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On the dynamics of the primary housing market and the forecasting of house prices[1]

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On the dynamics of the primary housing market and the forecasting of house prices

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Abstract

This paper discusses and explains the dynamics of the primary housing market, focusing on housing supply, demand, price and the growth rate of construction costs. The attention is placed on the primary housing market because it can create excessive supply, which can cause distress to the economy.

Due to multiplier effects, even small changes in fundamental factors, such as 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 time lag. Housing developers have marketing tools to heat up the market for a prolonged period of time. Rising prices can lead to further demand increases as housing is a consumer and investment good. When demand moves back to its long-run level, the economy is left with excessive supply, falling prices and bad mortgages.

The simple four-equation model presented in this article is able to replicate the dynamics of the Warsaw primary housing market. Out-of-sample forecasting proves that the model replicates historical data in an appropriate way and the model is applied to forecast house prices, demand, supply and construction costs over two years on a 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 home plays an enormous role in the life of every household as a capital good that generates consumer services and an investment good that 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 the decisions of developers who produce it depend on prices and costs. An analysis of the housing market is very important because the housing market serves a social function and can increase the wealth of the home owner. However, during boom-bust episodes it can negatively affect financial stability. A permanent feature of the housing market is its cyclical character, which 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 the basic needs of households, not just by speculation.

The market is imperfect, there is a long construction process and the market players behave irrationally. Another problem is the information asymmetry, which means that during transactions one side 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[4], so the buyer can see a distorted picture of the market. However, developers face positive and negative consequences of this market intransparency. They can obtain higher returns, selling homes 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 for the primary housing market are not well developed. While there is a rich literature on the forecasting of house prices (see Rahal, 2014 for a detailed review), those models do not forecast the demand, supply and construction costs explicitly. In order to provide proper policy advice about the housing market, it is not enough to know how prices will evolve, but also what will drive them. Thus, supply, demand and construction costs need to be analysed and forecasted, too. Some macroeconomic models take the housing market into account, but it usually plays a minor role. Researchers that try to incorporate housing in DSGE (dynamic stochastic general equilibrium) 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. Those models do not account for accelerator effects and frictions in the housing market, speculative behaviour and finally the time to build. As Iacovelli (2010) explains, DSGE models aim to explain how housing affects consumption or how monetary policy affects the housing market. This is a great and important task, but it is also crucial to go more into the details of the housing market, such as the number of newly constructed dwellings. If DSGE models contained a fully developed housing market, they would be too complicated to be solved with state-of-the-art mathematical tools. This is

[4] Soo (2013) constructed a sentiment indicator from the tone of local housing news from 20 largest cities in the US during the 2000-2011 period. His sentiment indicator is able to predict house price booms and busts with a significant lead, which shows that mass media have a big impact on consumer behaviour and affect housing demand.

understandable, as their aim is to model the whole economy and explain inflation. However, if one wants to model house price dynamics, it is necessary to understand the connections between the demand and supply side. The model introduced in this paper presents a detailed explanation of the relationships between demand, supply, costs and prices, and is useful in an analysis of the impact of changes in income or mortgage rates on house prices.

It is important to stress that the model focuses on newly constructed housing and not the whole housing stock. Adjustments of the housing stock through migration, the construction of new housing and its depreciation or destruction happen only in the long run. The division of a housing unit into two or the conversion of commercial real estate into housing is very costly, happens only on a very small scale and takes a lot of time. In the short term, increased housing needs can be satisfied only with new construction, and through rising prices, rising demand leads to construction booms. These booms end quite often in excessive debt accumulation and sometimes in banking crises that are accompanied by an economic slowdown (see the case of the US, Spain and Ireland discussed in André, 2010, André, 2011 and Cerutti et al., 2015).

The aim of this paper is to forecast house prices, construction costs, demand and supply, thus the whole housing market. A housing model is set up that is based on the Augustyniak et al. (2014a) model and the dynamics of the primary housing market are explained with a simple four-equation model of housing supply, demand, price and construction costs. The model replicates historical data well, and it is applied to predict the future value of house prices, demand, supply and costs in the next two years on a quarterly basis. The economy has a direct impact on the housing market, while the effects of the housing market feed through the labour market and the banking sector with a certain delay to the economy and might be non-linear. Therefore, the whole economy is taken as given and the official NBP NECMOD[5] forecast is used (see NBP 2014b).

