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Abstract

This article discusses and explains the dynamics of the primary housing market, focusing on housing supply, demand, price and construction costs dynamics. We focus our attention on the primary housing market, because it can create an excessive supply, which can cause distress to the economy.

Due to multiplier effects, even small changes in fundamental factors, such as a minor changes in the interest rate, result in demand shocks. Positive demand shifts cannot be easily satisfied, as supply is rigid in the short run. This usually makes house prices grow and developers increase their production, which will be delivered to the market with a lag. Housing developers have the marketing tools to heat up the market for a prolonged period of time. Rising prices can lead to further demand increases, because housing is a consumer and an investment good. When demand moves back to its long run level, the economy is left with excessive supply, falling prices and bad mortgages.

We create a simple four-equation model, which is able to replicate the dynamics of the Warsaw primary housing market. Our model replicates historical data in an appropriate way and we apply it to forecast house prices in the next two years on quarterly basis.

JEL classification: E32, E44, E37, R21, R31

Key words: Housing market cycles, disequilibrium demand and supply forecast

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1. Introduction and motivation

A dwelling plays an enormous role in the life of every household as a capital good, that generates consumer services and an investment good, which is a source of income for the future (see DiPasquale, 1992, Henderson and Ioannides, 1983 and Łaszek, 2013). The decisions of households that buy housing on the primary market depend on incomes, interest rates and prices, while those of developers who produce it depend on prices and costs.

The analyses of the housing market is very important because the housing market serves a social function but also because it can negatively affect financial stability. The cyclical character is a permanent feature of the housing market and can be explained by the low elasticity of supply. The financial system and consumer behaviour have a pro-cyclical effect on demand. Ciarlone (2012) claims that housing booms in Eastern Europe were mainly caused by regulations and the lack of housing in comparison to basic needs of the households, not just by speculations.

Moreover the market is imperfect, there is a long construction process and market players behave irrational. Another problem is the information asymmetry, which means that during transactions one party is better informed than the other. Problems with reliable and complete information are in many cases a result of brokers' and developers' marketing activities in mass media, so the buyer can see a distorted picture of the market. However, developers face positive and negative consequences of the market intransparency. They can obtain higher returns, selling dwellings at high prices to uninformed clients. However, it is difficult for them to plan future production when signals from the market are misleading.

While demand is analysed in various articles, the supply side is less often studied and models of the market that could be used to make forecasts are not well developed. We can find complex economic models in the literature, where the housing market is taken into account, but it usually plays a minor role. Researchers that try to incorporate housing in DSGE models need to simplify the housing market and the supply side is usually not captured or it is ad-hoc, included just to close the model. They usually do not account for accelerator effects and frictions in the housing market, speculative behaviours and finally the time to build. If DSGE models would include a fully developed housing market, they would be too complicated to be solved with state-of-the-art mathematical tools. This is understandable, as their aim is to model the whole economy and explain the inflation. However, if one wants to model house price dynamics, it is necessary to understand the connections between the demand and supply side. We believe that our model describes the reality of the primary housing market better than other models do and it is useful in the analysis of the impact of changes in income or mortgage rates on house prices. Additionally, we explain the influence of regulations on the real estate market.

It is important to stress that we analyze newly constructed housing and not the whole housing stock. Adjustments of the housing stock through migrations, the construction of new housing and its depreciation and destruction happen in the long run only. People move relatively seldom and the wealth effect will hinder housing owners from selling them if prices rise. In the short term, increased housing needs can be satisfied only with new construction and rising demand leads through rising prices to construction booms. Those booms end quite often in excessive debt accumulation and sometimes in banking crises that are accompanied by an economic slowdown.

The aim of our article is to forecast house prices in the most accurate way. We set up a housing model that bases on our work in Augustyniak et al. (2014a) and explain the dynamics of the primary housing market with a simple four-equation model of housing supply, demand, price and construction costs. Our model replicates historical data well and we apply it to predict future value of the house prices, demand, supply and costs in the next two years on quarterly basis. The economy has a direct impact on the housing market, while the effects of the housing market come through the labour market and the banking sector with a certain delay to the economy and might be non-linear. Therefore, we decided to model the housing market only and take the whole economy as given and apply the official NBP NECMOD forecast for the whole economy (see NBP 2014b).

