the seven states, where prices have been least volatile, the stability of the relationship between prices and personal income was, as the authors stated, remarkable. Moreover, the explanatory power of income was up to ninety-nine percent of the house price variation. On the other hand, this relationship in most volatile states was found to be very unstable. Only 45% of the data was found to fit the regression. The authors concluded that increases of real properties prices in the vast majority of U.S. States could be explained almost completely by personal income alone.

Vizek used cointegration and error-correction models to detect the short-run and long-run relationships between house prices and price fundamentals, including income. Based on analysis of 1995 – 2009 data from four post-transition and three developed EU countries, the author concluded that there is a long-run cointegration relationship between house prices and both income and interest rate. Nonetheless, in the case of all post-transition countries, the income could be excluded from the model, not causing any serious worsening of the model quality. For the record, Poland was considered as post-transition country.

Another empirical study for eight post-transition countries including Poland was conducted by Egert and Mihaljek. Additionally, the authors collected data from 19 developed OECD countries for comparison. They obtained strong positive relationships between GDP per capita and house prices. Also, the interest rates, mortgage growth, demographic factors and the development of housing finance were identified as important house price determinants.

The hypothesis of the relevance of income as a house price driver had been confirmed in a large number of other studies for different countries. Sutton (2002) concluded that the income to a great extent is positively correlated with house price level in six developed countries, same

was done for Ireland (McQuinn and O'Reilly, 2008), for Australia and U.S.A. (Posedel and Vizek, 2010) and for Spain (Pagés and Maza, 2003).

The price determinants specifically in Poland was investigated by Leszczyński and Olszewski in 2017. They analyzed annual data for the 2002 – 2015 period for the 17 biggest cities in Poland and reached the conclusion that property prices do depend on fundamental variables such as wages, the rate of unemployment and the real interest rate. In terms of further parts of this paper, there was an interesting finding: the prices in the secondary market react significantly more strongly than the primary market prices, as a consequence of changes of mentioned determinants. The authors suggest that it may be due to the fact that, usually, completely different groups of people buy properties on those markets. The secondary market, in all likelihood, is picked by first-time buyers as it is cheaper than the primary market. Thus, it is expected that the primary market reacts less to economic fundamentals, and the secondary – the opposite.

On the other hand, there exist papers denying that income can be perceived as a house price driver. Wei and Cao tried to use the dynamic model averaging method to predict changes in house prices for thirty Chinese cities. The tested determinants were growth rates of consumer price index, gross domestic product, investment in real estate market, real disposable income, unemployment and also the financial determinants. It turned out that over a 30-years period none of the determinants was superior to any other. The authors concluded that the Google search index has a bigger explanatory ability of house prices than any traditional macroeconomic variable.

A similar view was presented by Gallin in the paper checking long-run relationship between house prices and income. Based on 23-years period data for the United States, the author did not find evidence for the existence of cointegration between mentioned variables. He underlined the meaning of that finding: income perhaps is determinant of house prices, but there is no evidence about the strict association of the level of house prices and the level of income. Likewise, Drachmal tried to analyze the determinants of the increase of house prices in Poland. In conclusions, where he listed the determinants of house prices, he omitted the income.

To conclude, majority of numerous studies confirms that an increase in personal income, household income or gross domestic product per capita results in increase of residential real estate prices. Such link is very intuitive. In the author's opinion, the relationship shall be based on the fact that demand for property, to a considerable extent, depends on the amount of disposable income. Moreover, real estates are normal goods, as the demand for them increases

due to a rise in consumers' income. Thus, increase in average personal income leads to higher house demand, ceteris paribus, driving up the level of house prices. Income variable is going to be included in regression model, analyzed in next section.

Rate of return

Another important and intuitive house price driver is a rate of return. Buying a house or flat certainly can be perceived as the start of a new investment, no matter if it is the investor's first real estate bought for housing purposes or umpteenth small apartment for rent. Therefore, most topic related papers do acknowledge the rate of return as a major house price driver.
But how to define the rate of return? The broad scope of the literature, again, is helpful, but first the determinants need to be predefined, just to keep this paper neatly presented. Generally, the rate of return could be divided into two groups. First is the capital gain (or loss) on immovable. Simply, it is the change of asset price due to the changes in the appraised value of a property. The second group are the determinants of user cost. This category consists of various components, depending on the paper.

Literature overview shows, two different approaches to analyzing the rate of return can be found. Some authors treat capital gains described above as separate from user costs. (Muellbauer and Murphy, 2008; Hort, 1998). Thus, in these papers, there is no possibility of positive user costs in case of house price appreciation on a decent level, in the sense of exceeding the total user costs. The opposite is for papers that qualify capital gains as a part of the user cost (Gallin, 2003; Case, 2004). Regardless of the approach to the determinant allocation, all mentioned above papers recognize capital gains or losses as an important factor of prices of houses. The reasoning behind this, however, varies a lot. The most obvious component of the capital gain is a change in the price of real estate. The market value of the flat increases, resulting in the profit for the owner if he decides to sell the property. There is also second, more interesting component: price persistence. It can increase the expectation of capital gains on a macro scale.

Simply put, price persistence is the tendency of a price to continue moving in its present direction. According to this phenomenon, assuming the house prices in Poland have been consistently growing for the last 5 years, there exists a high probability the prices will continue to grow. The concept is much proved by existing articles. For example, Terrones in 2004 analyzed the sample of 18 countries during 1971-2004 and confirmed the high persistence of

real house prices. Similarly, Hort[14] showed this phenomenon to occur in the housing market of Sweden in the period 1967-1994. Sutton in 2017 described the house price persistent as *striking*. It is difficult not to agree with him as 85% of analyzed advanced economies had been experiencing nominal house price growth by on an average of at least 6% yearly for forty to fifty years. Interesting conclusions can be drawn if collate price persistence concept with the price bubble theory. "*A tendency to view housing as an investment is a defining characteristic of a housing bubble."*[15] Logical conjecture is that widespread consideration of the housing market as profit-bearing may constitute robust encouragement for investing in residential real estate. Obviously, it can directly lead to strong increases of prices on real estate market. What is more, the price persistence will likely ensure buyers about very little risk of such investment, thus encouraging them to invest larger amounts. Additionally, there can exist a group of first-time buyers, worried about the rapid increase in prices. As a consequence, they can be forced to buy the property immediately, as in later time, possibly, they will not be able to afford it. Taking into account this group, the straightforward recipe for rapid price increase is obtained. In turn, exponential rise of prices is the main condition for price bubble.

The important part of the housing rate of return is the user cost. Mentioned above literature use different factors to define it. The most important is the mortgage or the opportunity cost, as the homeowner had to forgo some alternative investment. It well to notice the fundamentals of the relationship. Unsurprisingly, the cheaper the mortgage, the more likely the consumer will buy the house. (Sutton, 2002) Also, the better the availability of the mortgage, the more consumers will get a credit and more flats will be sold. What does it make the mortgage cheap and what are the determinants of mortgage availability? Concepts are going to be deeply developed in the next section.

The real estates are assets that deteriorate over time, thus losing value. With time the roof gets leaky, the plaster is coming off the wall and the heating system gets less and less effective. The totality of this kind of processes is called depreciation. Many studies recognize depreciation as user cost (Brown, 2007; Case, 2003; Gallin, 2003; Hort, 1998). To prevent a property from decreases in value, one ought to bear the cost of its maintenance and repairs. If it becomes more expensive, as the prices of construction materials grow or it becomes more difficult to hire a worker, the user cost grows. As a consequence, the demand for properties becomes smaller.

[14] Hort K., 1998. The determinants of urban house price fluctuations in Sweden 1968-1994. Journal of Housing Economics, 7, 93-120.
[15] Case K. E. & Shiller R. J., 2004. Is there a Bubble in the Housing Market? Yale University Paper no. 1089. Connecticut

The key takeaway is the following: the larger the depreciation, the higher the construction costs and eventually the lower the demand for real properties.

Last but not least, property taxation affects user cost. It can be defined as a compulsory financial charge imposed on the owner of real estate. The literature authors agree that there exists a positive correlation between property tax rate and user cost, and thus a negative correlation between taxation and housing demand (Muellbauer and Murphy, 2008; Andre, 2016; Hort, 1998; Gallin, 2003; Case, 2003; Brown et al., 1997). In Poland, there are two major taxes. The new homeowner is faced with a tax on a civil law transaction. It needs to be paid by the buyer of real estate on the secondary market and is equal to two percent of the transaction price. Additionally, every homeowner needs to pay property tax every year. The tax value constitutes on average less than 0.015%[16] of the property value. Because both tax rates had been constant in the 2010-2019 period, it will be omitted in further parts of the paper.[17]

Logical conjecture is that all mentioned components of rate of return were approximately constant over analyzed period. On the other hand, it turned out difficult task to find trustworthy estimates of user cost and price persistence. Hence, both factors are going to be omitted in next section of paper. Such a simplification will not affect the quality of the findings of the paper, but will allow formulating important conclusions in a neat and achievable way.

Demographic factors

Common sense tells that demographic factors impact house prices. The more the people, the bigger the demand for houses. This logical conjecture seems to be proved by existing literature. The majority of topic-related literature qualifies demographic factors as a house price driver. Drachmal concluded that the cumulation of demographic and socio-cultural factors, such as rural-urban migration, growing number of marriages, economic transformation and convergence, are the most important price drivers.

The important conclusions were drawn by Heiborn. He stated that the housing demand depends on population age and, additionally, is the highest among the 25-44 years old group. Similarly, Mankiw and Weil (1989) found the entry of the Baby Boom generation into its house-buying years to be the significant reason for the increase in prices of real estates in the 1970s in the United States. On the other hand, the authors predicted the substantial fall of housing prices

[16] Own calculations based on: Główny Urząd Statystyczny. Real Estate Sales in 2019. Warsaw 2020
Ministry of Finance, the maximum amount of the real estate tax rate in 2019. Warsaw 2019

[17] The maximum amount of the real estate tax rate is announced every year by Minister of Finance. Values announced in period 2010 – 2019 did not vary much.

over the period 1990 – 2010. In reality, the average real price of real estate grew up by 25% at that time.[18] One should notice an extremely important fact – the knowledge about the existence of the cause-effect relationship does not necessarily imply the ability to model the relationship and to reliably measure the strength of the relationship. Mankiw and Weil found that it was the case of the demography-house prices relationship. The fact of the complexity of demographic factors drivers, compounded by their potential interactions, makes this relationship challenging to deal with.

Additionally, Leszczyński and Olszewski in empirical research regarding Poland listed demographic aspects as one of house price driver but decided to exclude all of them from regressions. The reason was that factors did not show enough variation to affect the regression to a sufficient degree, based on 2002-2015 data.

Above mentioned facts about the complexity of the demography-house price relationship could make empirical model too complicated. Hence, finding a reliable estimator of demography factors was important task. The most logical choice was to estimate this variable with the number of new marriages in 2010-2019 period in Poland. Usually just after the wedding new couples try to buy their own place to live in. Undoubtedly it is a bit of simplification but still the reasonable way to estimate influence of complicated demography factors.

Supply

At the end the latter determinant "supply" should be described. Posedel and Vizek (2009) used the multiple regression and SVAR models to analyze real estate price drivers in three EU-15 countries and, separately, in three Eastern European countries. Poland was assigned to the latter group. The authors found that in both groups of countries the supply was fixed. It means that no supply-side factor determined residential real estate price in the short-run.

Sutton stated that the supply is mainly defined by five main determinants: the price of land, construction costs, credit costs, supply restrictions and the price of houses. He considered the supply-side variables as difficult to obtain and did not include them into analysis. Additionally, Muaellbauer and Murphy listed zoning and building regulations as main supply determinants.

[18] Own calculations based on: U.S. Bank for International Settlements., 2021. Real Residential Property Prices for United States [QUSR628BIS]. Retrieved from FRED, Federal Reserve Bank of St. Louis. On line. Date of access: June 1, 2021. https://fred.stlouisfed.org/series/QUSR628BIS.