The paper is organized as follows. A brief overview of the Polish housing market is presented in chapter 2. The dynamic model of the market is introduced in chapter 3, while its empirical analysis and the out-of-sample forecasting tests are performed in chapter 4. The forecast of house prices for the next two years is presented in chapter 5, while chapter 6 concludes the paper.

2. A short overview of the Polish housing market

After the Second World War, the housing stock in Poland was to a large degree destroyed and the socialistic system never managed to satisfy the needs of households. Since the change to the market economy, the primary market has become very important in Poland, as it contributes to growth of the housing stock and helps to satisfy the growing need of households to possess an apartment. The transformation changed significantly the size and investor structure of construction in Poland. The share of the private sector grew, while the share of housing cooperatives, company and communal housing fell. This was possible due to

[5] NECMOD is the structural macroeconometric model of the Polish economy

changes in the law, but also due to the emergence of banks that issued housing loans on a large scale.

Since the beginning of the 1990s, together with the withdrawal of the state from pursuing housing construction and its gradual withdrawal from funding too, a new form of housing developers has emerged. These companies realized investments at the risk of future homeowners and with the funds provided by them (prepayments), supplemented sometimes with loans. The investments were often risky for the clients and very profitable for the developers. The risk associated with this form of activity was an important factor that limited construction demand. In 2012 a law to protect buyers of developer housing was introduced.

The transformation of the production sphere had a positive impact on the housing construction sector in the long term, eliminating large state enterprises and expensive, poor quality production based on prefabricated technology. However, the changes in the basic proportions of the housing market, such as the private source of funding, changes in the price-to-income ratio of newly-built apartments, inflation and unemployment, and the collapse in the availability of credit affected housing demand, causing changes in construction size.

In the long term, the whole economy and the developer sector adopted to the new needs, and consequently new projects were begun on a larger scale. First of all, developers and new technologies appeared. The market structures of housing construction developed, especially in the largest cities in Poland, and its financing was privatized, which was a consequence of the withdrawal of the state from successive programmes subsidizing housing construction. The first programme that subsidized the owner-occupied housing segment, *Family on its own* (RnS[6]), was introduced in 2006. It operated in a pro-cyclical manner, strengthening the excessive increase in prices, bordering on a price bubble, and was abandoned in 2012. In 2014 the *Housing for the young* (MdM[7]) programme was introduced. The main change in the MdM programme was that households could not buy a subsidized flat from the secondary market until late 2015. The RnS programme cut the interest rate by half for the first eight years of the loan duration. The MDM programme is a down-payment subsidy, up to 30% of the loan value. It decreases the loan instalments and thus makes mortgage financed housing more affordable. Both subsidy schemes do directly or indirectly decrease the interest rate that the owner has to pay, but they can only be used for mortgage-financed housing purchases. According to NBP (2013, 2015) both programmes increased the demand for loans and also had a positive impact on house prices.

The structure of the investment sector of developer firms changed with Poland's accession to the European Union and the credit boom in the years 2005-2008. The EU accession in 2004 resulted in an inflow of foreign capital, while the easy access to foreign finance, stable inflation and growing income caused strong demand for housing. The market concentration of developers in the largest cities was growing. Developers bought land banks that are large enough to build housing

6 RnS – (Rodzina na Swoim; Family on its own) – the government programme intended to support the housing sector through subsidies to interest rates on housing loans. The programme was introduced in 2006 and closed at the end of 2012.

7 MDM – (Mieszkanie dla Młodych; Housing for the young) – the government-subsidized programme intended to support housing construction through subsidies for housing loans, entered into force at the beginning of 2014.

for six years without the need to buy more land. Governmental procedures were introduced that speed up the preparation of land for investment. As a consequence, the limited access to development land has been eased. The years 2005–2008 were characterized by a boom on the mortgage market and the beginnings of the creation of standards and regulations of this market. From the beginning of the outbreak of the global financial crisis to 2013, important financial supervision regulations were introduced which restricted access to credit (Recommendation S, Recommendation T, and Recommendation J).