Our paper is organized as follows. In chapter 2 we explain the housing dynamics, focusing especially on housing demand and supply in the primary market. We present a simple dynamic model of the market in chapter 3. In chapter 4 we estimate the model and discuss how well it fits empirical observations. The forecast of house prices for the next two years is presented in chapter 4, while chapter 5 concludes the paper.

2. Explanation of housing demand and supply dynamics

The transactions in the housing market are those of new constructed housing and sales of housing from the existing stock. A very detailed analysis of the relationship between those two markets can be found in Augustyniak et al. (2014a) and the relationship at the city level for Poland was investigated empirically by Leszczyński and Olszewski (2014). Because supply from the existing housing stock is rigid in the short and medium run, any excessive demand translates very quickly into excessive demand for new construction (see Augustyniak et al. 2014b). We now explain the demand and supply in the primary housing market.

2.1 Housing demand

Housing cycles are driven by excessive increases in housing demand, thus we start our analysis by explaining the dynamics of housing demand. Our simple housing demand model bases on the assumption that housing is bought with the use of a mortgage, thus the cost the household has to pay every month is the loan instalment. Households use their income for the loan repayment[4] and the consumption of other goods. In order to obtain a housing demand that is in line with empirical observations, we have to include the imputed rent in the

[4] Prudential regulations set a maximal limit of the monthly loan service to the income, to curb excessive housing demand.

utility function. This means that when house prices rise, the imputed rent rises too. Without this fact, rising prices would make households to decrease housing consumption and increase the consumption of other goods. In reality we observe that amidst rising prices households give up as much of consumption of other goods to increase housing consumption as much as possible. Similarly as in Bajari et al. (2013), the imputed rent $k * p * H$ is the size of the apartment H, multiplied by its price p and by a rent-to-price rate k. We write the utility function as:

$$U(C,H) = (\theta C^{\mu} + (1-\theta)A^{\gamma}(kpH)^{\mu})^{\frac{1}{\mu}}$$

where the parameter μ denotes the elasticity of substitution between consumption and housing, ε = 1 / (1-μ) and the parameter θ denotes the share of utility resulting from consumption of other goods. According to Henderson and Ioannides, 1983 and Łaszek, 2013 housing is bought for consumption and investment purposes. To capture the latter purpose, we include the appreciation of housing in the utility function $A = \frac{p_t}{p_{t-1}}$. We assume that consumers form extrapolative expectations and rising prices make housing a more desirable good (see Dunsky and Follain, 1997, Sommervoll et al., 2010 or Lambertini et al., 2012, Salzman and Zwinkels, 2013).

In order to find the optimal amount of housing, we optimize the consumers' utility under the following budget constraint: $b = rpH + C$. Under fixed loan instalments, the cost of housing borne by the consumer in a given period is the price per square meter of housing p multiplied by the mortgage rate r and the house size in sq. meters H. We normalize the price of the consumer good to 1. Solving this problem yields the following optimal substitution of consumption of housing and other goods

$$\theta C^{\mu-1} rp = (1-\theta)A^{\gamma}(kp)^{\mu}H^{\mu-1}$$

When we include this optimality condition in the budget constraint, we get the optimal choice of consumption goods and housing.

$$C^* = \frac{b}{1 + rp\left(\frac{\theta}{1-\theta}\frac{rp}{A^{\gamma}(kp)^{\mu}}\right)^{\frac{1}{\mu-1}}}$$

$$H^* = \frac{b}{rp + \left(\frac{1-\theta}{\theta}\frac{A^{\gamma}(kp)^{\mu}}{rp}\right)^{\frac{1}{\mu-1}}}$$

The housing demand equation tells us that housing rises with income increases and also when interest rates rise. High prices have the usual negative effect on demand, but if they rise fast in a given period, they increase housing demand. The rationale is that consumers are worried about even faster rising prices and anticipate housing purchases or hope to sell it later at a higher price. We would like to refer to Augustyniak et al. (2014b), where we show

how a simultaneous growth in income, decline of mortgage rates and increase of house prices leads to an increased housing demand.

2.2 Supply of housing from real estate developers

Housing supply is the other leg of the housing boom, but unlike the demand side it gained little attention in the literature. There are studies on the supply of housing such as Muth (1960), Smith (1976), DiPasquale (1999), Epple, Gordon and Sieg (2010), but most of the studies do not go into details about producers' decisions under the time to build problem. The biggest obstacle to the empirical analysis of housing supply at the firm level or even the city level is the lack of data on individual developers and their cost functions. The costs and duties of a developer at each stage of the construction process are described in detail in Augustyniak et al. (2014b) and we refer there, while in this article we focus on the average housing supply function.

