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An analysis of the primary and secondary housing market in Poland: evidence from the 17 largest cities

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ABSTRACT

We analyse the determinants of prices of flats that are bought on the primary (new construction) and secondary markets (existing stock) in the 17 largest cities in Poland during the 2002–2015 period. We find that prices are driven by economic fundamentals, such as income growth and drop in the unemployment or real interest rate. Interestingly, prices in the secondary market react strongly to those fundamentals than to prices in the primary market. Especially, the reaction to the real interest rate is more than twice as high. The most likely buyers on the secondary market are first-time buyers with little own capital, and need a large mortgage. On the other hand, those who buy housing in the primary market quite often sell their old flat, so they only need to acquire the difference. Our finding indicates that the primary and secondary markets need to be analysed separately.

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1. Introduction

Growth in house prices in the primary market (new construction) and the secondary market (existing housing stock) is the subject of continuous interest of central banks and regulators, as it rapidly translates into changes in real estate construction, drives housing cycles (see Augustyniak, Łaszek, Olszewski, & Waszczuk, 2014a) and generates risk for the banking sector. The recent international financial crises were associated with a housing boom and bust in the U.S. and later major European countries. It has shown that housing is of paramount importance for households and the financial system, thus also for the whole economy. The stiffness of supply in the short term combined with rapidly growing demand can cause price shocks and also create bubbles. Mortgages constitute the largest liability of households and also a major asset of banks. Even though only a small fraction of housing is traded at a given time, it affects the value of the whole housing stock. During a price boom households and banks are willing to sign large mortgage contracts. However, during a price bust the loan value can exceed the collateral, which can cause problems to the stability of the financial system.

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Our study focuses on determinants of the average price¹ per square metre of housing in Poland's 17 largest urban markets in the 2002–2015 period. Because the majority of housing that is sold on the market are flats in multi-family dwellings, we focus on such flats.² The words house and flat are used as synonyms through the paper. The housing market is of high importance for the economy, and the 17 largest cities account for around 40% of housing mortgages issued in Poland (BIK – Consumer Credit Information Provider, see NBP, 2016 for details). Over the analysed period around 33% of the total number of housing units (all types of housing) was delivered in the largest markets, and among those completed, nearly 70% were produced by housing developers (Polish Central Statistical Office). In 2015, developers supplied over 80% of housing units in the largest cities, while 20 years earlier, their market share was only 10%. The analysed cities constitute the largest labour markets, are the regional capitals of the voivodships³ and also a significant part of GDP is created in those cities.

This study is, to our best knowledge, the first that analyses house prices in a Central and Eastern European (CEE) country on the existing stock market and the new construction market separately and uses data for 17 large cities in a panel. It shows that both markets need to be analysed separately and also indicates that at this stage of the market development the current supply is not high enough to satisfy housing needs, therefore has so far no effect on house prices. Our results should be useful for policy-makers and central banks in similar countries.

The aim of our analysis is to determine which economic variables explain the growth in house prices in the primary and secondary market. Unlike most of the studies which we know, we analyse both market segments separately. A recent analysis of the Warsaw primary market shows that housing developers use price discrimination and monopolistic competition to sell flats above their true value (see Łaszek, Olszewski, & Waszczuk, 2016). On the secondary market, where transactions are closed between average people, there is no significant information asymmetry. Another difference is that housing on the secondary market is mostly ready to move in and live, if one needs a shelter fast. Contrary, the majority of purchases in the primary market covers construction contracts, and it can take up to two years, until the buyer can move in. The secondary market shows also lower prices, thus one can infer that first-time buyers will rather chose housing on the secondary market.

Panagiotidis and Printzis (2016), who study the determinants of house prices in a vector error correction model framework for Greece provide also a very rich literature overview on this topic. Those authors find that for Greece there is a long run relationship between house prices and economic variables. In the long run, retail trade and mortgages determine house prices, while in the short run the consumer price index (CPI) can be added to the list of house price determinants. Igan and Loungani (2012) analysed house prices in 55 countries over a long period and found that prices follow income growth and demographic changes. The long run relationship is distorted by short-term fluctuations in income and mortgage conditions. This means that when income levels or loan availability improves in the short run, people buy more housing, ignoring the fact that the improvement can be temporary. An earlier study by Andrews (2010) comes to a similar conclusion, and show that factors such as mortgage market deregulation or tax reliefs on mortgages tend to add to house price growth. Rising transaction costs decrease the number of transactions and smooth the house prices. Very similar house price drivers in CEE countries are found by Égert and Mihaljek (2007), who state that

income, real interest rates, mortgage conditions and demographic factors explain house prices. They also find that changes in the quality of housing, measured by the size of an average flat or the floor space per person or measures such as access to piped water have a very strong effect on house prices. In sum, people are willing to pay much more for better quality housing. In Poland and other CEE countries better quality housing can hardly be achieved by renovations. According to the empirical analysis of Ciarlone (2015) the housing boom in Eastern Europe was not caused by speculations, as many assumed, but due to an insufficient high amount of housing stock in comparison to the basic needs of the inhabitants. The demand for floor space is so high in CEE countries that it can only be satisfied with a lot of new construction. Empirical analysis performed on NUTS 3 regions in Europe, presented in NBP (2015) shows that after controlling for economic and labour market differences, Poland and the other CEE countries lack around 52 housing units per 1000 inhabitants in comparison to the euro area.