In turn, Marcin Wagner wrote that only in the long run the supply adapts to the changes of the demand. Thus, one could deduct that in the short-run supply is constant. Therefore, the findings of Case about inelasticity supply in the short run can be treated as synonymous.

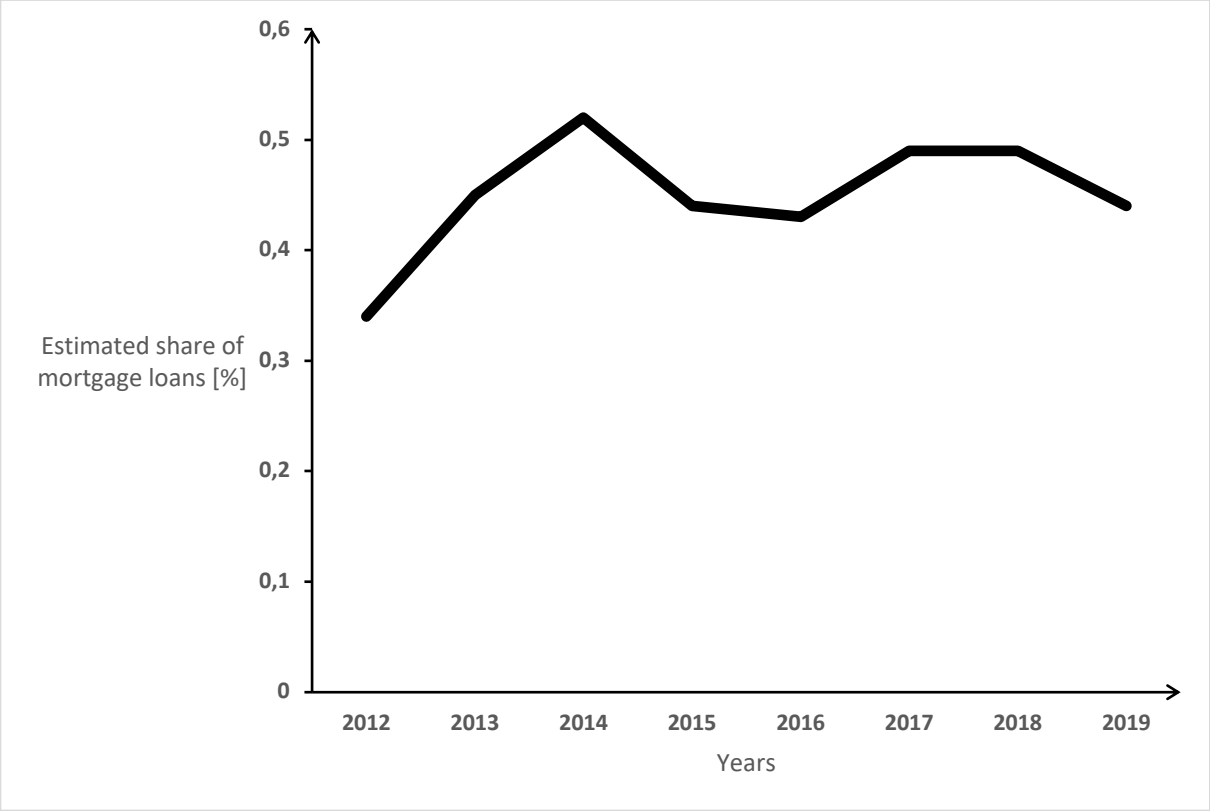
There is an issue with the limited supply of housing in central and eastern Europe countries, Egert and Mihaljek stated. Due to the transition processes of these countries, they experienced a significant housing gap per 1000 inhabitants. Because of the magnitude of shortages, even the newest, historically the highest levels of new dwelling construction have not changed the situation yet. Leszczyński and Olszewski in 2017 obtained results that confirm this theory. The authors did not have grounds to reject the hypothesis that "*the housing stock in Poland is insufficient to satisfy the growing housing needs, new supply is still not able to lower prices on both (primary and secondary) housing markets."* Based on that, the author found the supply of residential real estates in Poland is at a constant level both in the short-run and long-run and is inelastic.

Similarly to demography, supply is complicated, multiperspective factor that affect prices of real estates. The only way to include it in econometric model is to find adequate and relatable estimator of it. In the next section, assumption that supply can be estimated by number of square meters of residential real estates put into use will be made. Additionally, it can be very informative to include in the model variable indicating the cost of construction. Positive correlation between construction cost and house price is expected.

3.2. Financial determinants of house prices

One of the most importatnt determinants in real estate market are financial factors. This fact is supported both by the existing literature (Bernanke and Gertler, 1989; Muaellbauer, 2008; Terrones, 2004; Valverde and Fernandez, 2010; Sutton, 2002; Case, 2003; Egert and Mihaljek, 2008; Posedel and Vizek, 2009; Vizek, 2010; Główka, 2016; and other) and data. Please look at the graph 9.

Graph 9. Estimated share of the value of transactions financed by a mortgage loan in the total value of transactions on residential real estate market in Poland in 2012-2019 period



Source: Own study, based on: NBP. Information on housing prices and the situation on the residential and commercial real estate markets in Poland in first quarter 2012 – fourth quarter of 2019. 2012-2019

The graph depicts the estimated share of the value of transactions financed by a mortgage loan in the total value of transactions. The estimations apply only to the primary real estate market in the seven biggest cities in Poland for the 2012 – 2019 period. As can be observed, the share of credited transactions fluctuates between 25% in the fourth quarter of 2017 and 52% in the third quarter 2012, and the mean value for the presented period is equal to 37%.

Data does not take into account the purchasing processes on the secondary real estate market because of the difficulty or even impossibility of acquiring such information. Nevertheless, primary market data are a great way to show the collateral relationship between credit market and real estate market. What is more, existing literature proves that the share of credited transactions on the secondary market is at least as big as on the primary market. Leszczyński and Olszewski suggest that, with high probability, the first-time buyers who do need a mortgage to buy a house, choose a secondary market. The reason is the lower mean price of real estate on secondary than on primary market[19]. On the other hand, residential real estate

[19] Główny Urząd Statystyczny., 2020. Real Estate Sales in 2019. Warsaw

investors, who are in possession of big amounts of cash and does not need external financing most often choose the apartments from the primary market. Another argument why financial determinants should be analyzed is the growing number of mortgages. In the 2016-19 period, the number of active mortgage contracts increased by 16.1%, and in the period 2012-2019 – almost by 38% [20].

3.3. Important aspects of mortgage loans

Mortgage, as concluded above, is the most often used source of financing purchase of a dwelling excluding cash. It is not surprising, as mortgages are accessible to a big share of working people and often also are their only possibility to possess their own apartment. In the case of a mortgage loan, the borrower gets the amount of cash agreed with the bank, to finance the purchase of house. On the other hand, one ought to remember that bank is not a charity institution, and their business goal is achieving as big profit as possible. Therefore, the borrower has to give back the bank's money and some extra. It is done in small portions (as compared to the value of a mortgage) regularly, according to a previously agreed schedule.

The conditions of repayment are fixed in detail in the mortgage contract, that is signed by both side of the transaction before any flows of cash. One side of the contract is the borrower – the buyer of real estate, and another one is the lender – the financial institution. Polish law determines quite strictly how such a contract should look like. As can be found in The Banking Law Act[21], every loan agreement, including mortgage, should define, inter alia, the purpose, the amount and currency of the credit. Also, the repayment date and terms should be specified. Bank as a private, profit-driven company, a financial institution does not have interest in default of the borrower. Obviously, in such situations bank can sell the borrower's collateral, which is the real estate in the case of a mortgage. Nevertheless, as costs of such operations are high and real estate can be sold below the market price, such events are unfavorable to the bank. Thus, the bank needs to protect itself against such cases. To this end, a financial institution evaluates the creditworthiness of the potential borrower and then decides, whether the risk of giving him a mortgage is on a low-enough level. The following definition can be found useful in understanding this concept:

[20] Own calculations, based on: Centrum AMRON-SARFiN. Ogólnopolski raport o kredytach mieszkaniowych i cenach transakcyjnych nieruchomości Q4 2012 & Q4 2016 & Q4 2019. Warsaw 2013 & 2017 & 2020
[21] The Banking Act of 29 August 1997 Article 69. Journal of Laws of 2015, item 128.

[…] The creditworthiness shall be understood as the capacity to repay the loan taken, together with interest, at the dates specified in the agreement. […][22]

This definition is pretty foolproof. It can be said that the bank assesses how likely the borrower is going to pay back a mortgage. This is the top priority issue for all financial institutions that lend money, thus the tools of estimating creditworthiness are sophisticated these days. An example of such is credit scoring.

In case of analysis of any mortgage application, Banks in Poland are obliged to use this method, according to Recommendation T of Polish Financial Supervision Authority. The scoring models differ from bank to bank, because it is related to bank actual credit policy[23]. Hence, there can occur a situation in which a potential borrower gets rejected from bank A but accepted by bank B. Procedure of scoring, designed to assess the risk of granting the loan to a specific person, is as following: the bank selects important (from his point of view, according to current strategy, including attitude to risk) criteria and assigns points and weights to them [24]. It can be, inter alia:

- criterions characterizing potential borrower: age, education, marital status, income, number of dependents, other financial obligations or type of job contract
- criterions characterizing loan applied for: type of installments (equal versus decreasing), mortgage repayment period or currency, type of collateral (value of dwelling).

The sources of such characteristic can come from an interview with the potential borrower, cooperating banks, Credit Information Bureau or other institutions. The sum of points makes up the total score. The higher it is, the lower is the risk of mortgage and higher the amount borrower can be granted with. To additionally minimize the risk of default of the borrower, the bank can use other methods, such as describing method, CAMPARI ICE method or 5C/6C method.

Another apparatus used in the process of loan granting is the credit rating calculator[25]. It is a simple tool that can be used by borrower to learn which characteristics of mortgage should be chosen to get the best-adjusted value of the credit. Firstly, borrower is assumed to characterize as following: his household consists of 4 persons, total monthly earnings are eight thousand zlotys, there are two thousand zlotys of permanent commitment and one thousand

[22] The Banking Act of 29 August 1997 Article 70. Journal of Laws of 2015, item 128.
[23] Wysiński P., 2013. Zastosowanie scoringu kredytowego w zarządzaniu ryzykiem kredytowym. International Business and Global Economy 2013, no. 32, pp. 253–268. Gdansk
[24] Juszczyk S., 2008. Zdolność kredytowa w ocenie banku na przykładzie małych i średnich przedsiębiorstw. Zeszyty Naukowe SGGW - Ekonomika i Organizacja Gospodarki Żywnościowej, no. 66, pp. 17-35. Warsaw
[25] Totalmoney.pl Sp. z o.o., 2021. Calculator of credit rating. On line. Date of access: June 1, 2021. https://www.totalmoney.pl/kalkulatory/kredyt-hipoteczny-kalkulator-zdolnosci-kredytowej

zlotys of other installments to be paid monthly. There are no other commitments, the rate of interest is constant and equal to 2,5% yearly. The variables are repayment period and type of installment (decreasing or constant). The result of such calculation is presented in the table 2.

Table 2. Borrowing Power calculation

No.	Name of parameter	Values of the parameters of assessment [polish zloty] according to length of period of mortgage						
		5 years	10 years	15 years	20 years	25 years	30 years	35 years
1.	Borrowing power, constant installments	154 952	291 715	412 424	518 963	612 995	695 989	769 241
2.	Borrowing power, decreasing installments	146 666	264 000	360 000	440 000	507 692	565 714	616 000

Source: Own study, based on: Calculator of credit rating. On line. Date of access: June 1, 2021. https://www.totalmoney.pl/kalkulatory/kredyt-hipoteczny-kalkulator-zdolnosci-kredytowej

The following conclusions occur:

- The longer the period of mortgage, ceteris paribus, the higher the amount of borrowing power.
- Choosing constant over decreasing installments enables the potential borrower to get a higher amount of mortgage.