Although the housing production function can be written as a Cobb-Douglas function, most empirical works do not base on micro-foundations but rather run ad-hoc regressions. We think that the basics should be well explained and we base on a housing production function developed by Smith (1976), which we replicate here in detail. Smith makes two important assumptions, which are very close to reality and help to understand the developer market. First, house producers have a constant returns to scale production function, thus they can produce any amount of housing if they increase their production capacity. Secondly, developers create a good which is not homogenous but is of varying quality. This quality depends on the land L and materials K that are used and buyers pay a price P for the quality Q. The market price of housing P^* is the product of the house quality and its price. Housing of a given quality is produced with the following production function $Q=Q(L,K)$. For simplicity we set the price of land as R and normalize the price of capital to one. In order to maximize profits, the developer has to choose the optimal amount of land and capital and his profits at a given location can be described as:

$$\pi = PDQ - KD - R$$

We focus on profits that are obtained from an unit of land, where D is the density of housing units put on a piece of land $(D=1/L)$. The production function per unit of land can be written as $q(D,K)$ and we set up the Lagrangean to solve the problem:

$$\mathcal{L} = PQD - KD - R - \mu(q(D,K) - Q)$$

After taking first derivatives of the Lagrangean in respect to D, Q an K and solving the system, we obtain two first order optimality conditions:

$$PQ = K - D(q_D/q_K)$$

$$P = 1/q_K$$

In equilibrium developers choose such a type of housing that the marginal cost of increased density equals the market price P* and the marginal cost of increased quality of a dwelling equals the price of quality (see Smith 1976, p 394). In the long run the profits of the developers should be zero and all profits go to the land owners. From this follows that the price of land is given as *R=PQD-KD*. Smith shows that from this equation follows that land prices and housing quality are positively related. This theoretical finding is in line with empirical observations, as better locations usually offer housing of higher quality[5]. No reasonable developer would pay for good land and construct poor quality housing.

In fact the urban housing development process is more complex and allows the developer to make certain adjustments. As we show in Augustyniak et al. (2014b), the developer faces a virtual and a real supply curve. In short, the developer can increase his production without increasing costs, as he uses outsourcing of construction services. Moreover, he uses the pre-payments of clients which is basically an interest free source of funding and buys most of production factor just in time. This makes him assume that he can expand his production and make significant profits. However, in reality there are many housing producers, by which construction, material and land costs increase, thus the factual supply curve has the well-known shape each usual productive firm faces. Moreover, housing is a heterogeneous good and allows the developer to use a price discriminating strategy, by which he sells each apartment to the highest bidder and rises his profits (see Łaszek and Olszewski, 2014) for more details.

For the analysis of housing dynamics at the city level it is enough to understand that developers are profit maximizers which choose the optimal amount of land and housing quality. Here we need to go one step further. As developers have to form expectations, we assume that they increase their production if their short-term profits increase and if they assume that house prices will rise further.

3. Simple representation of the housing demand and supply cycle

Before we move to the estimation of the housing demand, supply, price and cost equations, we show a simple graphical analysis of the housing cycle that bases on the cobweb model. We start from the equilibrium point, where new production meets housing demand. The market price covers the production costs, average profits and the risk premium, but there are no extraordinary profits (see Figure 1). Under fixed supply in the short run a positive demand shock changes the established equilibrium and causes price increases (see Figure 2). Taking into account constant costs in the short run, extraordinary profits are appearing, which encourages housing producers to start new construction. New projects are delivered to the market after one year and supply increases (see Figure 3). One of the consequences of

[5] Grimes and Aitken (2010) discuss whether one can assume that construction costs are proportional to land costs, but our observations and also data presented in the detailed analysis of housing construction costs presented in NBP (2014a) indicates that this assumption is backed empirically. If house demand rises, developers need to buy more land, which becomes more expensive. At the same time the demand for workers and construction material increase, thus total construction costs rise. Such an approach is used by Glaeser and Gyourko (2006) and Glaeser, Gyourko and Saiz (2008).

the supply rise is the lagged increase of construction costs and moreover, at some point excessive supply can emerge, leading to price declines. As a consequence, developers' profits decrease and they will not be any longer willing to produce more dwellings. In the next step the decrease of new projects will cause price increases and construction cost decreases. As a result developers' profits will increase, as we show below, which can trigger a new supply cycle (see Figure 4). In reality the market does not only face a one-time shift in demand, but rather a series of demand shifts that result from income growth, demographics, interest rate changes and various government subsidy schemes.