The analysis of the Polish housing market (see NBP, 2013) and an that of the CEE market (see Augustyniak, Łaszek, Olszewski, & Waszczuk, 2014b) indicates that there is a high demand for owner occupied housing. The desire to own housing stems from two main reasons. Renting is quite costly and in many cases the loan instalment can be even lower than the rent and when the loan is paid back, the owner keeps the house forever. Secondly, there are investment motives, because housing is not only a durable consumer good but also an investment good (see Łaszek, 2013 for a detailed discussion). The desire to own housing can be only satisfied if the household has enough income to accumulate the down payment and to cover the loan instalments and expects that it will receive income in the future. The abovementioned factors increase the demand for housing, which under fixed supply in the short run leads to house price growth. We formulate the following research hypotheses:

Research hypothesis 1a: House prices in the major markets in Poland are determined by fundamental economic determinants.

Research hypothesis 1b: The housing stock in Poland is insufficient to satisfy the growing housing needs, new supply is still not able to lower prices on both housing markets.

Housing demand can be satisfied with housing from the existing stock or with newly constructed housing. The consumer choice is determined by price levels, and new constructed housing is usually more expensive than housing from the existing stock. We assume that a different group of buyers purchases housing on the primary market and another group on the secondary market. First-time buyers chose houses from the cheaper existing stock, and have to take a large mortgage to finance it. Homeowners, who improve their living conditions, quite often move from the existing stock to new construction and only need to finance the price difference with the mortgage. This allows us to formulate the following research hypothesis:

Research hypothesis 2: House prices in the secondary market react stronger to income and mortgage conditions than prices in the primary market.

The remainder of the paper consists of the empirical analysis. In section 2 we analyse the price drivers in the primary and secondary housing market. Section 3 discusses the main results.

2. Empirics

We use the results from the literature, presented in the introduction as a starting point for our empirical analysis. The analysis of transaction prices of housing in the primary and secondary market of 17⁴ cities in Poland is based on annual data for the years 2002–2015.⁵ The analysis takes into account the relatively stable period in the housing market (2002–2005), the housing boom period (2006–2008) and the market's slow return to its equilibrium (2009–2015). Due to data limitations this is the longest period that we can analyse, but it captures at least a full real estate cycle and gives a good picture of the determinants of price changes in the residential market. In 16 of the largest cities the primary market prices are higher than the secondary market prices, while the opposite was true for Warsaw during 2002–2013. For presentation purposes we present the CPI deflated house prices in the primary and secondary market in the six biggest cities on Figure 1. Usually new construction is of better quality than the existing housing stock, it is more energy efficient and has many amenities, such as parking space under the building or elevators. It also can be directly used without the need of a general refurbishment. However in the case of Warsaw most of new construction took place in parts of the city that are rather distant from the city centre and which initially lacked a well-developed cultural, educational and transport infrastructure, thus potential buyers were willing to pay less than for the existing housing stock. This relationship switched in 2014, when developers started to supply housing in good locations. According to the estimates presented in NBP (2013), in the regional cities approximately around one third of transactions in the

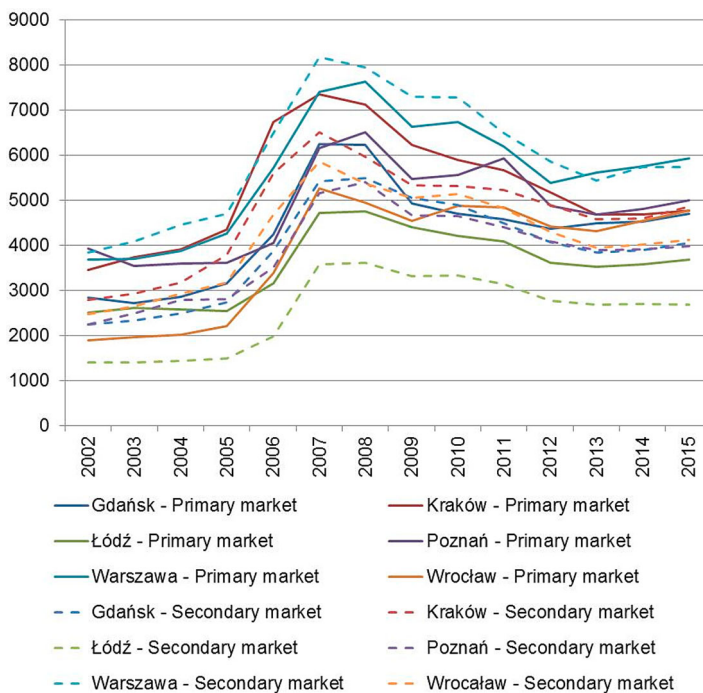


Figure 1. House prices on the primary and secondary market – 6 biggest cities, CPI defl. price per sq. metre in PLN (y-axis). Source: NBP.

housing market took place in the primary market, while two-thirds took place in the secondary market. This results from the lower prices but also from the much higher supply of housing in the secondary market.

In Figure 2 we present the main determinants of house prices for the Warsaw housing market that is the unemployment rate, credit costs, construction costs and wages. The data shows that during the whole period wages were rising, while the price boom was preceded and accompanied by a falling unemployment rate and falling credit costs. As a result of the housing boom, the constructions costs started to rise, but declined slowly after the boom faded out at the beginning of 2009.