When mortgage is granting, the potential borrower needs to formally prove that he is worthy of such an investment. Thus, the banks by law got permissions to verify potential borrower's official documents. As can be read in the Polish Banking Act:

"*The borrower shall be required to present, at the bank's request, such documents and information as are necessary to make an assessment of this capacity.*"

The mortgagor in some sense is also profit-driven. It is logical that from the borrower perspective the most important characteristic of a mortgage is its price. The total cost of credit is the sum of three main types of costs: interest rate, bank commissions and other fees.[26]

The mortgage interest rate can be fixed or variable. On polish mortgage market the first one is not commonly offered by banks or is offered conditionally. In order to check it, he analyzed the offers of the five biggest (in terms of values of mortgages loans granted in 4Q

[26] Wilczek M. T., 2013. Wybrane czynniki popytowe kształtujące decyzje inwestora na rynku nieruchomości mieszkaniowych i źródła informacji o nich. Studia Ekonomiczne / Uniwersytet Ekonomiczny w Katowicach 2013, no. 155, 175-188. Katowice

2019[27]) banks in Poland. These are: PKO Bank Polski, ING Bank Śląski, Bank Pekao, mBank and Santander Bank Polska. It turned out that these institutions indeed offer financing with a fixed interest rate, but only for 5 years period from the date of signing the mortgage contract. After 60 months, the bank is going to propose new fixed interest rate of unknown value for the consecutive period. If the consumer rejects such a preposition, the mortgage is again based on variable interest rate. Additionally, it should be pointed out that in comparison with mortgages based on variable interest rate, these with fixed interest rates are much more expensive. The difference can be as high as 50% of the annual percentage rate. The variable interest rate can be described with the following formula:

Formula 1: $$Variable\ Interest\ Rate = Reference\ Rate + Bank\ Margin$$

The Reference Rate is the Interbank Deposit Rate, which fixes the rates on the interbank deposits market. The representatives of 13 most important polish banks meet every day at 11 AM at the meeting called *fixing*, to determine levels of these rates. It is done by taking an average of banks' offered deposit rates. The rates are determined for different maturities, from the shortest WIBOR ON – overnight deposit, to the longest WIBOR 1R – one year deposit. On the polish mortgage market the most commonly used reference rates are WIBOR 3M and WIBOR 6M, rates offered for 3 months and 6 months deposits, respectively.

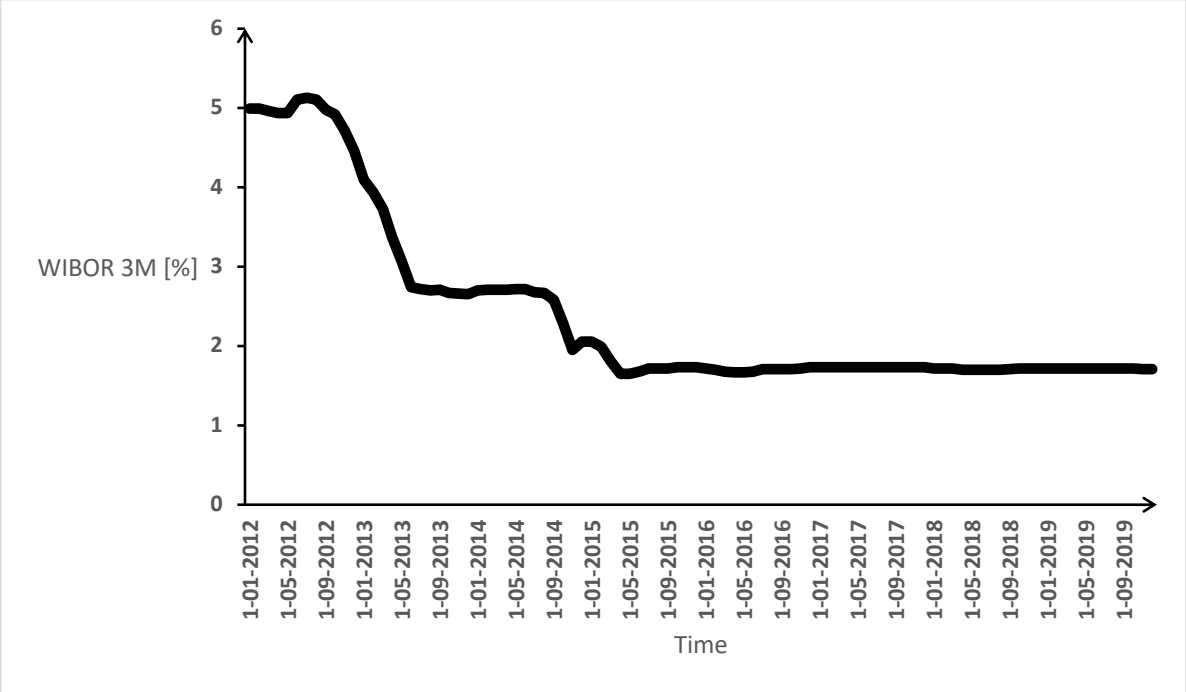
Additionally, the mortgage loan could be granted in other currencies than the polish zloty. In such cases, specific interbank deposits rates are used:

- LIBOR – London Interbank Offered rate. Determined by taking an average of interest rate at which major banks borrow from each other. Fixed every day for five currencies (the Euro, the U.S. Dollar, the British Pound, the Japanese Yen, the Swiss Franc) and for seven maturities: Overnight, One week, One month, Two months, Three months, Six months, Twelve months.
- EURIBOR – Euro Interbank Offered rate. Determined by taking an average interest rate at which twenty eurozone banks offer lending on the inter-bank market. Corresponds to eight different maturities: Overnight, One week, One month, Two months, Three months, Six months, Night months, Twelve months.

[27] Boczoń W., 2021. Raport PRNews.pl: Rynek kredytów hipotecznych – IV kw. 2019. Date of access: June 1, 2021. https://prnews.pl/449588-449588

As more than 98% of new mortgage loans in 2019 were denominated in Polish Zloty[28], the most important reference rate is WIBOR. On the graph 10 values of Warsaw Interbank Offer Rate for 3 months maturity are presented.

Graph 10. WIBOR 3M in 2012-2019 period



Source: Own study, based on: WIBOR 3M archive. Money.pl 2012 -2019. On line. Date of access: June 1 2021. https://www.money.pl/pieniadze/depozyty/zlotowe/WIBOR3M,depozyty.html

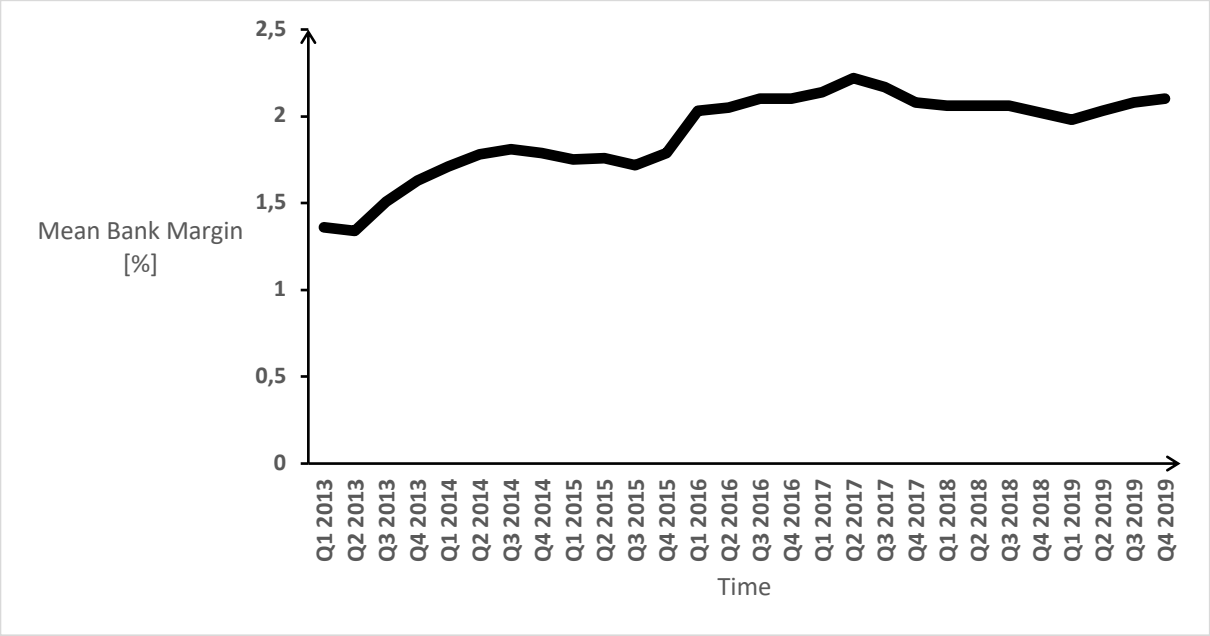
As can be observed on the graph, the values of WIBOR in 2012 fluctuated near a 5% level. In the following year it plunged and reached approximately 2.7% level, which remained constant until the end of 2014. Then a second, smaller drop can be observed, that bottomed out on a 1.7% level and remained unchanged until the end of 2019.

The second part of the interest rate is the bank margin, which is usually fixed for the whole period of mortgage loan contract. In simple words, bank margin is the profit of a lender. This remuneration is dependent on the risk of default by a borrower. The higher the risk occurs to be, the higher bank margin is proposed for the credit asker. Also, it depends on the value of the loan. Hence, presenting and comparing values of mean bank margins should be done on basis of the exemplary mortgage loan. On the graph below the mean margins are presented for

[28] Centrum AMRON-SARFiN., 2020. Ogólnopolski raport o kredytach mieszkaniowych i cenach transakcyjnych nieruchomości Q4 2019. Warsaw

credit as follows: 300 thousand zlotys of capital, repayment period equal to 25 years, LtV[29] equal to 75%.

Graph 11. Mean bank margin on new mortgage loans in Poland in 2013-2019 period



Source: Own study, based on: AMRON-SARFiN. Ogólnopolski raport o kredytach mieszkaniowych i cenach transakcyjnych nieruchomości Q1 2013 – Q4 2019.

Since the second quarter of 2013, mean bank margin had been climbing steadily up to 1.8% level, on which it leveled off. After 2015, percentage value had been increasing at a different rates and eventually remained steady near 2 – 2.1% level until the end of 2019.

In case of costs of mortgage loans, the second significant part are bank commissions. In this category, inter alia, such commissions can be included:

- drawdown of the mortgage loan
- early repayment
- extension of the repayment period
- currency conversion.

The last category of fees, that can increase cost of credit are fees, inter alia, for:

- processing loan application
- insurance of real estate
- property valuation.

[29] Loan-to-Value Ratio. The lower it is, the higher own contribution of borrower is required.

In the table 3, the example standard fees and commissions for a mortgage loan in one of the biggest banks in Poland are presented.

Table 3. Exemplary fees and commissions for a mortgage loan in Polish Bank

Action type	**Fee or Commission**
Processing loan application	0 PLN
Insurance of real estate	0,0065% of the value of real estate monthly
Property valuation	400 or 700 PLN
Provision for a drawdown of mortgage loan	from 0% to 4% of amount of credit
Provision for early partial repayment	0% of the amount of credit
Provision for early complete repayment in first three years of the credit period	2% of the amount of outstanding capital
Provision for extension of the repayment period	0,5% of the extended loan amount
Provision for currency conversion	1% of the value of the operation

Source: Own study, based on: Taryfa prowizji i opłat bankowych dla osób fizycznych w ramach bankowości detalicznej mBanku S.A.

As can be observed, the number of fees and commissions can be overwhelming, even though above presented are only the most important one. Due to author's best knowledge, historical data about values of provisions or commissions and commonness of usage of them is not available. The fact of rather small mean shares of second and third types of fees in the total cost of credit should be underlined. Additionally, these groups of costs had been approximately constant in the 2012-2019 period. Logical conjecture is that taking them into account in the empirical analysis could significantly increase its complexity. For all stated reasons, the second and third group of credit cost should be omitted in further parts of this paper.