The years 2002-2014 left many housing issues unresolved, mainly in the sphere of social housing (after the expiry of the Social Building Society TBS[8] programme) and rental housing, but also mortgage lending, remained a problem. Twenty five years after the transformation, the state has not settled the issue of the rental market and social housing for the poorest, and the demand for owner-occupied housing from the primary market is still large. The rental market is tiny, mostly restricted to the largest cities and in many cases is found in the grey-zone (see Augustyniak et al., 2013). The dominant share of owner-occupied housing was obtained by the current owner in socialistic times, and there is little trade of those dwellings. As the empirical analysis in NBP (2015) shows, even controlling for the GDP per capita differences, CEE countries lack around 50 housing units per 1000 inhabitants to meet the EU average, which is around 340 housing units per 1000 inhabitants. This excessive demand can be satisfied only with new construction.

3. Explanation of housing demand and supply dynamics

The transactions in the housing market are those of newly constructed housing and sales of housing from the existing stock. A detailed analysis of the relationship between these two markets can be found in Augustyniak et al. (2014a). 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 term, any excessive demand translates very quickly into excessive demand for new construction (see Augustyniak et al. 2014b).

There are other approaches to the analysis of housing cycles, some of them are presented below. Capozza and Helsley (1990) present a theoretical dynamic model of a growing urban area, in which land has been converted from agricultural to urban use. Developers maximize their profits by selecting the optimal time to convert land from agricultural to urban use and build houses. It is assumed that a city has potentially infinite borders, so it can expand outward from a city centre (business centre) to which all residents must commute. A city has an exogenous function of housing rents, fixed lot and house sizes and the authors decompose theoretically price rents into their components. Capozza and Helsley also introduced uncertainty and claimed that uncertainty, and the irreversibility of development,

[8] TBS (Towarzystwa Budownictw Socjalnego; Social Building Society) – a company operating under the Act of 26 October 1995 on certain forms of subsidizing housing construction, the subject of which was housing construction and maintenance based on rental, provision of management and administration services and conducting business related to housing construction and accompanying infrastructure. The TBS offer was planned to be addressed to non-affluent families eligible for a loan subsidy from the National Housing Fund (KFM).

slow down the development process and could cause an increase in the value of land if the boundary of the urban area is exogenous.

Abraham and Hendershott (1996) describe and empirically verify metropolitan real price changes. They divide the determinants of real house price appreciation into two groups: one that accounts for the deviations from the equilibrium price and another that explains changes in the equilibrium price. This approach helps to explain cross sectional variation in real housing price changes in 30 US cities over the period 1977-1992.

Mishkin (1995) stressed an important fact that there are different channels through which mortgage financing affects the housing market ('banking lending' and 'balance sheet' channels). Changes in monetary policy affect the availability of households debt and asset prices.

3.1 Housing demand

Housing cycles are driven by excessive increases in housing demand, thus the analysis starts by explaining the dynamics of housing demand. Throughout the paper 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[9] and the consumption of other goods. In order to obtain housing demand that is in line with empirical observations, the imputed rent has to enter the utility function. This means that when house prices rise, the imputed rent rises too. Without this fact, rising prices would make households decrease housing consumption and increase the consumption of other goods. In reality, amidst rising prices households give up as much consumption of other goods as possible to increase housing consumption. 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*. The utility function can be written as follows:

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

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, the appreciation of housing $A = \frac{p_t}{p_{t-1}}$ is included in the utility function. Consumers form extrapolative expectations and rising prices make housing a more desirable good (see Dunsky and Follain, 1997, Somerville et al., 2010, Lambertini et al., 2012, Hott, 2012, Salzman and Zwinkels, 2013).

In order to find the optimal amount of housing, the consumers' utility is maximized 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 metre of housing *p* multiplied by the mortgage rate *r* and the house size in sq. metres *H*. The price of the consumer good is normalized to 1.

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

Solving this problem yields the following optimal substitution of consumption of housing and other goods

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

Substituting this condition in the budget constraint, leads to 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 increases in income and also when interest rates fall. High prices have the usual negative effect on demand, but if they rise fast in a given period, they increase housing demand. The rationale for this phenomenon is that consumers are worried about even faster rising prices and anticipate housing purchases or hope to sell the house later at a higher price. Augustyniak et al. (2014b) show how a simultaneous growth in income, decline in mortgage rates and increase in house prices leads to increased housing demand.