The main economic and fundamental drivers of housing demand in the remaining cities behave in a similar fashion. The analysis of the Warsaw market performed by Augustyniak et al. (2014a) shows that housing demand increases when income rises and/or when interest rates fall, which leads to lower loan instalments. Another important factor on the primary housing market are construction costs, which increase when demand rises and supply rises quickly. We include the average unemployment rate, which is a good proxy for the overall performance of the economy. One important feature of using the unemployment rate rather than its complement – the employment rate – is the fact that it reacts strongly when the economic situation improves. A falling unemployment rate indicates that the economy is growing and makes people more optimistic, by which demand for housing increases. In an international panel of house prices Schnure (2005) found that a rise of the unemployment rate by 1% decreases house prices by 1%. Our empirical model draws on the metropolitan area house price model of Jud and

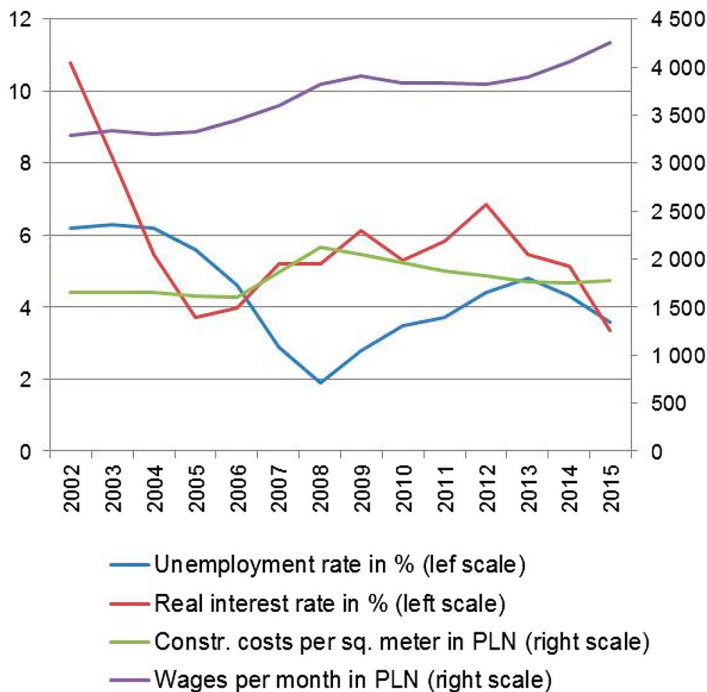


Figure 2. Unemployment rate, credit costs, construction costs and wages in Warsaw. Source: NBP, CSO.

Winkler (2002), the previously described empirical literature and the detailed analysis and description of the housing market in Poland presented in Baldowska, Myszkowska, and Leszczyński (2014). Following the notation of Jud and Winkler (2002) and Égert and Mihaljek (2007) we express the demand for housing Q_d as a function of the following factors:

$$Q_d = f(\text{price, wages, loan availability, credit costs, unemployment rate}),$$

while the housing supply Q_s is expressed as:

$$Q_s = f(\text{price, construction costs, credit costs}).$$

Because demand has to equal supply in equilibrium, we can join the two equations and obtain the determinants of the house price:

$$P = f(\text{wages, loan availability, credit costs, unemployment rate, construction costs}).$$

We chose the explanatory variables on the basis of the previously discussed empirical literature and the detailed statistical and graphical analysis of house prices and their drivers in the Polish house market presented in NBP (2013). We decided to include the following explanatory variables: average wages in the enterprise sector, the unemployment rate, the average available mortgage, the weighted real interest rate⁶ and construction costs. All monetary variables are deflated with the CPI in order to exclude the inflation trend. For each market we use local explanatory variables, only the interest rate and the construction cost growth rates are the same for all analysed cities. The construction cost growth rates are very similar for various regions, because they result from changes of the costs of material and labour. Both factors are very mobile in Poland, the prices differ in levels, but not much in growth rates. The time series for individual demographic factors like migrations or new marriages, which should increase housing demand, do not show enough variation to enter the regression in a significant way and are therefore excluded in the final regression.

In the regressions we use the logarithms of the house prices, income levels, unemployment rates and construction costs, while the real interest rate remains as it is. The interest rate is not transformed into logs, which allows us to capture the non-linear effect of the interest rate on the house price. We apply the fixed effects (FE) regression method⁷ with robust standard errors (bootstrapped 1000 times).

House prices,⁸ wages and construction costs are non-stationary, yet, the Pesaran test (2004) shows that the error terms of our regression are not correlated and we find that the error terms are stationary. This allows us to conclude that the regression models are correctly specified. The tests were repeated for every specification that is presented in this paper and the stationarity of the error terms was always confirmed. We provide a brief description of the data and its sources in Tables 1 and 2.

2.1. Analysis of the primary market

In the first regression we explain the transaction price per square metre of housing with its lagged price, the rate of unemployment, building costs and the average wage in the enterprise sector. In order to an increase in the unemployment rate decreases house prices with an elasticity of 0.35, while an increases of income increases prices with an elasticity of around 0.50, *ceteris paribus*. The real interest rate has a negative effect, as it makes mortgages

Table 1. Variable description and sources.

Variable name	Description	Source
L_price_primary	Log of the price of flats in the primary market, PLN per sq. metre	NBP ^a PONT
L_price_secondary	Log of the price of flats in the secondary market, PLN per sq. metre	NBP, PONT
L_unemployment	Log of the unemployment rate	Central Statistical Office (CSO)
L_wages	Log of average monthly wages in the private sector	CSO
real_intrate	Real interest for mortgages, deflated with the CPI	NBP, CSO
L_constr_costs	Log of construction costs in PLN per sq. metre of housing	Sekocenbud, CSO
L_average_mortgage	Log of the average mortgage, in PLN	NBP, own calculation
L_flats_stock.D1	Growth rate of the available housing stock (units of flats)	CSO
L_new_flats	Log of the number of newly constructed flats	CSO
L_new_flats.D1	Growth rate of new housing construction (units of flats)	CSO

^ahttp://www.nbp.pl/homen.aspx?f=/en/publikacje/inne/real_estate_market_q.html.

more expensive. A rise in the real interest rate by 1% decreases house prices by 1.14%. Rises in construction costs by 1% increase prices by 0.55%. Construction costs grow if construction accelerates quickly. During a boom period, factories have problems to create enough construction materials and the labour market for skilled construction workers gets tight. It should be mentioned that after the price boom the slowly declining construction costs added to the slow decline of house prices. The within R^2 of the regressions in the primary market is close to 80%. The regression results are presented in Table 3.