Interest rate

The most important financial determinant is the interest rate. In the paper by Gabriel Główka, the author stated that increase of credit costs, meaning interest rates, have a powerful negative influence on the level of activity of real estate market. He concluded that low interest rates are

a strong monetary stimulus of demand for immovables, causing typical demand-pull inflation on the market. Similarly, Egert and Mihaljek proved a strong negative short-term and long-term relationship between real interest rates and house prices. Also, the research by Hlavacek and Komarek confirmed such a discovery. Terrones found that the average correlation between house prices and interest rates in both short-term and long-term is negative. From the mentioned before paper by Case and Shiller, comparable conclusions can be drawn. The authors claimed that a substantial fall in interest rates accelerated the growth of prices of real estates in the period 1995-2003. However, analyzing U.S. data, they observed this relationship only in some American cities.

Vizek in mentioned above research, with the use of cointegration and error-correction models, proved the long-run cointegration relationship of interest rates with house prices. Additionally, the author found that in all analyzed post-transition countries, interest rates could not be excluded from the model without the decrease of the quality of the model.

Valverde and Fernandez in 2010 performed econometric analysis to check the short-run and long-term relationship between house and mortgage markets in Spain. Authors found that these two markets have been mutually interacting both in short-run and long-run in Spain. Also, used Vector-Error-Correction model allowed assuming that interest rates significantly affect the prices of houses. Additionally, Pages and Maza (2003) found that nominal interest rate are the main determinant of prices on the Spanish real estate market. Gimeno and Martinez-Carrascal in 2010 analyzed mortgage and real estate markets and found interdependence between them in the long-run.

In 2002 Sutton examined the relationship of chosen economic indicators, including interest rates, with house price changes. He stated that indeed such a relationship exists and is important if it comes to determine the prices of real estates. The same author in another paper written in 2017 estimated that in countries like Poland, a one percentage point decrease in domestic short-term interest rates, combined with a corresponding decrease in the US real rate, causes an increase in house prices as high as three and a half percentage points, comparing to baseline, after 3 years.

Existing literature enables to assume interest rate is very important financial determinant of house prices. This assumption is going to be verified in the empirical section of this article.

Credit availability

From the literature, credit availability can be distinguished as second and the last financial determinant of house prices. The reasoning behind is, again, pretty straightforward: the lower

the availability of mortgages, the lower value of credits granted and, the smaller demand for houses and, eventually, ceteris paribus, the higher the prices of real estates.

Goodman et al. analyzed this issue with the following approach: they estimated the number of mortgage loans that would be granted in 2012 using 2001 standards, which were greatly more liberal. Subsequently, they compared estimates with 2012 real-life data. It turned out that much stricter requirements formed by banks caused a drop of 1.2 million new loans in the United States in 2012 alone.

Another empirical study about credit availability was conducted by McQuinn and O'Reilly in 2008 with the use of Irish data. In the first part of the paper, the authors proposed a theoretical model, in which the main determinant of demand for immovables was the amount of credit that an individual could borrow from financial institution. This amount was assumed to be dependent on the income of the potential borrower and interest rates. The second part of the elaboration was devoted to the empirical test of the proposed model. The authors found there exist a long-run relationship between credit availability and house prices. A similar idea was presented in paper by Laufer and Paciorek. The authors constructed a measure of mortgage loan credit availability and then verified its relationship with the real estate market. They concluded that credit score thresholds, which can be considered as a measure of credit availability, have a very large negative effect on borrowing for housing purposes. Obviously, such an effect lowers the demand for real estate and thus can negatively impact the prices of houses. Similarly, Wilczek recognized credit availability as one of the most important demand stimulating factor. His reasoning was similar to those described above.

On the other hand, there exist papers that reject theory about the strength of credit availability – housing demand relationship. Its author, Meltzer, did not find any evidence that credit availability has an important or lasting effect on the consumer's purchase decision.

Taking all mentioned above elaborations into account, it seems that credit availability can impact house prices. Nevertheless, from econometric point of view including this factor into model, most likely, would be a serious mistake. One should remember that credit availability mainly and directly depends on personal income of borrower and interest rates on the market. Both factors already have been described and assumed to include into model. Hence, adding the extra variable that is primarily based on values that are already included in model, would be perfect example of multicollinearity. Obviously, such a feature of econometric study would be very undesirable. Having all mentioned in mind, credit availability will not be included in practical part.

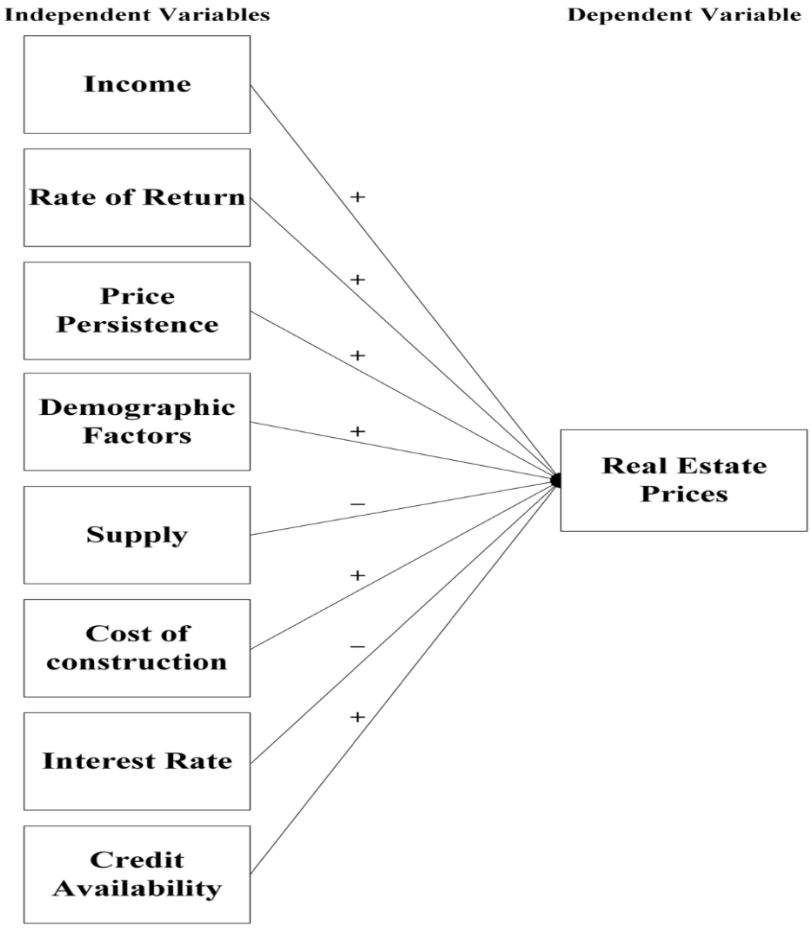
Summary

Concluding, house prices may depend on many different external factors. In literature broad scope of price determinants can be found. Factors that can possibly influence real estate prices are:

- income
- rate of return
- price persistence
- demographic factors
- supply
- cost of construction
- interest rate
- credit availability.

In graph 12 schematic view of mentioned determinants can be found.

Graph 12. Blog diagram of determinants of real estate prices



Source: Own study, based on presented literature.

4. Empirical analysis

4.1. Data and description of the sample

Finding the relevant data for purposes of this paper was a laborious but also exciting task. In order to conduct the research, publicly available data from across Poland was collected. All variables were aggregated for a given quarter. Monthly data were transformed to appropriate form, so that they coincide with the rest. Data includes period from the first quarter of 2010 to the fourth quarter of 2019. The choice of such period is not accidental. The 10-year period is long enough to be able to make reliable estimates. On the other hand, the data from the selected period should not be distorted by independent external factors. In 2010, one can expect stabilization of abnormal trends on the real estate market, mainly resulting from the crisis from the previous years. In turn, the global pandemic of the Sars-CoV-2 virus, which broke out in the first quarter of 2020, significantly influenced real estate markets in Poland, in Europe and all over the world.

All collected data are aggregated for voivodeships, the highest-level administrative divisions in Poland. The selection of data divided into voivodeships provides a large number of observations. Additionally, not all variables would be available for smaller administrative units. Specified as above, presented data is perfectly in accordance with definition of panel data, that is: "[...] has observations on the same units in several different time periods [...]".

Collected longitudinal data relate to 16 units (voivodeships) and comes from 40 time periods (quarters). In total, it constitutes 640 observations for every variable. All observations have been imported into the Software Stata in order to conduct an econometric study.

In the model, the dependent variable is price - the average level of 1 square meter of residential real estates in specific quarter in specific voivodeship. This variable is expressed as the Price Index ("price" in Stata), where the value of the price level in the corresponding quarter of the previous period is equal to 100. These values are published by the Central Statistical Office (GUS). The explained variable is continuous and can take values from zero to infinity.

The independent variables in the model are as following:

- *cost* ("cost" in Stata) is average cost of construction of 1 sqm of residential real estate in specific quarter in specific voivodeship. Every provincial governor has to publish this data every 2 quarters. Such an obligation is imposed on the voivodeship authorities by law. Two values are published every 6 months in public information bulletin for every voivodeship: first one concerns construction cost in the capital of the voivodeship and second one – a cost in the voivodship, excluding capital city. In order to attain only one

value per each quarter and per each area, the best way to establish weighting factors, by which the observed values could be multiplied have to be find. It was done in the following way:

Formula 2: $$\boldsymbol{Wf_v = \frac{vv}{vv+vc}}$$

where:

Wf_v - weighting factor for average value in voivodeship excluding capital city

vv - value of transactions in particular voivodeship in particular period, excluding capital city, expressed in Polish zloty

vc - value of transactions in particular capital city in particular period, expressed in Polish zloty

Formula 3: $$\boldsymbol{Wf_c = 1 - Wf_v}$$

where:

Wf_c - weighting factor for average value in capital city

Wf_v - weighting factor for average value in voivodeship excluding capital city

Calculated weighting factors was multiplied by adequate values of cost of construction. This way, precise cost of construction of 1 sqm for every voivodeship was calculated. Source of data used is GUS.

- *demography* ("demography") is the number of new marriages in specific quarter for specific voivodeship. Logical conjecture is that such values can be a good estimation of demographic trends in Poland. Additionally, they are unchallenging to obtain and easy to use in model. Therefore, these values are used as estimators of demographic factors in Poland. Again, *demography* values come from GUS.
- *income* ("income") is the average monthly gross salaries in national economy, published quarterly by GUS, in specific quarter in specific voivodeship.
- *interest* ("interest") is the average mortgage total interest rate. Such data is collected by Centrum AMRON-SARFiN on monthly basis. Quarterly values of mean interest rates were obtained by averaging data from 3 relevant months.
- *supply* ("supply") is the number of sqm of residential real estate put into use in specific quarter in specific voivodeship. Data are available on GUS webpage.

There are two additional variables, specific for panel data:

- Cross-sectional variables, indicating to which voivodeship data are related. In order to conduct econometric study, names of all administrative areas were sorted alphabetically and numbers in ascending order were assigned to them. This way, in "Stata":
  - Dolnośląskie Voivodeship was marked as "1"
  - Kujawsko-Pomorskie Voivodeship was marked as "2"
  - Lubelskie Voivodeship was marked as "3"
  - Lubuskie Voivodeship was marked as "4"
  - Łódzkie Voivodeship was marked as "5"
  - Małopolskie Voivodeship was marked as "6"
  - Mazowieckie Voivodeship was marked as "7"
  - Opolskie Voivodeship was marked as "8"
  - Podkarpackie Voivodeship was marked as "9"
  - Podlaskie Voivodeship was marked as "10"
  - Pomorskie Voivodeship was marked as "11"
  - Śląskie Voivodeship was marked as "12"
  - Świętokrzyskie Voivodeship was marked as "13"
  - Warmińsko-Mazurskie Voivodeship was marked as "14"
  - Wielkopolskie Voivodeship was marked as "15"
  - Zachodniopomorskie Voivodeship was marked as "16".