3.2 Supply of housing from real estate developers

Housing supply is a crucial factor in the housing boom, but unlike the demand side it has received 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 empirical details about producers' decisions concerning at which point in time to start the development process and at what scale. A notable exception is the article by Bulan et al., 2009, who study irreversible investment decisions in Canada. The biggest obstacle to the empirical analysis of housing supply at the company level or even the city level is the lack of data on individual developers and their cost functions. The costs of a developer at each stage of the construction process are described in detail in Augustyniak et al. (2014b). Taking into account the factual development process, the average housing supply function is analysed.

Although the housing production function can be written as a Cobb-Douglas function, most empirical works are not based on micro-foundations, but rather run ad-hoc regressions. A good starting point for the analysis is the housing production function developed by Smith (1976), which is replicated here in detail. Smith makes two important assumptions, which bring his model close to reality and help to understand the developer market. Firstly, 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 the price of land is denoted *R* and the price of capital is the numeraire. 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 follows:

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

The focus is on profits that are obtained from a 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 the following Lagrangean is set up to solve the problem:

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

Taking first derivatives of the Lagrangean in respect to *D, Q* an *K* and solving the system results in 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 should go to the land owners. From this it follows that the price of land is given as *R=PQD-KD*. Smith shows that from this equation it 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[10]. 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 shown 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 the 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, due to which construction, material and land costs increase, thus the factual supply curve has the well-known shape that each 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 raises 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 who choose the optimal amount of land and

[10] 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 increases, thus total construction costs rise. Such an approach is used by Glaeser and Gyourko (2006) and Glaeser, Gyourko and Saiz (2008).

housing quality. Developers form extrapolated expectations (see Wheaton et al., 2001 and Hendershott et al., 2002), thus they increase their production if their short-term profits increase and if they assume that house prices will rise further.

4. Estimation of the housing demand and supply dynamics

The estimation of the housing market bases on the above presented micro-founded model and the work of Mayer and Somerville (2010), Steiner (2010) and Augustyniak et al (2014b). The time-series that are available for most countries do not allow us to estimate the previously presented micro-models directly. The housing demand equation cannot be transformed into a log-linear equation and non-linear estimation methods would need to be used. There are some parameters that would be estimated jointly and there is no 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. As in Mayer and Somerville (2000), log-linear models of supply and demand that describe the number of housing units placed and sold on the market are estimated.

For the empirical analysis, quarterly data for the Warsaw primary housing market is applied and to cope with short-term shocks the four-quarters moving average is used. It is Poland's biggest market, with the highest number of transactions. The Warsaw market has higher price levels, but behaves in a very similar way as the markets in other Polish cities do (see Baldowska et al., 2013 and NBP, 2015). Conclusions from the Warsaw market are therefore applicable to the markets of the other large cities. The house prices (P_t) originate from the NBP database BaRN. The number of housing units sold and placed on the market (HD_t, HS_t) comes from REAS data[11]. Sekocenbud[12] is the source of the construction costs (PC_t). The Central Statistical Office (GUS) provides data on income in the private sector ($Income_t$) and the mortgage rate ($Intrate_t$) is calculated from NBP data. The supply, demand, price, income and construction costs time series are in logarithms. Because the REAS data starts only in 2007 Q1, it is extended with the dynamics of GUS data on completed housing, lagged by 8 quarters. It takes around two years 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 on quarterly data for 2005 Q1-2014 Q3. Due to limitations in available data, the price equation was estimated for 2007 Q1-2014 Q3. Each equation was estimated jointly using the OLS regression, correcting for heteroskedasticity and autocorrelation. The recursive regression test for each regression showed that the regression coefficients are robust.

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

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

Here *Pt* is the log house price, *D(Pt)* is the rate of house price growth. The interest rate *($Intrate_t$)* and income in log terms *($Income_t$)*account for the changing

[11] REAS is a consulting company providing services related to the housing market.

[12] Secocenbud is a source of information concerning prices in the building industry

economic situation. The empirical results (see table 1) show that there is a positive relation between aggregated demand and income and a 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 past information. The housing supply is the number of dwellings put on the market in a given quarter and is estimated with the following equation

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

The constant $\beta 1$ captures the autonomous production, a particular number of housing units that will be produced regardless of current prices or costs (see Augustyniak et al., 2012). Based on empirical observation, the lagged price (lagged by one year) is included *($D(P_{t-4})$)*. 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 also cause 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[13] *($HS_{t-1} - HD_{t-1}$)*. Excessive demand makes prices rise, while they start to fall under excessive supply.