Figure 1 Demand and supply in the housing market

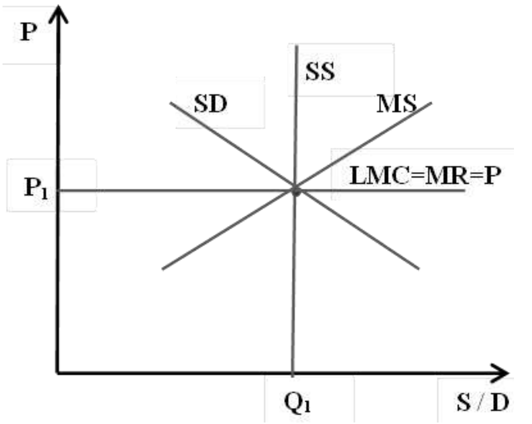


Figure 2 Demand shift

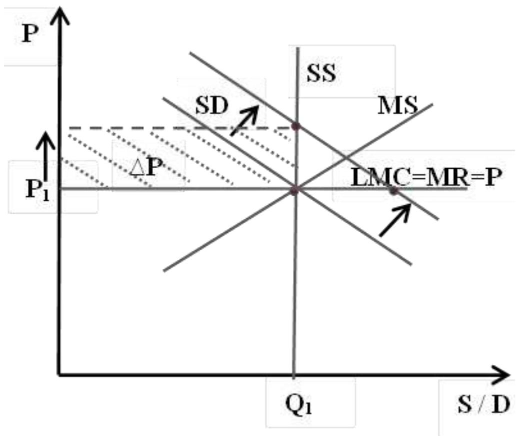


Figure 3 Supply response to a demand shift

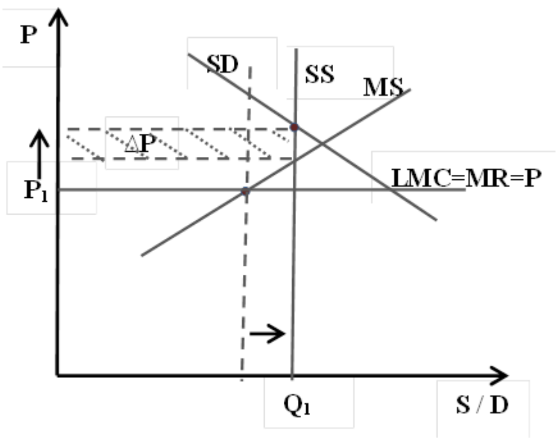
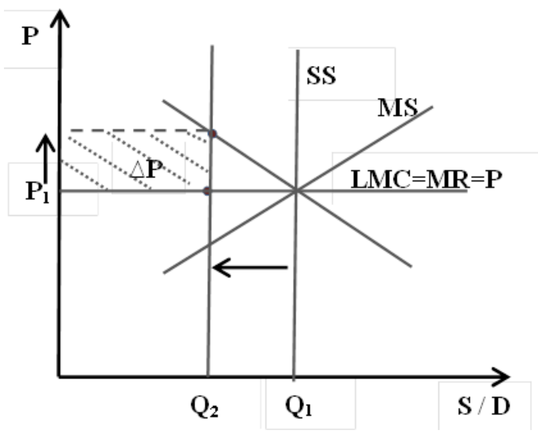


Figure 4 New equilibrium



4. Estimation of the housing demand and supply dynamics

In this chapter we base on above presented micro-founded model and the work of Mayer and Sommervolle (2010), Steiner (2010) and Augustyniak et al (2014b)[6]. The time-series that are available for most countries does not allow to estimate the previously presented micro-models directly. The housing demand equation cannot be transformed into a log-linear equation and we would need to use non-linear estimation methods. There are some parameters that would be estimated jointly and we do not have auxiliary data to disentangle the parameters. A reasonable approach is to rewrite the model with log-linear equations, which correspond to the initial micro-funded equations. We estimate our model using quarterly data and to cope with short-term shocks we use the four-quarters moving average. As in Mayer and Sommerville (2000), we create log-linear models of supply and demand, that describe the number of housing placed and sold on the market.