- Time-series variables, from which quarter indicating observation is presented. Again, data was sorted in chronological order and number in ascending order were assigned to them. This way, in "Stata" first quarter of 2010 was labeled as "1", and fourth quarter of 2019 was labeled as "40".

Concluding, panel data set that will be used in analysis includes 640 observations for every variable: for one dependent and five independent variables. Therefore, total number of observations is 3840. All data was collected and prepared according to the best econometric practices:

First, it was checked that all observations concern regular time intervals.

Second, verification of number of units (voivodeships) and number of time periods (quarters) was done. Accordingly, it was concluded that used panel data is neither short nor long.

Third, the conclusion that all units, also called entities, have measurements in all periods was drawn. Therefore, panel data is balanced.

Fourth, as the same units are observed for each quarter, data set is a fixed panel.

Five and last, other potential problems such as too small data set or changes in measurement methods employed have been ruled out.

Having prepared well organized data, estimating process can be began.

4.2. Descriptive statistics of the sample

In the table 4 descriptive statistic of all variables are presented.

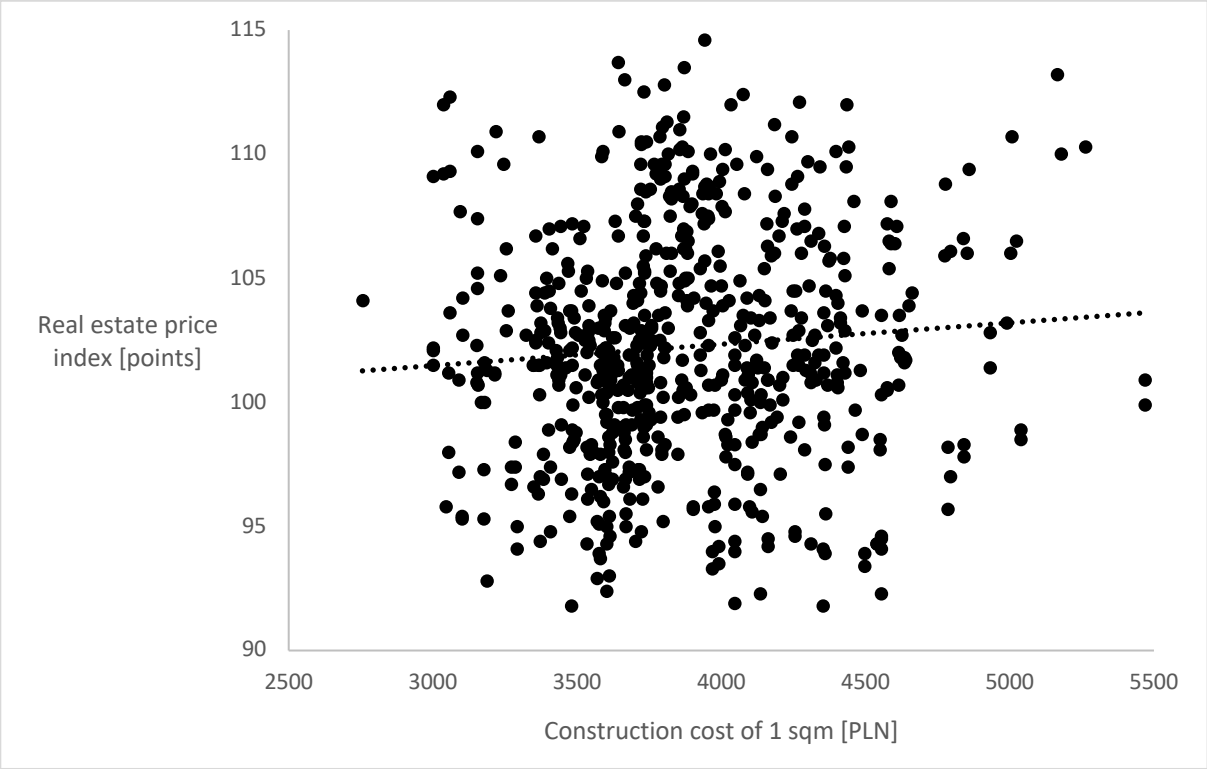
Table 4. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
voivodeship	640	8.5	4.613	1	16
time	640	20.5	11.552	1	40
price	640	102.23	4.616	91.8	114.6
cost	640	3868.17	434.19	2755.8	5468.85
demography	640	3068.42	2449.95	318	13068
income	640	3968.19	637.41	2825.99	6392.72
interest	640	4.43	.84	3.45	6.18
supply	640	586500.34	539511.4	46554	3551751

At first glance, above mentioned general insights about presented data can be confirmed. Also, it seems that in 2010-2019 period, mean change of house prices was 2.23% yearly with fairly high standard deviation. The maximum decrease of price was over 8% year to year, and maximum increase – almost 15%. The average price of construction was 3868.17 PLN. Additionally, in examined period it fluctuated between 2755.8 PLN to 5468.85 PLN, depending on voivodeship. Average income was 3968.19 PLN, with lowest values of 2825.99 PLN and highest of 6392.72 PLN. Average cost of external financing of real estate was equal to 4.43%, while number of square meters put into use was 586500.

It would be very informative to analyze relationships between variables and to check its correlations. Hence, below are presented scatter plots of all independent variables on dependent one. Additionally, values of Pearson correlation coefficients between mentioned variables for all voivodeships are presented.

Graph 13. Real estate price index and construction costs for all voivodeships in period 2010-2019



Source: Own study, based on *price* and *cost* variables.

Graph 13 represents scatter plot of construction cost on real estate prices. Every dot represents values for both variables in specific quarter for specific voivodeship. The position of each dot on the vertical axis indicates value of Price Index in specific time and region. In turn, dot position relative to horizontal axis shows construction cost. The dotted line signals strength of correlation between the two variables. It is called trend line. Logically, it can be interchangeably used with correlation coefficient. This way, perfect linear correlation exists if trend line is at a 45 degree angle or correlation coefficient is equal to 1. Likewise, flat trend line or coefficient equal to 0 would mean the total lack of correlation. Different angles of trendline and different values of correlation coefficient should be interpreted in a similar manner.

Returning to the graph, trend line with slope that is near to flow indicates weak and likely unimportant correlation between variables. Value of correlation coefficient presented in table 5 seems to confirm this observation.

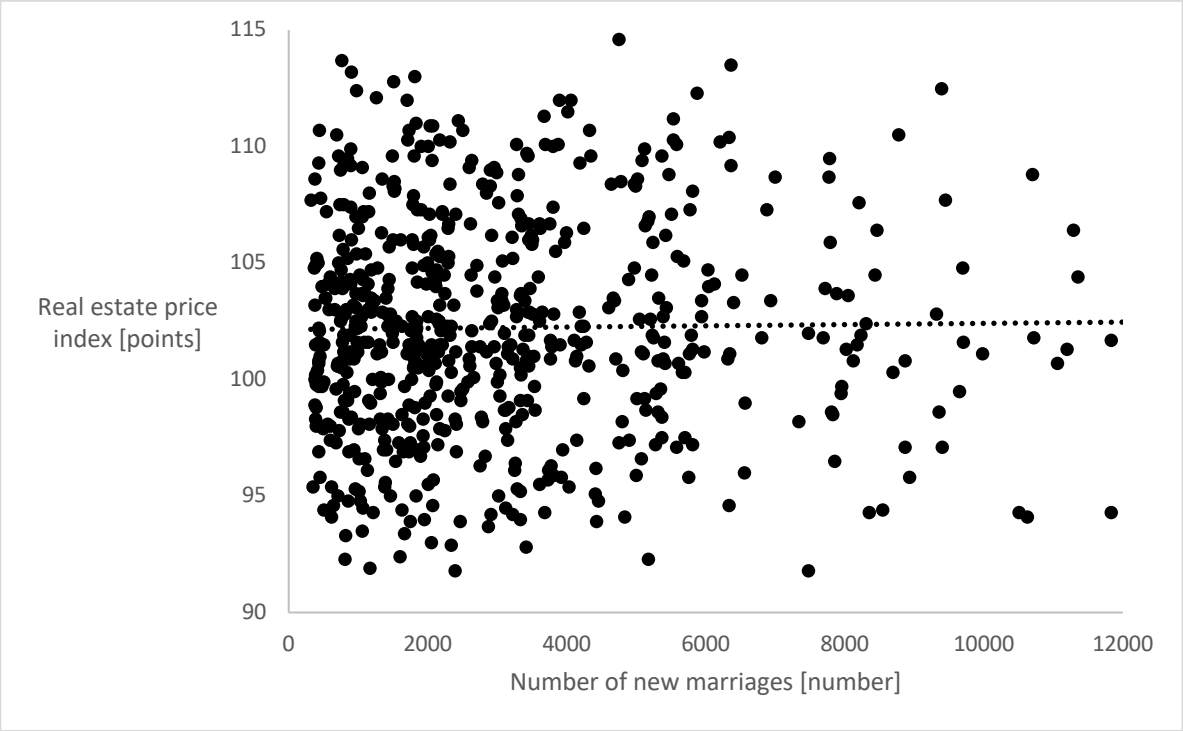
Table 5. Correlation coefficients of variables *price* and *cost* for 16 voivodeships and Poland for 2010-2019 period

No.	Region	Value of correlation coefficient
1.	Dolnośląskie	0.2381
2.	Kujawsko-Pomorskie	-0.0718
3.	Lubelskie	0.2311
4.	Lubuskie	0.394
5.	Łódzkie	-0.5331
6.	Małopolskie	0.4059
7.	Mazowieckie	0.3148
8.	Opolskie	0.0234
9.	Podkarpackie	0.2017
10.	Podlaskie	0.3752
11.	Pomorskie	0.3718
12.	Śląskie	0.3398
13.	Świętokrzyskie	0.4173
14.	Warmińsko-Mazurskie	0.4364
15.	Wielkopolskie	0.0193
16.	Zachodniopomorskie	0.6511
17.	Poland	0.0811

Source: Own study, based on *price* and *cost* variables.

Values of coefficients differ much on voivodeships level, from -0.5331 in Łódzkie to 0.6511 in Zachodniopomorskie. It means that in former existed strong negative correlation and in latter – strong positive. In eight out of the rest of analyzed regions moderate positive correlation between house prices and cost could be observed, what is in accordance with logic. Moving further, please look at graph 14.

Graph 14. Real estate price index and number of new marriages for all voivodeships in period 2010-2019



Source: Own study, based on *price* and *demography* variables.

Position of every dot relative to vertical axis depicts value of house price index and relative to horizontal axis – number of new marriages. As can be observed, densest area of chart is for values of price index between 95 and 105 points and for number of new marriages smaller than 4000 per quarter. Trendline, as previous case, indicates very light rather negligible correlation between these two parameters. Value of Pearson's correlation coefficient is approximately 0, which indicates no correlation at all, as showed in table 6.