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

Asymmetric price adjustment reactions were tested for, but it turned out that the price increase in response to excessive demand is as strong as the price decrease in response to excessive supply. One could expect prices to decline faster than they rise, which would help developers to reduce the stock of unsold housing and make the market move back to its equilibrium. However, developers lower their price expectations slowly, looking 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 reducing 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 units 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 (see Grenadier, 1996, Łaszek and Olszewski, 2014).

[13] Indeed this is the same as the adjustment of the stock of unsold housing, which evolves as Stockt= Stockt-1+HSt-HDt, thus its change ΔStockt equals HSt-HDt.

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

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

The four equations presented above, describe the dynamics on the housing market. The empirical results indicate 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 US), which forced 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 ***** (2.365)	**8.857 ***** (0.382)	0.001 (0.003)	0.0003 (0.001)
Adj. R^2	0.82	0.71	0.69	0.89

*Newey-West standard errors HAC in brackets, ***, **, * significant at: 1%, 5% or 10%.*
HD_t, HS_t -the number of housing units sold / placed on the market
$\mathrm{PC_t}$ - construction costs
$Income_t$ - income in the private sector
$Intrate_t$ - mortgage rate
Symbols: L - logarithms, (t-i) - lagged variables, D – first differences.

5. Analysis of deviations from the equilibrium

In this subsection the empirical values are compared with observed demand, supply, prices and the construction costs data. Factors which most likely caused the small differences between those values are discussed.

From 2004 to 2006, demand for new apartments rose, caused by mortgage availability, increasing wages and expectations of price increases. From 2007, fewer households could afford to buy dwellings, which were getting more expensive. The model predicts the demand decline in 2009 quite well, but due to the global crisis and prudential constraints on mortgages disbursed to households, demand decreased faster than suggested by the model. In contrast, from 2010 Q3 till the end of 2012 the empirical demand was observed to be greater than the estimated demand, which most likely was a result of the government subsidy scheme *Family on their own,* which aimed at subsidizing mortgages. The programme ended at the beginning of 2013 and during 2013 there was no subsidy programme. Buyers delayed their purchase decisions, waiting for the implementation of the new *Housing for the young* scheme that came into force in 2014. This fact explains why demand in 2013 was lower than the model demand and shows that housing policy works. From 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 the construction of housing units. Even when the supply recovered, the increase in the number of housing offers was not as strong as the model predicts. This was probably caused by developers' difficulty with selling dwellings and their problems with financing new investments. Since 2012, the model supply has been very close to the empirical supply.

The empirical price and construction cost increases were close to 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 with a 1 quarter lag.

Figure 1-4. Theoretical and empirical values of demand, supply, prices and construction costs, Warsaw primary housing market