In regression (2) we substitute in the core model (1) the weighted real interest rate and the log wage with the log of the average available mortgage. This measure is the maximal amount of mortgage a household can obtain under the assumption that it uses at most 60% of its income for the payment of a mortgage that has to be repaid in 20 years.⁹ This measure rises when income levels increase or interest rates fall. The available mortgage has a strong positive effect, its increase by 1% leads to an increase in prices by 0.6%. It has such a strong effect that the effects of the unemployment rate and construction costs decrease, yet those variables remain statistically significant. We also tested whether the amount of new supply has an effect on prices. The growth of the whole housing stock was added to the baseline regression in regression (3), however it turned out to be insignificant. Also the growth rate of new production (regression 4) and the log of new production (regression 5) did not enter the regression in a significant way. It seems that the supply of new housing is still not high enough to have an impact on house prices. This finding is in line with the significant housing gap per 1000 inhabitants in CEE countries (see NBP, 2015). The price elasticity of

Table 2. Variable statistics and unit root test results (Harris and Tzavalis (1999)).

Variable name	Mean	Std. deviation	Min.	Max.	Unit root test (z-value)
L_price_primary	8.266	0.277	7.463	8.940	-0.2581
L_price_secondary	8.060	0.368	7.240	9.010	-0.4384
L_unemployment	1.992	0.475	0.531	2.950	-1.5080
L_wages	7.927	0.181	7.621	8.398	3.0870
real_intrate	0.035	0.022	0.010	0.087	-7.1694
L_constr_costs	7.490	0.087	7.378	7.662	-1.2702
L_average_mortgage	12.674	0.278	12.137	13.431	-5.4008
L_flats_stock.D1	0.016	0.013	-0.005	0.083	-16.2459
L_new_flats	7.378	0.951	4.736	9.877	-10.4616
L_new_flats.D1	0.028	0.367	-1.172	1.233	-21.8869

Note: The unit root test for the primary market was performed only for those cities which had all observations as the Harris and Tzavalis (1999) test requires a balanced panel. Białystok, Bydgoszcz, Katowice, Kielce, Opole, Rzeszów and Zielona Góra were excluded, because we do not have data for 2002–2004.

Table 3. Regression results for the primary housing market in 17 cities. 2005–2015.

L_price_prim	(1)	(2)	(3)	(4)	(5)
L_unemployment	−.3502*** [.0642]	−.1549*** [.0530]	−.3508*** [.0580]	−.3642*** [.0648]	−.3945*** [.0560]
L_wages	.4964*** [.1470]		.4160*** [.1530]	.6544*** [.1415]	.6845*** [.1702]
real_intrate	−1.1480*** [.3075]		−.2210 [.8085]	−.5787 [.6965]	−.7847** [.3272]
L_constr_costs	.5585*** [.1814]	.1276* [.1923]	.6479*** [.2119]	.3658 [.2456]	.3721* [.1947]
L_average_mortgage		.6402*** [.1343]			
L_flats_stock.D1			−1.4536 [1.4228]		
L_new_flats.D1				−0.0152 [.0218]	
L_new_flats					−.0263 [.0426]
Constant	.8439 [2.1874]	−.1288 [1.5189]	.8081 [2.3041]	1.1104 [2.3732]	1.0284 [2.1301]
No. Obs.	210	180	200	183	193
R-sq. within	0.7957	0.7682	0.7756	0.7997	0.8181
Between	0.4228	0.7646	0.4277	0.4414	0.3595
Overall	0.6462	0.7672	0.6256	0.6190	0.6109

Note: Level of significance: * – 10%; ** – 5%; *** – 1%; heteroskedasticity and autocorrelation consistent standard errors in brackets.

the unemployment rate and income did not alter very much and are highly significant throughout the various model specifications. We finally want to point out that the effect of the real interest rate is not robust for the different model specification. When the growth of the housing stock or the growth of new supply is added in the model, the real interest rate does not enter the regression in a significant way. Only when the new supply of housing is added, it enters the regression with significance at the 5% level, but its economic effect is slightly lower than in the baseline model. This indicates that for purchasers of new dwellings the real interest rate is not a strong and robust demand factor.

We compare the actual prices and the predicted prices in individual cities in [Figures A1–A4](#), which can be found in the appendix. To improve the visibility of the results, we divide the cities into eight large and nine smaller ones.¹⁰ The fit is quite good in most cities and only in the case of Katowice we observe a significant shift between the actual and predicted prices (see [Figure A4](#)). The explanation for this phenomena is that Katowice is a quite small market in the whole Silesian agglomeration and shows a very high average wage level, while many people employed in Katowice live in the surrounding cities. The factual housing demand, if we would calculate it on wages of people who actually live in Katowice (but such data are unavailable), would be lower than the predicted one. The city has also a large housing stock in relation to its inhabitants. In consequence, the house price in Katowice is overestimated. We also tried to run regressions 1–5 without Katowice but the results do not alter significantly.¹¹

2.2. Analysis of the secondary market

The next step in our analysis is the secondary housing market. The estimation of various specifications leads us to the same models that we apply to the primary market. The first model for the primary market seems to be well suited for the secondary market, too. It has a similarly high within R^2 value (80%) and the explanatory variables are significant at the 1% level. In model 6 the price elasticity of the unemployment rate is -0.43 , that of wages 0.76 and that of the interest rate is close to -3 , *ceteris paribus* (see [Table 4](#)). We substitute the wages and the real interest rate with the average mortgage in regression 7 and find that a 1% rise in the available mortgage leads to a 0.88% increase in house prices. The elasticity of the unemployment rate decreases to -0.09 . This finding is in line with the fact that

Table 4. Regression results for the secondary housing market in 17 cities, 2005–2015.