Table 6. Correlation coefficients of variables *price* and *demography* for 16 voivodeships and Poland for 2010-2019 period

No.	Region	Value of correlation coefficient
1.	Dolnośląskie	0.0674
2.	Kujawsko-Pomorskie	0.0688
3.	Lubelskie	0.1764
4.	Lubuskie	0.0273
5.	Łódzkie	-0.0045
6.	Małopolskie	-0.0111
7.	Mazowieckie	0.0116
8.	Opolskie	-0.0005
9.	Podkarpackie	0.0671

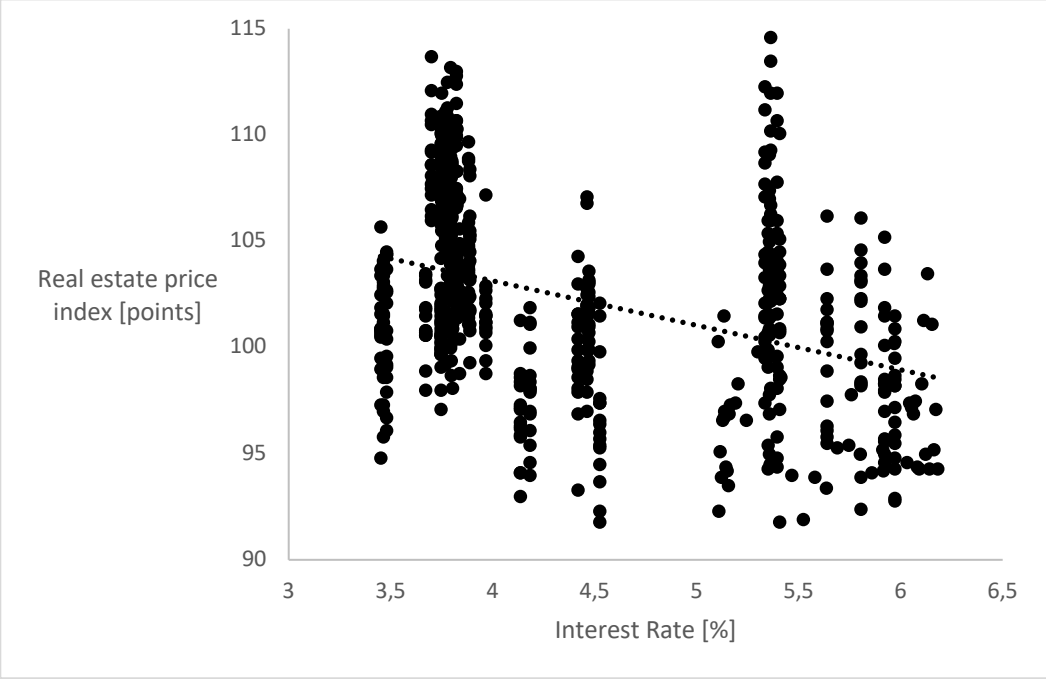
10.	Podlaskie	0.0395
11.	Pomorskie	0.1133
12.	Śląskie	-0.1123
13.	Świętokrzyskie	-0.0067
14.	Warmińsko-Mazurskie	0.011
15.	Wielkopolskie	0.0373
16.	Zachodniopomorskie	0.0192
17.	Polska	0.014

Source: Own study, based on *price* and *demography* variables.

Interestingly, values of other coefficients are all close to zero, which denotes lack of correlation. This remark is surprising, therefore to a greater extend needs to be analyzed with more advanced econometric tools.

Graph 15 depicts correlation between real estate prices and interest rates. As demonstrated in previous section, one should expect this correlation to be negative.

Graph 15. Real estate price index and interest rates for all voivodeships in period 2010-2019



Source: Own study, based on *price* and *demography* variables.

As can be deducted both from the chart above and from the value of Pearson's coefficient from the table 7, there exists moderate negative correlation between house prices and demography factors. Its power differs from voivodeship to voivodeship, with weakest values of correlation of -0.0511 in Lubelskie Voivodeship and strongest values of correlation of -

0.6107 in Mazowieckie Voivodeship. In all regions only negative values of coefficients can be observed, which is perfectly consistent with literature overlook presented in previous section. In 10 out of 17 regions coefficients indicates a non-negligible relationship between mentioned variables.

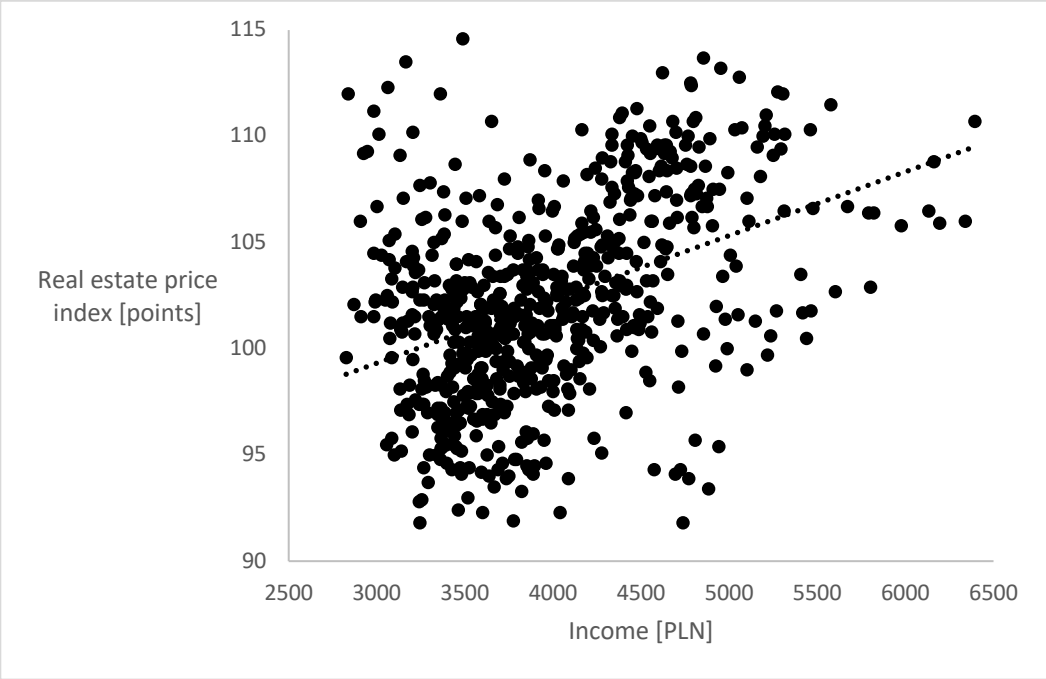
Table 7. Correlation coefficients of variables *price* and *interest* for 16 voivodeships and Poland for 2010-2019 period

No.	Region	Value of correlation coefficient
1.	Dolnośląskie	-0.2736
2.	Kujawsko-Pomorskie	-0.2916
3.	Lubelskie	-0.0511
4.	Lubuskie	-0.4934
5.	Łódzkie	-0.4701
6.	Małopolskie	-0.2854
7.	Mazowieckie	-0.6107
8.	Opolskie	-0.2652
9.	Podkarpackie	-0.2454
10.	Podlaskie	-0.5533
11.	Pomorskie	-0.4889
12.	Śląskie	-0.3318
13.	Świętokrzyskie	-0.1041
14.	Warmińsko-Mazurskie	-0.6324
15.	Wielkopolskie	-0.4353
16.	Zachodniopomorskie	-0.6353
17.	Polska	-0.3824

Source: Own study, based on *price* and *interest* variables.

The correlation of prices and income was checked as next. Results can be observed in the graph 16.

Graph 16. Real estate price index and average personal income for all voivodeships in period 2010-2019



Source: Own study, based on *price* and *income* variables.

It seems that income and house prices are moderately strong, positively correlated. Values of all coefficients are relatively high. Particularly noteworthy are correlations in Lubuskie, Łódzkie, Mazowieckie, Podlaskie, Warmińsko-Mazurskie and Zachodniopomorskie, where of coefficients higher than 0.7 can be observed. These denote strong positive linear relationships between house prices and income. In the rest of voivodeship only positive correlations can be observed, which are rather strong. These conclusions are in accordance with existing literature, where the authors often had been underlying strength of this income-price relationship.

Table 8. Correlation coefficients of variables *price* and *income* for 16 voivodeships and Poland for 2010-2019 period

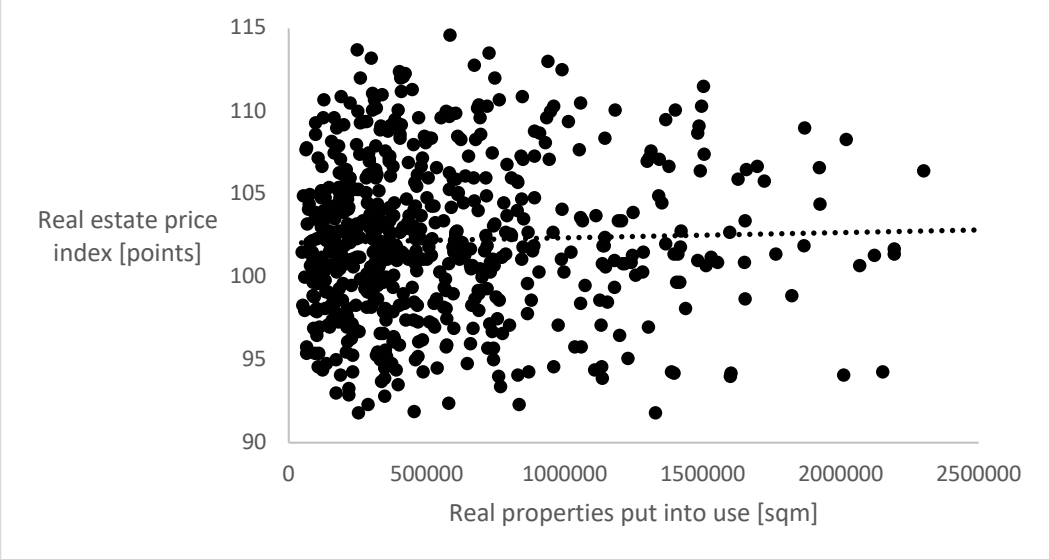
No.	Region	Value of correlation coefficient
1.	Dolnośląskie	0.3791
2.	Kujawsko-Pomorskie	0.535
3.	Lubelskie	0.2003
4.	Lubuskie	0.7009
5.	Łódzkie	0.6936
6.	Małopolskie	0.3767
7.	Mazowieckie	0.7137
8.	Opolskie	0.5294
9.	Podkarpackie	0.3401

10.	Podlaskie	0.7074
11.	Pomorskie	0.6786
12.	Śląskie	0.5935
13.	Świętokrzyskie	0.4891
14.	Warmińsko-Mazurskie	0.7103
15.	Wielkopolskie	0.5793
16.	Zachodniopomorskie	0.8235
17.	Polska	0.4146

Source: Own study, based on *price* and *income* variables.

The last correlation checked was between real estate prices and number of square meters of houses put into use in specific quarter and specific region. For results on country level, please look at the graph 17.

Graph 17. Real estate price index and number of square meters of houses put into use for all voivodeships in period 2010-2019



Source: Own study, based on *price* and *supply* variables.

The biggest density of data points can be observed on the left side of scatter plot. As previously, the most of data is located close to 100 point level on the vertical axis. The dotted line, that depicts trend is nearly flat, showing no correlation between two variables. Values of correlation coefficients also shows rather negligible relationship on all regions level.

Table 9. Correlation coefficients of variables *price* and *supply* for 16 voivodeships and Poland for 2010-2019 period

No.	Region	Value of correlation coefficient
1.	Dolnośląskie	0.0322
2.	Kujawsko-Pomorskie	0.1528
3.	Lubelskie	0.0591

4.	Lubuskie	0.3041
5.	Łódzkie	0.1099
6.	Małopolskie	-0.0347
7.	Mazowieckie	0.168
8.	Opolskie	0.1125
9.	Podkarpackie	0.0735
10.	Podlaskie	0.2538
11.	Pomorskie	0.1715
12.	Śląskie	0.1165
13.	Świętokrzyskie	0.1039
14.	Warmińsko-Mazurskie	-0.0015
15.	Wielkopolskie	0.2176
16.	Zachodniopomorskie	0.137
17.	Polska	0.037

Source: Own study, based on *price* and *supply* variables.

To sum up, use of correlation coefficient, enabled to draw the following conclusions:

- correlation between real estate prices and cost of construction could not be clearly specified
- correlation between real estate prices and demography factors does not exist
- correlation between real estate prices and interest rates is negative
- correlation between real estate prices and income is strongly positive
- correlation between real estate prices and supply does not exist.

However, it needs to be remembered that plain correlation is undoubtedly simple tool. Hence these results can be much too simplified and thus, describing reality falsely. Taking it into account, there exists a strong need to use more advanced econometric tools. Much more developed method of analysis in next sections will be presented.