For the empirical analysis we use quarterly data for the Warsaw primary housing market. The house prices (P_t) origin from the NBP database BaRN. The number of housing units sold and placed on the market (HD_t, HS_t) comes from REAS data. Sekocenbud is the source of the construction costs ($\mathrm{PC_t}$). We use the Central Statistical Office (GUS) data on income in the private sector ($Income_t$) and the mortgage rate ($Intrate_t$) is calculated on NBP data. The supply, demand, price, income and construction costs time series are in logarithms. Because the REAS data start only in 2007Q1, we extended the data on housing sold and put on the market with the dynamics of CSO data on completed housing, lagged by 8 quarters. It takes around two years of time between the date at which the pre-sale contract is sold and the moment that the housing unit is completed. The demand, supply and construction costs equations were estimated separately on quarterly data for 2005Q1-2014Q3. Due to limitations in available data, the price equation was estimated for 2007Q1-2014Q3. We did not want to extend the time series for demand and supply with the same dynamics, thus we used only the original data for the price equation. We estimated each equation using the OLS regression, correcting for heteroskedasticity and autocorrelation. The recursive regression test for each regressions showed that the regression coefficients are robust.

The first equation describes the aggregated housing demand (HD_t):

$$HD_t = \alpha 1 + \alpha 2 * P_t + \alpha 3 * D(P_t) + \alpha 4 * Intrate_t + \alpha 5 * Income_t + \epsilon_t \ (1)$$

Here Pt is the log house price, $D(P_t)$ is the rate of house price growth. The interest rate ($Intrate_t$) and income in log terms ($Income_t$) are account for the changing economic situation. The empiric results (see table 1) show that there is a positive relation between aggregated demand and income and negative one in the case of prices and interest rates. As expected, the appreciation has a positive effect on housing demand.

The next step is the estimation of the supply in the primary housing market. Wheaton et al. (2001) and Hendershott et al. (2002) state that housing producers base their decisions on

[6] See Mayer and Sommerville (2000) or Steiner (2010).

past and information. The housing supply is the number of dwellings put on the market in a given quarter and is estimated with the following equation

$$HS_t = \beta 1 + \beta 2 * D(P_{t-4}) + \beta 3 * D(PC_{t-4}) + \beta 4 * Intrate_{t-4} + \epsilon_t \quad (2)$$

Here $\beta 1$ is the autonomous production, a particular number of housing units that will be produced regardless of current prices or costs (see Augustyniak et el. 2012). Basing on empirical observation, we include price increases lagged by one year *($D(P_{t-4})$)*. Producers of dwellings react directly to price increases and start new constructions, but those dwellings will be delivered to the market in the form of pre-sale contracts one year later. Higher construction costs lagged by one year $D(PC_{t-4})$ and lagged interest rates $D(Intrate_{t-4})$, lower the developers' willingness to begin new projects. The interest rates inform developers about consumers' financial affordability, which determines their ability to buy housing. Higher interest rates cause also higher alternative costs of investments in real estate.

The price adjustment mechanism is estimated in equation 3. The house price dynamics depend mainly on their lagged levels, so $D(P_t)$ depends on its past realizations $D(P_{t-1})$. Moreover, as in Tse, Ho and Ganesan, 1999 prices react with a one quarter lag to the supply and demand mismatch[7] *($HS_{t-1} - HD_{t-1}$)*. Excessive demand makes prices rise, while they start to fall under excessive supply.

$$D(P_t) = \vartheta 1 + \vartheta 2 * D(P_{t-1}) + \vartheta 3 * (HS_{t-1} - HD_{t-1}) + \epsilon_t \quad (3)$$

We tested the price adjustment for asymmetric reactions and found that the price increase in response to excessive demand is as strong as the price decrease in response to excessive supply. We would expect prices to decline faster than they rise, which would help developers to decrease the stock of unsold housing and the market move back to its equilibrium. However, developers lower their price expectations slowly, looking forward to find a buyer, that will be willing to purchase the dwelling for the high price. When dwellings are financed with credit, the loan agreement would refrain housing producers from decreasing prices below a certain level. Purchasers could negotiate the price, but they have very little negotiation power and not enough information about the number of unsold housing in a given location. Housing producers are not interested in lowering the price and amidst oversupply they still place new dwellings on the market. To some extent this is the result of projects which are under way and cannot be stopped. We observe this phenomenon, not just in the Polish housing market, but in other housing markets, too.