L_price_second	(6)	(7)	(8)	(9)	(10)
L_unemployment	−.4310*** [.0425]	−.0960** [.0377]	−.4394*** [.0397]	−.4492*** [.0401]	−.4518*** [.0364]
L_wages	.7655*** [.1113]		.7761*** [.1525]	1.0245*** [.1616]	.9842*** [.1179]
real_intrate	−2.9649*** [.4891]		−2.8279*** [.7673]	−2.2836*** [.6986]	−2.2607*** [.4766]
L_average_mortgage		.8893*** [.0599]			
L_flats_stock.D1			−.3996 [1.2613]		
L_new_flats.D1				.0175 [.0151]	
L_new_flats					−.0025 [.0285]
Constant	2.9549 [.8952]	−2.4351*** [.7756]	2.8892** [1.2262]	.9300 [1.2820]	1.2725 [.9867]
No. Obs.	238	187	221	204	221
R-sq. within	0.8063	0.8546	0.7683	0.8242	0.8481
Between	0.3666	0.7906	0.3441	0.3318	0.3481
Overall	0.5773	0.8061	0.5176	0.5219	0.5739

Note: Level of significance: * – 10%; ** – 5%; *** – 1%; HAC robust standard errors in brackets.

a large share of secondary market housing is financed with a loan. Rising interest rates make loans more costly and less available and therefore curb the price growth in the secondary market. Like in the case of the primary market, we add various measures of house supply to the baseline regression. However, the growth of the total stock, the new supply of housing and its growth (regressions 8–10) do not enter the regression significantly. The coefficients of the fundamental variables do not change much and they remain highly significant. We infer that the total stock of housing is too small to satisfy housing needs and new supply is insufficient, too. Unlike in the case of the primary market, the real interest rate is highly significant for all model variations and its coefficient is robust to changes of the model specification. The actual and estimated prices for the secondary market are compared on [Figures A5–A8](#). For the majority of cities the fit is very good, only the prices in Katowice are overestimated. This is due to the reasons mentioned in the analysis of the primary market. Moreover, the prices for Białystok, Lublin and Kielce are systematically underestimated. Those cities have a very high unemployment rate and quite low official wage levels. We assume that there is a significant share of people who work unofficially or work in larger cities or even abroad and buy housing with a salary that is higher than the city average. Another important factor is the unofficial trade with eastern countries, which boosts the income of people who live in those cities.

2.3. Comparison of the primary and secondary market

The empirical analysis of the both markets allows us to confirm that Hypothesis 1a and 1b is true for both markets. House prices in the primary market and the secondary market react to the unemployment rate, wages, the real interest rate and also the available mortgage. In order to verify Hypothesis 2, we compare the coefficients we obtain for both markets, comparing models 1 and 6, and also models 2 and 7. We find that prices in both markets react in a similar way to the unemployment rate. However, the reaction to income in the secondary market is nearly twice as high as in the primary market, while the coefficient on the real interest rate is nearly three times larger. Most likely first-time buyers, who have little own capital and depend very much on mortgages, prefer to buy housing on the cheaper secondary market. When wages increase or interest rates

decrease, more people can afford to buy housing. The same holds for the average mortgage availability, which has a larger effect on prices in the secondary market than in the primary market. Housing in the primary market is bought at least to some extent with cash (either from savings or from selling another dwelling, see NBP (2013)), therefore the loan availability seems to be less important on the primary market.

A robustness check was performed. We added the construction costs to the secondary market regression to apply identical models for both markets. As expected, the construction costs do not have any effect on house prices in the secondary market and the regression results of the price determinants which are presented in Table 4 did not change much.

We conclude that hypothesis 2 is true, thus the primary and the secondary market should be analysed separately.

3. Conclusions

The analysis confirms that property prices in the primary and secondary market in 17 largest cities in Poland depend on fundamental variables such as wages, the rate of unemployment and the real interest rate. However, prices in the secondary market react significantly more strongly to changes of income, the real interest rate and the mortgage availability than they do in the primary market. One possible explanation is that different groups of buyers operate on those markets. This finding indicates that the primary market and the secondary market should be analysed separately. Analysing the mean prices of both markets jointly (as if they were the same) can result in misleading empirical results for policy-makers. Most likely first-time buyers choose the cheaper secondary market, why buyers on the primary market quite often have already a flat and only need to pay for the difference in value. Therefore, buyers on the primary market react less to economic fundamentals, than buyers on the secondary market do.

Various housing supply measures have no significant effect on house prices on both markets. This indicates that there is a significant shortage of the housing stock in comparison to the income levels that people obtain. Any new construction is sold quickly and the excessive demand remains.

To our best knowledge this is the first study that investigates the relationship between economic fundamentals and the primary and secondary housing market for a CEE country separately and for a panel of cities. The results can be especially useful for emerging markets, which are faced with a high demand for housing and have an existing housing stock that is relatively small and to a large extent outdated.