Figure 5. Housing demand

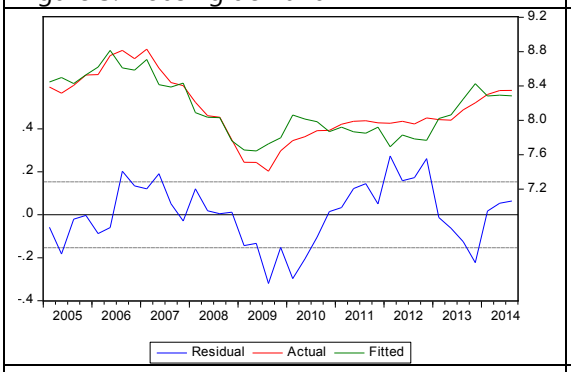


Figure 6. Housing supply

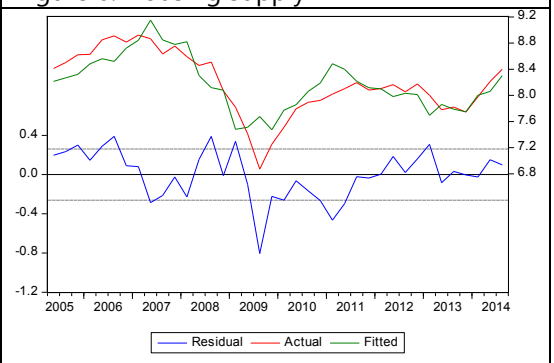


Figure 7. House price dynamics

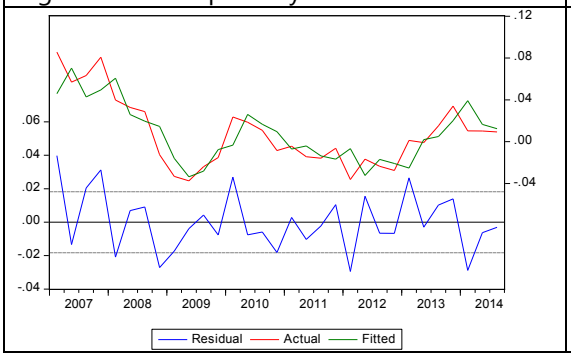
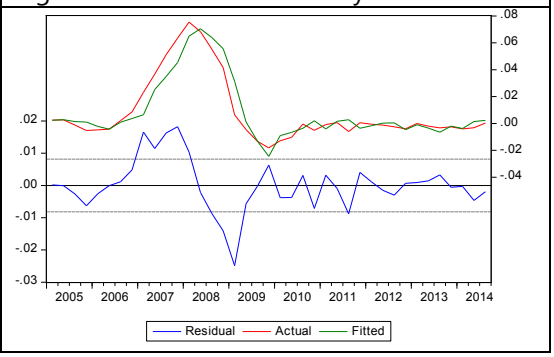


Figure 8. Construction cost dynamics



6. Forecasting of house prices

To forecast house prices the housing cycle model is used, which is based on 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, and Sekocenbud, as described in chapter 4. The equations are recursive, which allows future values to be calculated basing on their past realizations. The two exogenous variables (the interest rate and economic growth) stem from the NECMOD projection (see Budnik et al., 2009) and are 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 the mortgage rate is also constant. The housing forecast covers the next 2 years on a quarterly basis until the end of 2016. The forecast results were transformed from logs to normal numbers and are presented in Figure 5. 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. The root mean squared error of the forecast (RMSE), calculated on past forecast errors is presented in table 2. It should be highlighted that the accuracy of the four equations is tested for, while the literature review by Rahal (2014) indicates that only the accuracy of the price forecast is measured.

Figure 5. Forecast of housing demand, supply, house prices and construction costs (dashed line).

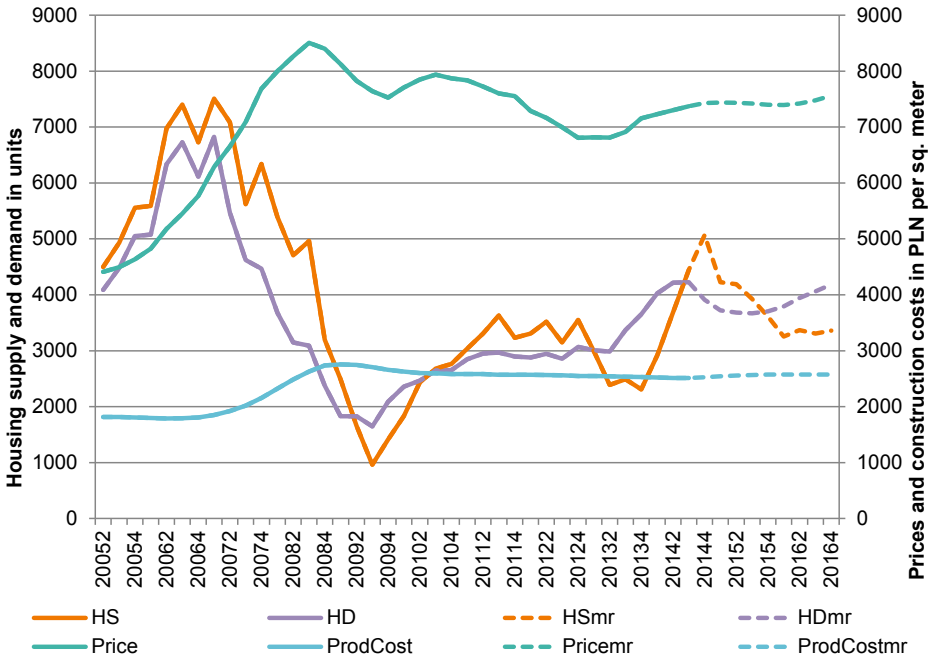


Table 2 Root mean squared error (RMSE) of the forecast, based on out-of-sample forecasting.