4.3. Selecting a functional form

Developing more sophisticated kind of data research – econometric model is essential. In order to do it, question about most appropriate form of such a model needs to be answered first. The best literature overview and most accurate data is not enough, if chosen functional form is wrong. Typical procedure is to start with pooled OLS estimation, because this method is pretty straightforward, and correctness of its choice can be easily verified.

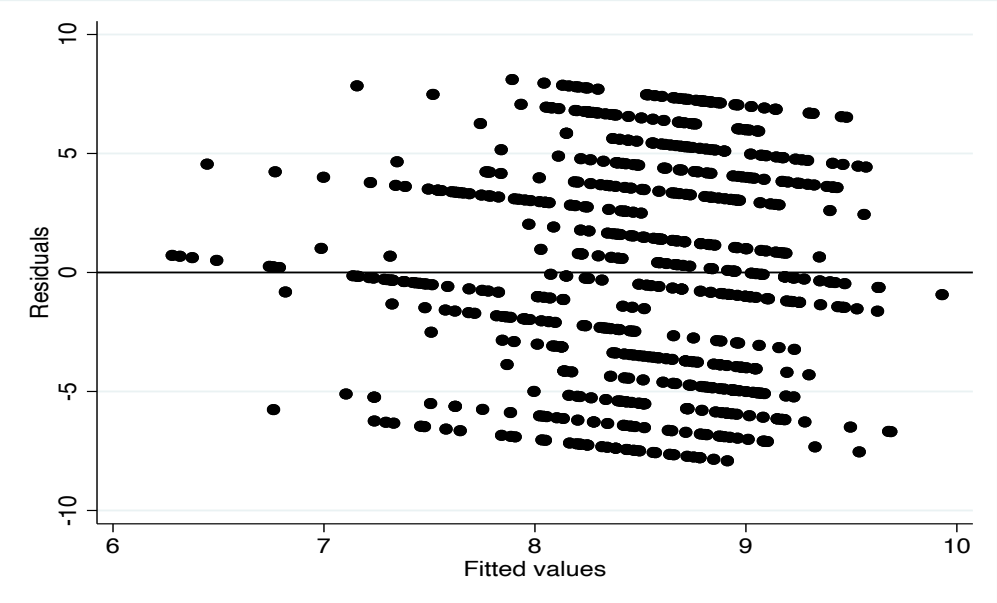
Pooled OLS

There exist six fundamental assumptions of Ordinary Least Squares:

- linearity – linear function of independent variables and error terms formulates dependent variable
- exogeneity – expected value of error term is zero
- homoskedasticity – error terms have constant variance
- nonautocorrelation – error terms are not related with each other
- independent variables are not random but fixed in repeated samples
- no multicollinearity – there cannot be exact linear relationship among independent variables.

All assumptions need to be fulfilled to be able to use pooled OLS. Equivalently, violation of any of them makes using Ordinary Least Squares method inappropriate. It is easiest to check the condition of homoskedasticity.

Graph 18. Homoskedasticity Test



Source: Own study, based on *price, cost, demography, income, interest and supply* variables.

Bare eye inspection concludes that data points seem to spread out, which is indicator for heteroskedasticity. Just to be sure, the homoskedasticity test, called White-Test was conducted. After using appropriate formulas and simple calculations, p-value obtained was near 0 (0.0000). Thus, the null hypothesis of homoscedascity can be strongly rejected.

From proof that data is heteroscedastic can be concluded that OLS method should not be used in estimation. Therefore, there still exists a need to for looking for appropriate model. Fixed or Random Effects models are probably more suitable.

Fixed versus Random Effects

Panel data models identify fixed and random effects of individual (voivodeship) or time (quarters). Key difference between two models is the role of dummy variables. In random effects model, parameter estimate of dummy variable is an error component. In fixed effects model it is a part of intercept. Having mentioned about theoretical concept, much more important question arises: how to decide which model is more appropriate? Luckily, it is pretty straightforward. It is enough to conduct the Hausman specification test, that compares both of them. If the null hypothesis, which says that the individual effects are uncorrelated with the other regressors, is rejected, a fixed effects model is more favorable than a random effects model.

To check it, the appropriate function in Stata was used. The attained p-value was near 0, which suggests rejection of null hypothesis. Therefore, Fixed Effects Model seems to be better choice.

Just to make sure that Fixed Model is appropriate, overall F-test was checked. In such a case, the null hypothesis is that all independent variables have coefficients equal to zero. As expected, the p-value was small enough to reject null and that way use of fixed effect model was confirmed to be appropriate.

4.4. Estimating Fixed Effects model

There exist two ways of estimating fixed effects. First method is called the “within” estimation, second – LSDV – least squares dummy variables estimation. Both of them was conducted and concluded that the latter one is better choice, as LSDV regression indicates higher values of goodness-of-fit.

LSDV estimation method enables examining fixed effects by introducing unit dummy variables. Again, units are voivodeships. The dummy variable g_1 is set to 1 for voivodeship 1 (Dolnośląskie, as set above), and 0 for other voivodeships. Similarly, g_2 is set to 1 for voivodeship 2 (Kujawsko-Pomorskie) and 0 for any other, and so on, up to g_{16}.

Thus, estimated model has the following form:

Formula 4:

$$\boldsymbol{price_i = \beta_0 + \beta_1 cost_i + \beta_2 demography_i + \beta_3 income_i + \beta_4 interest_i + \beta_5 supply_i + \sum_{i=1}^{7} u_i g_i + \sum_{i=9}^{16} u_i g_i + \varepsilon_i}$$

where:

$price_i$ – real estate price index

β_0 – intercept

β_1 – coefficient of cost variable

$cost_i$ – cost variable

β_2 – coefficient of demography variable

$demography_i$ – demography variable

β_3 – coefficient of income variable

$income_i$ – income variable

β_4 – coefficient of interest variable

$interest_i$ – interest variable

β_5 – coefficient of supply variable

$supply_i$ – supply variable

u_i – coefficient of ith-dummy variable

g_i – ith-dummy variable

ε_i – error term

Please note that one of sixteen dummies, g_8 was excluded from regression. It was dropped and used as a reference group. It is standard procedure to avoid perfect multicollinearity in model. The results of regression for model are presented in table 10.

Table 10. Linear regression results

price	Coef.	St.Err.	t-value	p-value	[95%	CI]	Sig
g1	-2.6535	0.9600	-2.76	0.0059	-4.5388	-0.7682	***
g2	2.2932	0.9162	2.50	0.0126	0.4939	4.0925	**
g3	1.3532	0.8554	1.58	0.1142	-0.3267	3.0331	
g4	2.1360	0.8475	2.52	0.0120	0.4716	3.8003	**
g5	0.3551	0.8723	0.41	0.6841	-1.3579	2.0680	
g6	-1.2919	1.0211	-1.27	0.2063	-3.2971	0.7133	
g7	-9.4647	1.3598	-6.96	0.0000	-12.1351	-6.7942	***

o.g8	0.0000	.	.	.	.	.	
g9	2.7475	0.8646	3.18	0.0016	1.0495	4.4454	***
g10	0.5726	0.8566	0.67	0.5041	-1.1096	2.2548	
g11	-1.9794	1.0453	-1.89	0.0588	-4.0323	0.0734	*
g12	-2.6143	0.9587	-2.73	0.0066	-4.4970	-0.7315	***
g13	1.3533	0.8461	1.60	0.1102	-0.3083	3.0149	
g14	0.8910	0.8715	1.02	0.3070	-0.8204	2.6025	
g15	-0.5928	0.9963	-0.60	0.5521	-2.5495	1.3638	
g16	-0.8073	0.8514	-0.95	0.3434	-2.4793	0.8647	
cost	0.0006	0.0006	0.91	0.3639	-0.0007	0.0018	
demography	0.0004	0.0001	4.34	0.0000	0.0002	0.0005	***
income	0.0057	0.0005	12.64	0.0000	0.0049	0.0066	***
interest	0.3288	0.2564	1.28	0.2002	-0.1748	0.8324	
supply	-7.12e-07	4.64e-07	-1.54	0.1250	-1.52e-06	1.98e-07	
Constant	75.5480	3.1529	23.96	0.0000	69.3564	81.7396	***

Mean dependent var	102.2278	SD dependent var	4.6161
R-squared	0.3577	Number of obs	640.0000
F-test	17.2399	Prob > F	0.0000
Akaike crit. (AIC)	3531.6773	Bayesian crit. (BIC)	3625.3681

*** $p<.01$, ** $p<.05$, * $p<.1$

Source: Own study, based on *price, cost, demography, income, interest and supply* variables.

Presented regression can be a bit confusing at first glance, hence detailed description will be given. In the fixed effect model each unit (voivodeship) has its own intercept but shares the same coefficients of independent variables. Thus, one may consider how to get voivodeship specific intercept and how to interpret the dummy coefficients u_1-u_{16}. It is pretty straightforward. As mentioned before, 8th dummy variable should be treated as reference unit. Therefore the regression for Opolskie, 8th Voivodeship in alphabetical order, is as follows:
Voivodeship 8:

$$price_8 = 75.5480 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

Each of other u_i represent deviation of its Voivodeship specific intercept from the baseline intercept 75.5480. For example, u9 means that the intercept of Podkarpackie is 2.7475 higher

than baseline. One ought to remember that in this case all unit dummies other than g9 are zero. Therefore, its intercept is 78.2955=75.5480 + 2.7475[30]

Similarly, other intercepts were computed and eventually sixteen regression equations were obtained, as shown in Annex 1.

Again, note that all regressors coefficients are the same, regardless of voivodeship. The coefficients should be interpreted in such a manner:

The intercept of Voivodeship 1 is 2.6535 smaller than that of baseline intercept and this deviation is statistically discernable from zero at the .05 level (p<.0059).

The intercept of Voivodeship 2 is 2.2932 larger than that of baseline intercept (p<.0126).

The intercept of Voivodeship 3 is 1.3532 larger than that of baseline intercept, but this deviation is not statistically significant at the .05 significance level (p<.1142).

As in examples, g's that have large p-values (>0.05), are not statistically significant and thus does not deviate from the baseline intercept (intercept of voivodeship 8).

3.5. Results of regression

As can be observed in the table above, both essential goodness-of-fit measures, F-test and its significance (Prob>F), implies model is significant. Sum of Squares coming from model is slightly above 4871, and coming from errors – almost 8745. There are 619 degrees of freedom for errors and total number of observations is 640. Proportion of the variance for a dependent variable that is explained by regressors, R-squared, is 35.77%. It is much "better" in comparison with pooled OLS estimation (23,26%).

Using fixed model implies that all regressors have the same standardized coefficients, but different intercepts. Focus can be shifted to the former, as the latter one was reported previously.

For 1 unit increase in cost of construction, the average price increases by 0.0006 units. It can be interpreted in the following way: if cost of construction increases by 1000 polish zlotys, average price of 1 sqm of residential real estate increases by 0.6 percentage points. Surprisingly, this variable is not statistically significant at the .05 significance level (p<.3639). It means that results of model suggest that there is no relationship between cost of construction and price of real properties. Standard error is .0006.

[30] More formal computation would be 78.2955 = 75.5480 + (-2.6535)*0 + (2.2932)*0 + (1.3532)*0 + (2.1360)*0 + (0.3551)*0 + (-1.2919)*0 + (-9.4647)*0 + (0.0000)*0 + (2.7475)*1 + (0.5726)*0 + (-1.9794)*0 + (-2.6143)*0 + (1.3533)*0 + (0.8910)*0 + (-0.5928)*0 + (-0.8073)*0. Obviously, this type of computation can be skipped for simplicity reasons.

Whenever number of new marriages increases by 1000, the average price increases by 4 percentage points. This relationship can be perceived as interestingly strong, but model results confirm demography variable is significant (p<.0000). Standard error is .0001.

Income variable has coefficient equal to 0.0057. Therefore, if mean income in Poland increases by 100 PLN, increase of average price of 1 sqm by 0.57 percentage point can be expected. Income variable is significant (p<.0000). Standard error is .0005.