Notes

1. Dwellings in the primary and secondary market display differences in terms of building technology, quality of finishing, as well as in location. However Widlak (2013) and the analysis in NBP (2016) show that in Poland the hedonic price follows the average price very closely. Our aim is to introduce an empirical framework that can be quite simply applied to other regional markets, where usually only the average price is available.
2. Flats are the major form of housing in cities, houses can be found mostly in smaller towns and villages. Detached houses are very heterogeneous goods and traded infrequently.
3. A Voivodship is the administrative level of area in Poland, corresponds to the NUTS 2 regions. Poland is divided into 16 Voivodships.

4. Those are the capital cities of the 16 voivodships, with the exception that for the Pomorskie region we analyse Gdańsk and Gdynia, because those two cities are very close to each other and are equally important housing markets.
5. Transaction prices of housing for the years 2006–2015 are from the BaRN database (primary and secondary market). Prices in the period 2002–2005 were extrapolated on the basis of offer price dynamics coming from the PONT Info database.
6. The real interest rate is the weighted interest rate of PLN (Polish złoty) and FX denominated loans, where the weight results from the value of loans granted in a given year. FX mortgages were granted together with PLN mortgages during 2005–2011, whereas in the remaining years only PLN loans were granted.
7. The choice of the fixed effects regression model has theoretical foundations. This method is used when the selected sample is not random, but represents the entire population. Moreover, the economic analysis of individual markets, presented by Baldowska et al. (2014) shows that each market has a unique character, which practically does not change over time. The fixed effects method makes it possible to exclude this fixed element which is impossible to detect with any of the included explanatory variables, and would be erroneously attributed to the error term of the model. We also run the Hausman test. It showed that the random effects model can be used. However, the results of this test can be considered reliable only if a much bigger number of observations (at least 20–30 observations in a time-series) is present.
8. Gupta, Andre, and Gil-Alana (2015) performed a cointegration analysis of house prices among various countries in the euro area and found a long memory of house prices.
9. The calculation is described in detail in NBP (2016).
10. The division was based on the number of inhabitants in a particular city. 'Large' cities, i.e. with population exceeding 400 thousand inhabitants include: Gdańsk and Gdynia (as one big market), Kraków, Łódź, Poznań, Szczecin, Warsaw and Wrocław. The group of 'small' cities, i.e. with population of less than 400 thousand inhabitants include: Białystok, Bydgoszcz, Katowice, Kielce, Lublin, Olsztyn, Opole, Rzeszów and Zielona Góra.
11. The results are available upon request.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix: Graphical analysis of the regression results

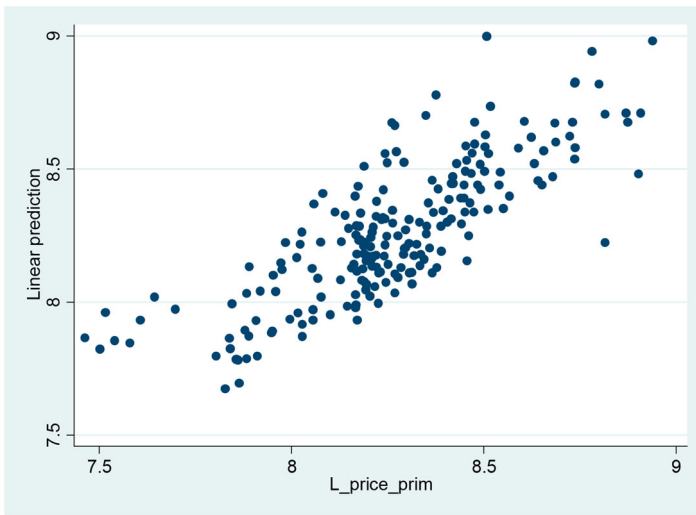


Figure A1. Predicted (y-axis) and actual log price per sq. metre (x-axis) for Model (1) – Primary market.

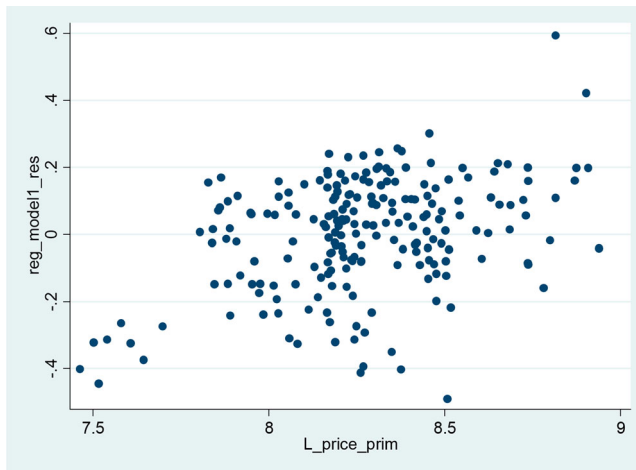


Figure A2. Error term (y-axis) and actual log price per sq. metre (x-axis) for Model (1) – Primary market.