Forecast horizon	HS	HD	P	PC
1	991.8	668.7	125.9	20.5
2	982.8	854.1	260.2	53.9
3	937.4	915.7	432.7	101.4
4	840.4	926.6	673.3	162.3
5	751.0	922.8	920.3	234.7
6	604.0	772.5	1159.6	313.4
7	635.4	676.5	1395.6	396.2
8	695.9	605.1	1610.6	481.1

The observed values are presented as solid lines and the dashed lines show the predictions. 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 from the middle of 2015. As stated earlier, housing policy has a strong effect and changes in the housing subsidy scheme can have a significant impact on demand. Also, potential changes in interest rates will change the demand and supply of housing. The forecast should be understood only as an academic analysis and an indicator that tells in which direction the housing market will evolve. It should not be used to make investment decisions, because external interest rate shocks, large capital flows or unexpected changes in housing policy can affect the market.

7. Conclusions

The four equations model describes the main drivers of housing demand and supply in the primary housing market in Warsaw. Housing demand is mainly driven by rises in income and interest rate declines. Contrary to what would be expected, the appreciation of housing boosts its demand. Housing supply rises if increases in prices are higher than increases in construction costs.

The four-equation model replicates the real dynamics of the housing market well, which is confirmed by the results of the out-of-sample forecasting exercise. This model can be used to forecast the behaviour of the housing market for the next two years on a quarterly basis. As it can be easily replicated, the model should be 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.

The model focuses only on the primary market, thus further research should incorporate the secondary market. The inclusion of the rental market could be another improvement of the model, but at this stage the aim is to provide a quite simple model that provides an understanding of where housing booms and bust come from.

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Irving Fisher Committee on
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BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

On the dynamics of the primary housing market and the forecasting of house prices[1]

Krzysztof Olszewski, Hanna Augustyniak, Jacek Łaszek, Robert Leszczyński and Joanna Waszczuk,
Narodowy Bank Polski (Poland)

[1] This presentation was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

NBP Narodowy Bank Polski

Hanna Augustyniak, Robert Leszczyński, Jacek Łaszek, Krzysztof Olszewski, Joanna Waszczuk

On the dynamics of the primary housing market and the forecasting of house prices

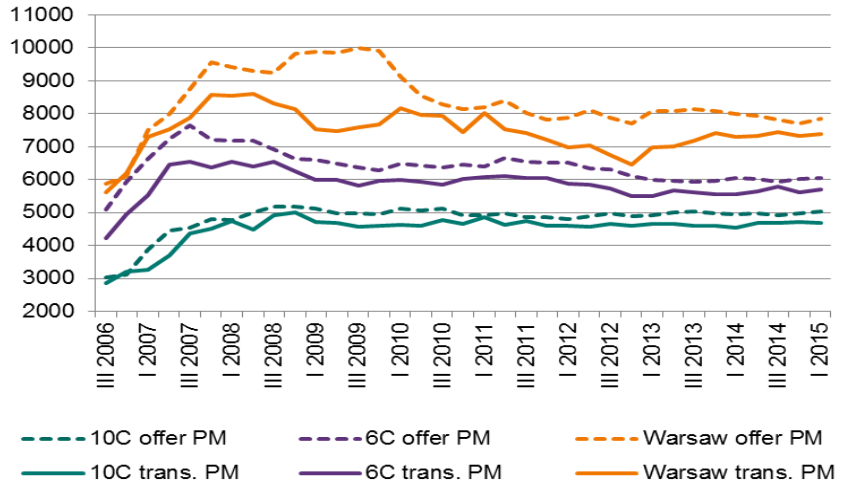
Irving Fischer Committee on Central Bank Statistics
Warsaw / December 14/15, 2015

The presentation presents the personal opinions of the authors and does not necessarily reflect the official position of the Narodowy Bank Polski or the Warsaw School of Economics.