The construction cost dynamics $D(PC_t)$, which affect the start of new construction are estimated in equation 4. We find that construction costs depend strongly on their past realization ($D(PC_{t-1})$). Moreover, they grow with house supply increases ($D(HS_{t-1})$), as more input goods are needed and their costs increase.

$$D(\mathrm{PC_t}) = \rho 1 + \rho 2 * \mathrm{D(PC_{t-1})} + \rho 3 * \mathrm{D(HS_{t-1})} + \epsilon_t \quad (4)$$

[7] Indeed this is the same as the adjustment of the stock of unsold housing, which evolves as $Stock_t = Stock_{t-1} + HS_t - HD_t$, thus its change $\Delta Stockt$ equals $HS_t - HD_t$.

Using the four equations described above, we describe the dynamics on the housing market. We observe that constantly low interest rates or increasing incomes lead to a demand boom, which in turn causes price increases and a supply boom. When incomes and nominal housing prices rise at the same pace, relative house prices remain stable, and the housing boom can last for a long time. It can be stopped only by a huge shock (for example the sub-prime crisis in the USA, which enforce banks to constrain the disbursement of mortgages).

Table 1. Regression results of the determinants of aggregate supply, demand, prices and production costs.

	LHD_t	**LHS_t**	**$D(LP_t)$**	**$D(LPC_t)$**
LP_t	**-0.894** ***			
	(0.189)			
$D(LP_t)$	**7.714** ***			
	(1.465)			
$D(LP_{t-1})$			**0.835*****	
			0.089	
$D(LP_{t-4})$		**9.922** ***		
		(1.966)		
$Intrate_t$	**-13.301** **			
	(6.065)			
$Intrate_{t-4}$		**-12.770** *		
		(6.670)		
$LIncome_t$	**1.164** ***			
	(0.339)			
$D(LPC_{t-1})$				**0.977** ***
				(0.103)
$D(LPC_{t-4})$		**-14.377** ***		
		(2.033)		
$D(LHS_{t-1})$				**0.022** ***
				(0.007)
$LHS_{t-1} – LHD_{t-1}$			**-0.022** *	
			(0.012)	
C	**6.925** ***	**8.857** ***	0.001	0.0003
	(2.365)	(0.382)	(0.003)	(0.001)
Adj. R^2	0.82	0.71	0.69	0.89

*Newey-West standard errors HAC in brackets, ***, **, * significant at the: 1%, 5% or 10%.*

4.1 Analysis of deviations from the equilibrium

In this subsection we compare the empirical values with observed demand, supply, prices and the construction costs data in figures 5-8 and explain, which factors most likely caused the small differences between those values.

From 2004 to 2006 the demand for new apartments rose, which was caused by mortgage availability, increasing wages and expectations of price increases. From 2007 less households could afford to buy dwellings, that were getting more expensive. Basing on our model we could expect that the situation would change in 2009 and it happened indeed, but our estimations indicates that supply changes should appear one quarter earlier and demand should remain stable at a higher level for the next 2 years. Due to the global crisis and prudential constraints on mortgage available to households, demand decreased faster than stems from our model. In contrast, from 2010Q3 till the end of 2012 we observe that the empirical demand was greater than the estimated one, which most likely was a result of government subsidy scheme *Family on their own* that was aimed at subsidizing mortgages. The program ran out in the beginning of 2013 and during 2013 there was no subsidy program. Buyers waited for the implementation of the new *Housing for the young scheme* that went into force in 2014 and delayed their purchase decision. This explains why demand in 2013 was lower than the model demand and shows us how strong housing policy works.

Since the beginning of the analysed period the supply increased, but from 2007 it started to decrease. In 2009 the global financial crisis and the increasing risk aversion contributed to a dramatic decline in construction of housing units. Even when the supply recovered, the increase in a number of housing offers was not as strong as we could expect on the basis of our model. This was probably caused by developer's difficulty with selling dwellings and their problems with financing new investments. Since 2012 the model supply is very close to the empirical supply.

The empirical price and construction cost increases did not vary from their theoretical values and periodical deviations were random. Price adjustments usually occur with a 1 quarter delay to differences between demand and supply. Likewise, production costs tend to adjust to changes in production level.