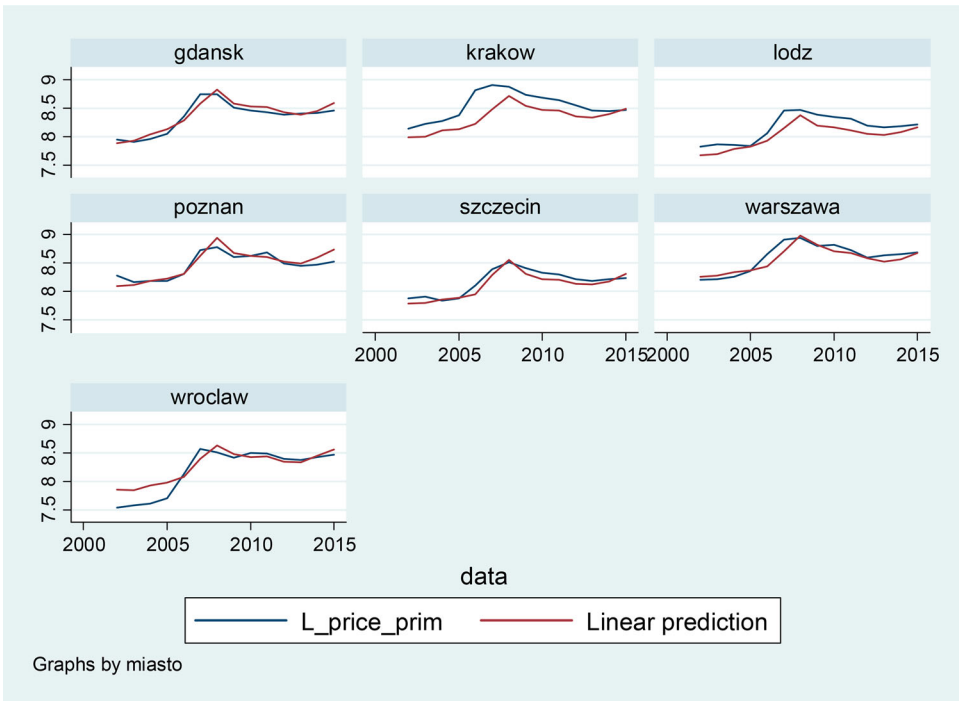


Figure A3. Predicted and actual log price per sq. metre for Model (1) for 'big cities'.

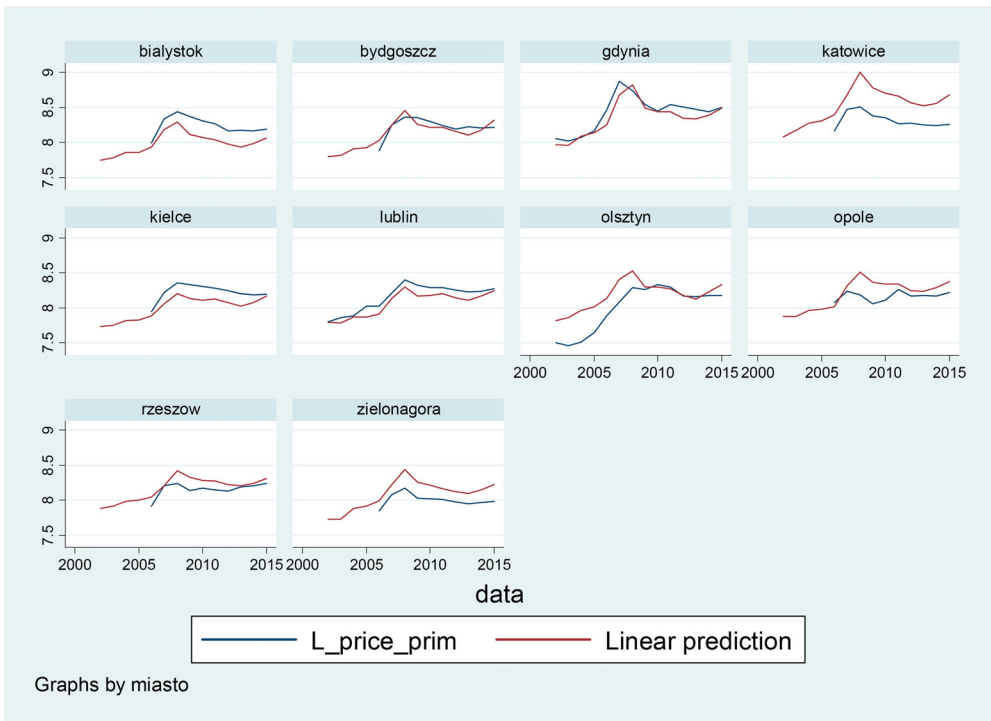


Figure A4. Predicted and actual log price per sq. metre for Model (1) for 'small cities'.

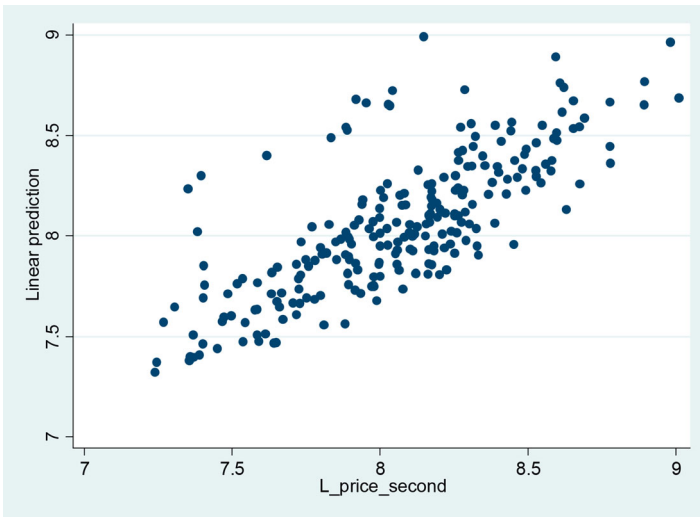


Figure A5. Predicted (y-axis) and actual log price per sq. metre (x-axis) for Model (6) – Secondary market.