For 1 percentage point increase in mortgage interest rate, the average price increases by 0.3288. Such a connection is in contradiction to analyzed literature, but one cannot forget that interest variable is not significant (p<.2564). It means that relationship between interest rates and house prices does not occur. Standard error is .2564.

Supply variable is also not significant (p<.1250). If it was, higher supply of residential real estate would increase its prices, which is contrary to logic. To be more specific, growth of supply by 1 million of sqm[31] would increase house prices by 0,712 percentage points. As the relationship is not significant, it should be skipped. Standard error is .000000464.

5. Conclusion

Knowledge of factors that impact house prices could be a revolution. It would enable governments and central banks to create more effective fiscal and monetary policies. This could stabilize trends of prices of real estates and eliminate undesirable phenomena. In turn stability of the market could facilitate satisfaction of housing needs. Then, banks would operate on lower levels of risk. Additionally, real estate developers would be able start new investments without big concerns about situation on the market when it would come to selling finished real estates.

In this paper authors conducted an investigation of house prices determinants, that could help mentioned parties of market to make appropriate decisions. Additionally, numerical values of factor-price relationships were tried to be established. Conducted broad overview of both global and polish real estate markets was important part of investigation. Also, it was essential for understanding the importance of chosen topic. It was proved occurrences of certain phenomena with comprehensive analysis of existing literature. Eight most important house price drivers were detailed:

- six that theoretically should positively impact house prices: income, rate of return, price persistence, demographic factors, credit availability and cost of construction
- two that theoretically should negatively impact house prices: interest rate and supply.

[31] 1 million of sqm is not abstractly big number, as mean supply in all voivodeships quarterly is 9.384 million sqm.

Price factors distinguished with the overview of literature was checked for possibility to use in empirical analysis. Factors that that were impossible to obtain or their use in econometric study was invalid were rejected. Simple linear method was used as first econometric tool. Additionally, verification of its results with more complicated, fixed effects regression model was done.

The hypothesis was: "The main determinants of housing prices in Poland are: personal income, demography, mortgage interest rates, cost of construction and supply of houses."

Results of econometric model enabled to reject the research hypothesis. However, it can be concluded that the main determinants of house prices in Poland are:

- income; if average monthly salary in Poland increases by 100 PLN, house prices increases by 0.57%
- demography; if number of new marriages increases by 1000 in every voivodeship, house prices increases by 4%.

Additionally, rest of analyzed determinants, such as cost of construction, interest rates and supply of houses was found to be insignificant price determinants on Polish real estate market. Similar conclusions could be drawn with the use of a simple regressions. Therefore, these factors cannot be perceived as factors that impact house prices on Polish market in 2010-2019 period.

References

Agnello L., Schuknecht L., 2009. Booms and Bust in Housing Markets: Determinants and Implications. ECB Working Paper Series. No 1071.

André Ch., 2016. Household debt in OECD countries: stylised facts and policy issues. OECD Economics Department Working Paper 1277. OECD Publishing.

Augustyniak, H., Łaszek, J., Olszewski , K., & Waszczuk, J., 2014. Modelling of cycles in the residential real estate market – interactions between the primary and the secondary market and multiplier effects. Kwartalnik Nauk o Przedsiębiorstwie 2/2014 (31).

Barnichon R., Matthes R., Ziegenbein A., 2018. The Financial Crisis at 10: Will We Ever Recover? Economic Letter, Federal Reserve Bank of San Francisco. August 2018

Boczoń W., 2019. Raport PRNews.pl: Rynek kredytów hipotecznych – IV kw. 2019. Date of access: June 1, 2021. https://prnews.pl/449588-449588

Cao Y. & Wei Y., 2007. Forecasting house prices using dynamic model averaging approach: Evidence from China. Economic Modelling 61:147-155. February 2007.

Case K. E. & Shiller R. J., 2004. Is there a Bubble in the Housing Market? Yale University Paper no. 1089. Connecticut

Centrum AMRON-SARFiN., 2012 – 2020. Ogólnopolski raport o kredytach mieszkaniowych i cenach transakcyjnych nieruchomości Q1 2011 - Q4 2019. Warsaw

Chang S., Stuckler D., Yip P., Gunnell D., 2013. Impact of 2008 global economic crisis on suicide: time trend study in 54 countries BMJ. Clinical Research Ed. September 2013

Drachmal K., 2011. Analiza determinant cen nieruchomości w Polsce. Świat Nieruchomości, 1(75) 30-33.

Egert B. & Mihaljek D., 2007. Determinants of House Price Dynamics in Central and Eastern Europe. BIS Working Papers No 236.

Emmons W. R. & Noeth B.J., 2012. Household Financial Stability: Who Suffered the Most from the Crisis? The Regional Economist, Federal Reserve Bank of St. Louis. July 2012

Gallin J., 2003. The Long-Run Relationship between House Prices and Income: Evidence from Local Housing Markets. April 2003

Gimeno R. & Martínez Carrascal C., 2006. The interaction between house prices and loans for house purchase: The Spanish Case. Working Paper 0605. Bank of Spain.

Główka G., 2016. Finansowe determinanty bańki cenowej na rynku mieszkaniowej w Polsce. Studia i Prace WNEiZ US, no. 45/1 2016. Szczecin

Główny Urząd Statystyczny, 2020. Real Estate Sales in 2019. Warsaw, February 2020

Główny Urząd Statystyczny, 2020 Wages and salaries Data. Warsaw, July 2020

Goodman L. S. & Zhu J. & George T., 2014. Where Have All the Loans Gone? The Impact of Credit Availability on Mortgage Volume. The Journal of Structured Finance Summer 2014, 20 (2) 45-53.

Heiborn M., 1994. Demographic Factors and the Demand for Housing. Department of Economics, Uppsala University, Working Paper 1994:30.

Hlaváček M. and Komárek L., 2009. Property Price Determinants in the Czech Regions. Financial Stability Report of the Czech National Bank, pp. 82-91. Czech National Bank. Prague

Hort K., 1998. The determinants of urban house price fluctuations in Sweden 1968-1994. Journal of Housing Economics, 7, 93-120.

Juszczyk S., 2008. Zdolność kredytowa w ocenie banku na przykładzie małych i średnich przedsiębiorstw. Zeszyty Naukowe SGGW - Ekonomika i Organizacja Gospodarki Żywnościowej, no. 66, pp. 17-35. Warsaw

Kucharska – Stasiak E., 2006. Nieruchomość w gospodarce rynkowej. Wydawnictwo Naukowe PWN. Warszawa

Leszczyński R. & Olszewski K., 2010. An analysis of the primary and secondary housing market in Poland: evidence from the 17 largest cities. Baltic Journal of Economics, 17:2, 136-151.

Mankiw G & Weil D., 1989. The Baby Boom, the Baby Bust, and the Housing Market. Harvard University. Cambridge

Martínez-Pagés J. and Maza L., 2003. A. Analysis of house prices in Spain. Working Paper 0307. Bank of Spain.

Maslow, A. H., 1943. A theory of human motivation. Psychological Review, 50(4), 370–396.

McQuinn K. & O'Reilly G., 2006. Assessing the role of income and interest rates in determining house prices. Research Technical Papers 15/RT/06, Central Bank of Ireland.

Meltzer A. H., 1974. Credit Availability and Economic Decisions: Some Evidence from the Mortgage and Housing Markets. The Journal of Finance Vol. 29, No. 3 (Jun., 1974), pp. 763-777.

Ministry of Finance, 2019. the maximum amount of the real estate tax rate in 2019. Warsaw

Nawrocka E., 2011. Obszary wzajemnego oddziaływania rynku mieszkaniowego i gospodarki rynkowej. Prace i Materiały Wydziału Zarządzania Uniwersytetu Gdańskiego. 4/8: 167-176.

Palacin J. & Shelburne R., 2005. The Private Housing Market in Eastern Europe and the CIS. United Nations Economic Commission for Europe Discussion Paper Series, No. 6, Geneve: UNECE.

Posedel P. & Vizek M., 2009. House price determinants in transition and EU-15 countries. Post-Communist Economies, 21(3), pp. 327-343. September 2009

Recommendation T., 2013. Polish Financial Supervision Authority. Warsaw

Schneider D., 2015. The Great Recession, Fertility, and Uncertainty: Evidence From the United States. Journal of Marriage and Family. 77 (5): 1144–1156.

Sutton G. D. Explaining changes in house prices. BIS Quarterly Review, September 2002

Terrones M., 2004. The Global House Price Boom. World Economic Outlook, Chapter II, pp. 71-136. International Monetary Fund. April 2004

The Banking Act of 29 August 1997 Article 69. Journal of Laws of 2015, item 128.

The Banking Act of 29 August 1997 Article 70. Journal of Laws of 2015, item 128.

The Business Research Company., 2020. Construction Global Market Opportunities and Strategies. July 2020.

Tostevin P., 2021. The 10 most valuable real estate markets in the world. The Savills Blog. On line. Date of access: June 1 2021. https://www.savills.com/blog/article/219340/international-property/the-10-most-valuable-real-estate-markets-in-the-world.aspx

Totalmoney.pl Sp z oo, 2021. Calculator of credit rating. On line. Date of access: June 1, 2021. https://www.totalmoney.pl/kalkulatory/kredyt-hipoteczny-kalkulator-zdolnosci-kredytowej

UNECE., 2021. Share of construction in GDP. 2019. On line. Date of access: June 1 2021. https://w3.unece.org/PXWeb/en/Table?IndicatorCode=8#

U.S. Bank for International Settlements., 2021 Real Residential Property Prices for United States [QUSR628BIS]. Retrieved from FRED, Federal Reserve Bank of St. Louis. On line. Date of access: June 1, 2021. https://fred.stlouisfed.org/series/QUSR628BIS.

U.S. Bureau of Economic Analysis., 2021. Personal consumption expenditures: Services: Housing and utilities [DHUTRC1Q027SBEA]. Retrieved from FRED, Federal Reserve Bank of St. Louis. On line. Date of access: June 1 2021. https://fred.stlouisfed.org/series/DHUTRC1Q027SBEA

Varian H. R., 2014. Intermediate Microeconomics: a Modern Approach. Norton & Company. New York

Vizek M., 2011. Short-run and Long-run Determinants of House Prices in Eastern and Western European Countries. Privredna Kretanja i Ekonomska Politika 20(125).

Wagner M., 2016. Rynek nieruchomości mieszkaniowych w strefie euro. Instytut Ekonomiczny, Materiały i Studia nr 322. Warszawa

Wilczek M. T., 2013. Wybrane czynniki popytowe kształtujące decyzje inwestora na rynku nieruchomości mieszkaniowych i źródła informacji o nich. Studia Ekonomiczne / Uniwersytet Ekonomiczny w Katowicach 2013, no. 155, 175-188. Katowice

Wysiński P., 2013. Zastosowanie scoringu kredytowego w zarządzaniu ryzykiem kredytowym. International Business and Global Economy 2013, no. 32, pp. 253–268. Gdansk

Laufer S. & Paciorek A., 2016. The Effects of Mortgage Credit Availability: Evidence from Minimum Credit Score Lending Rules. FEDS Working Paper No. 2016-098. December 2016

ANNEXES

Annex 1. Regression equations for voivodeships

$$price_1 = 72.8945 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_2 = 77.8412 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_3 = 76.9012 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_4 = 77.6840 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_5 = 75.9031 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_6 = 74.2561 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_7 = 66.0833 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_8 = 75.5480 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_9 = 78.2955 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_{10} = 76.1206 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_{11} = 73.5686 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_{12} = 72.9337 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_{13} = 76.9013 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_{14} = 76.4390 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_{15} = 74.9552 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

$$price_{16} = 74.7407 + 0.0006 * cost_i + 0.0004 * demography_i + 0.0057 * income_i + 0.3288 * interest_i + 0.000000712 * supply_i$$

University of Warsaw
Faculty of Economic Sciences
44/50 Długa St.
00-241 Warsaw
www.wne.uw.edu.pl