Figure 5-8. Theoretical and empirical values of demand, supply, prices and construction costs, Warsaw primary housing market

Figure 5. Housing demand

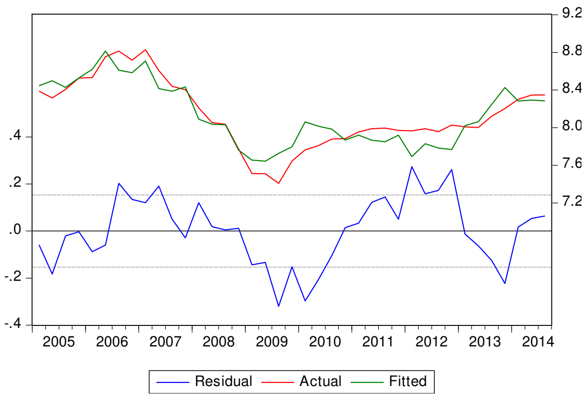


Figure 6. Housing supply

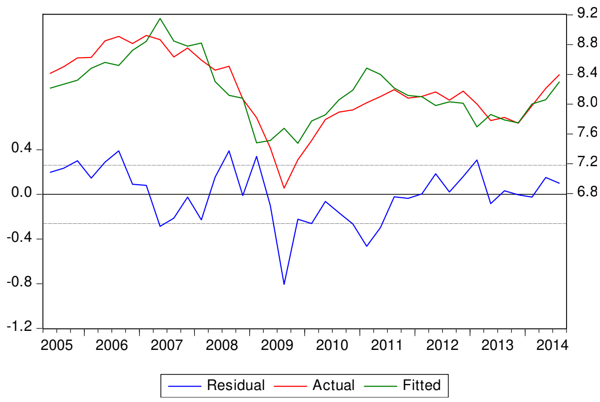


Figure 7. House price dynamics

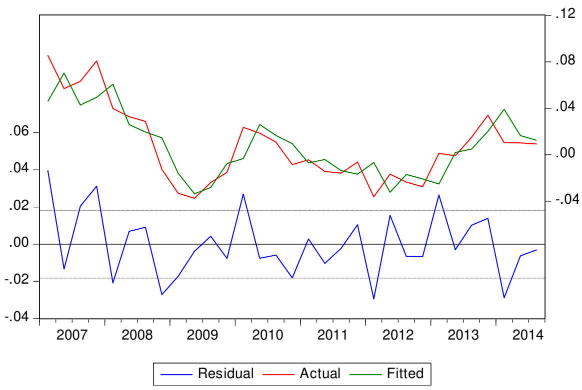
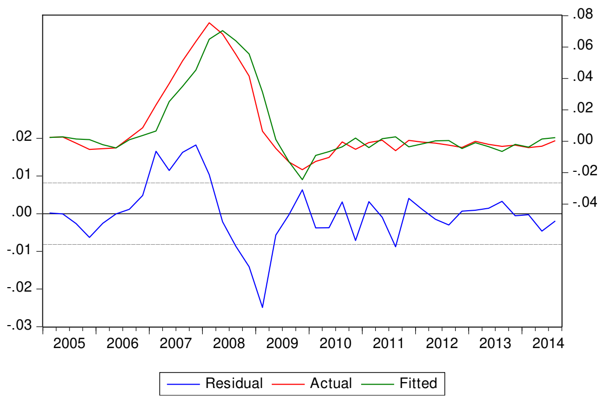