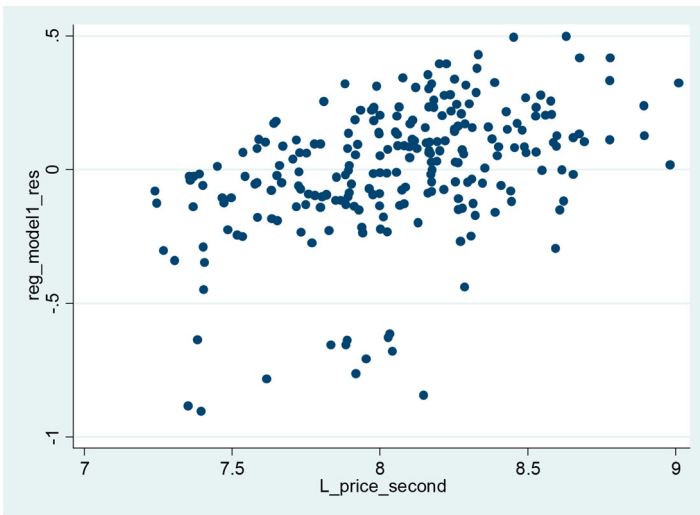


Figure A6. Error term (y-axis) and actual log price per sq. metre (x-axis) for Model (6) – Secondary market.

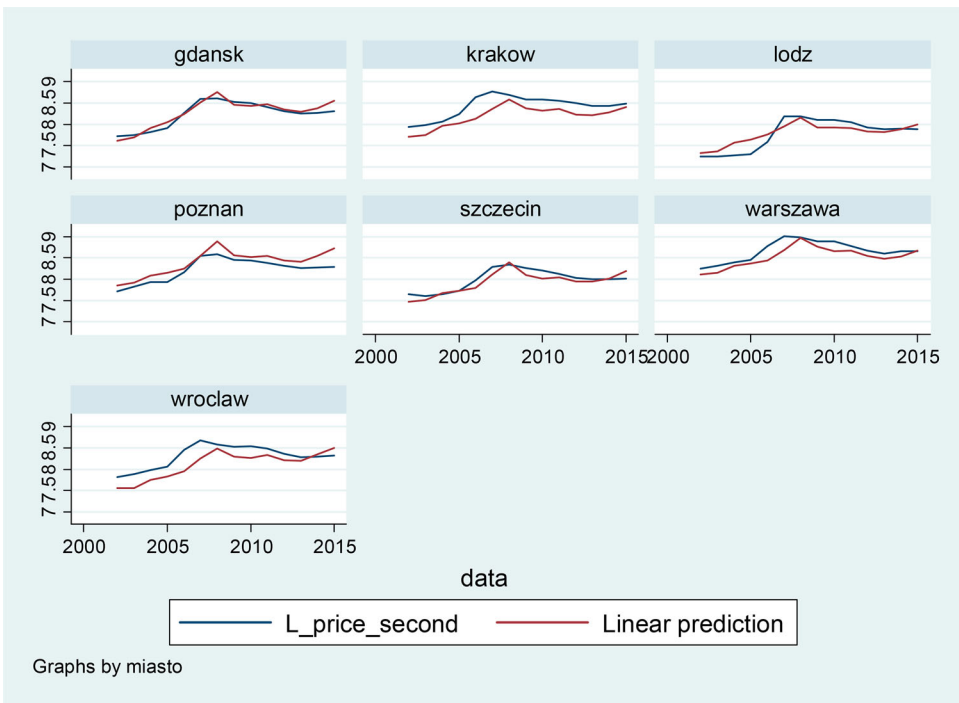


Figure A7. Predicted and actual log price per sq. metre for Model (1) for 'big cities'.

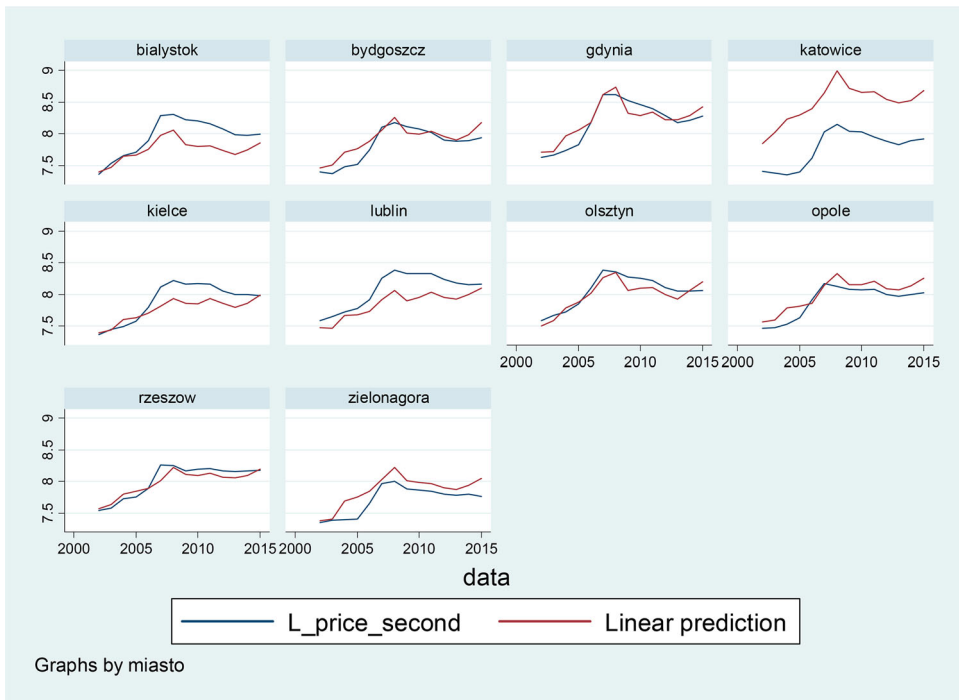


Figure A8. Predicted and actual log price per sq. metre for Model (1) for 'small cities'.