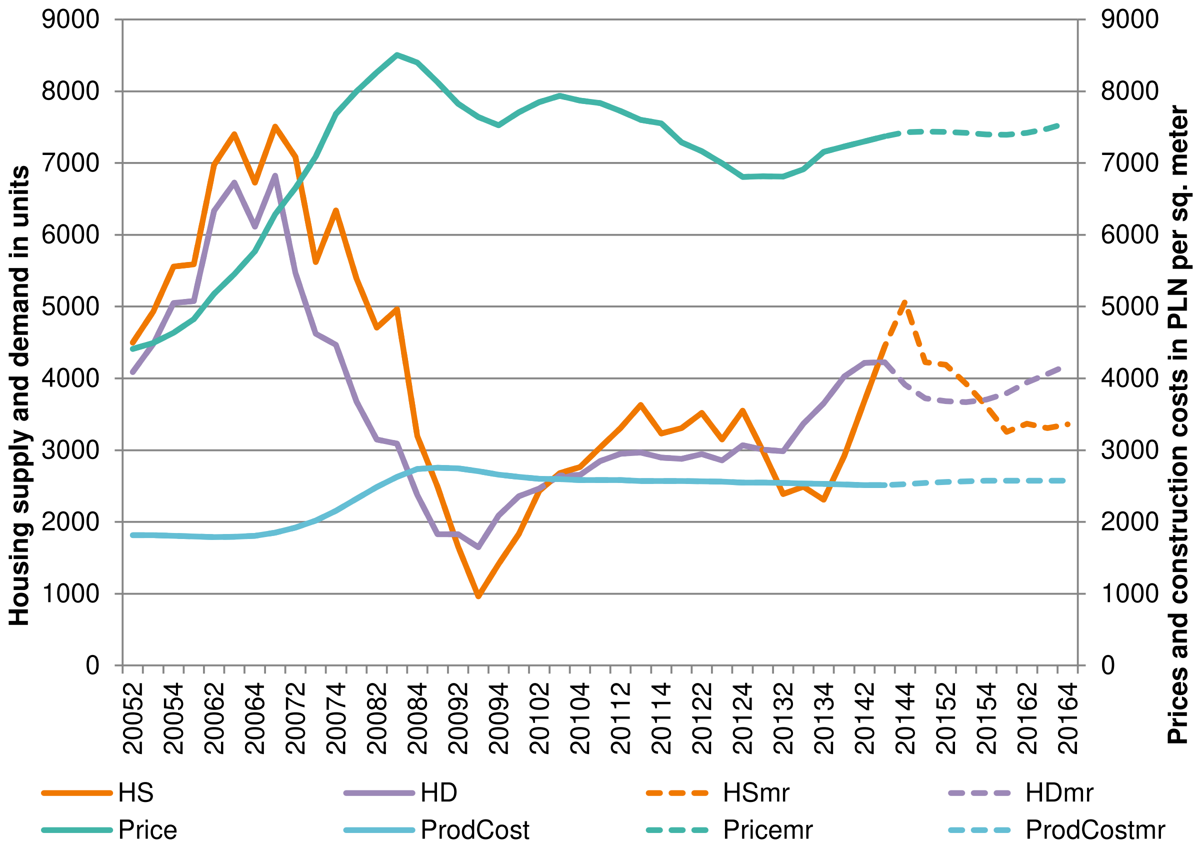
Figure 8. Construction cost dynamics



5. Forecasting of house prices

To forecast house prices we use our housing cycle model, which uses four endogenous variables (demand, supply, costs and prices) and two exogenous variables (mortgage rates and income). The historical data used in the analysis comes from the NBP database BaRN, REAS, GUS, Sekocenbud as described in part 3. The equations are recursive, which allows us to calculate the values for the next period and again for the next period, etc. For the forecast of the two exogenous variables we use the interest rate and economic growth projection stemming from the NECMOD model (see Budnik et al., 2009), published in the Inflation Report of the NBP (2014b). The income is assumed to grow at the same pace as GDP growth. Interest rates are always set constant over the forecast period, thus also the mortgage rate is constant. Our housing forecast covers the next 2 years on quarterly basis until the end of 2016. We would like to make our forecast as long as possible, but our intuition and also common knowledge on forecasting tells us that it is not reasonable to forecast for longer periods than two years. The forecast results were transformed from logs to normal numbers and are presented in Figure 9. The demand and supply measured in housing units is on the left axis, while prices and construction costs per sq. meter in PLN are presented on the right axis.

Figure 9. Forecast of housing demand, supply, house prices and construction costs



The observed values are presented as solid lines and the dotted lines show us the predictions. We see that prices should first decline and then increase slightly, while costs should be relatively stable in the future. Supply should rise for a short period and then decrease sharply. Demand should fall in the next quarters and increase gradually since the middle of 2015. As we stated earlier, housing policy has a strong effect and changes in the housing subsidy scheme can have a significant effect on demand. Also potential changes in interest rates will change the demand and supply of housing, but this is beyond the scope of this paper. Our forecast should be understood only as an academic analysis and an indicator that tells in which direction the housing market will evolve.

6. Conclusions

Our analysis allows us to determine the main drivers of housing demand and supply in the primary housing market in Warsaw. We first study the dynamics of the housing market and find that demand is mainly driven by rises in income and interest rate declines, und unlike expected, the appreciation of housing boosts its demand. The supply rises if increases in prices are higher than increases of construction costs.

We build a four equation model, which replicates the real dynamics of the housing market well. This model allows us to forecast the behavior of the housing market for the next two years on quarterly basis. As it can be easily replicated, we believe that our model is useful for policy makers, central banks and regulators to test how changes in mortgage rates or income affect prices, demand and supply in the primary housing market.

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