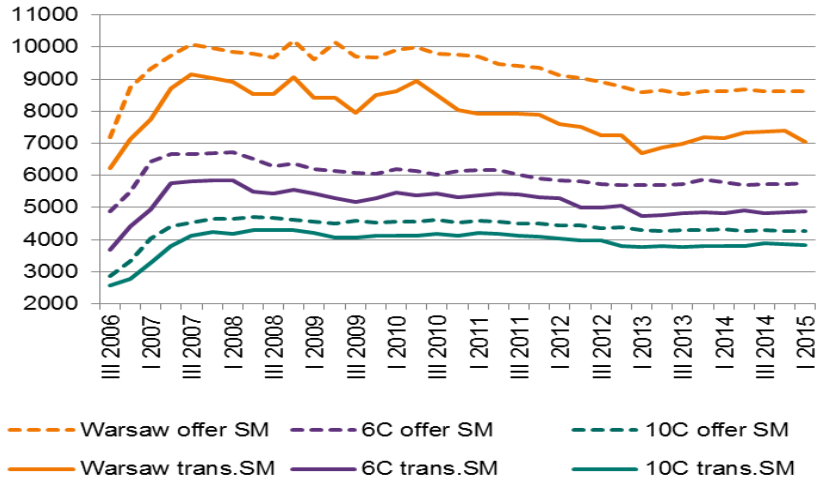
Overview of the Polish housing market

Narodowy Bank Polski

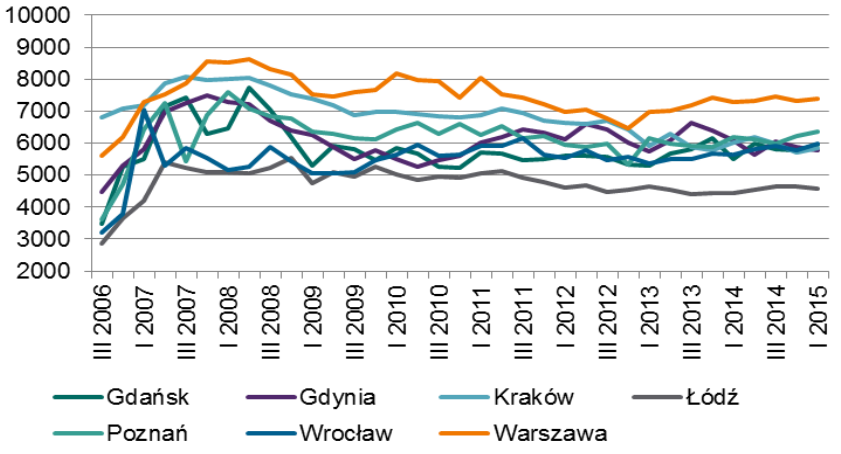
House Price Monitoring Program (BaRN) 1.



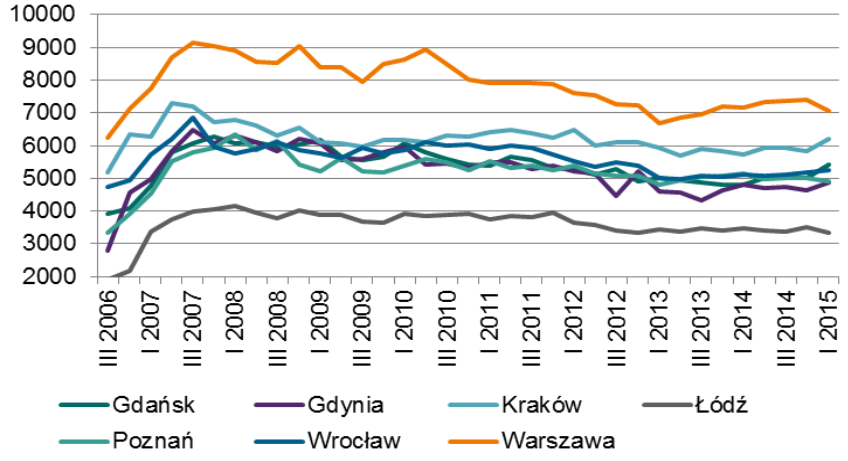
House Prices on the Primary Market (PM) in Poland
Source: NBP.



House Prices on the Existing Stock Market (SM) in Poland
Source: NBP.



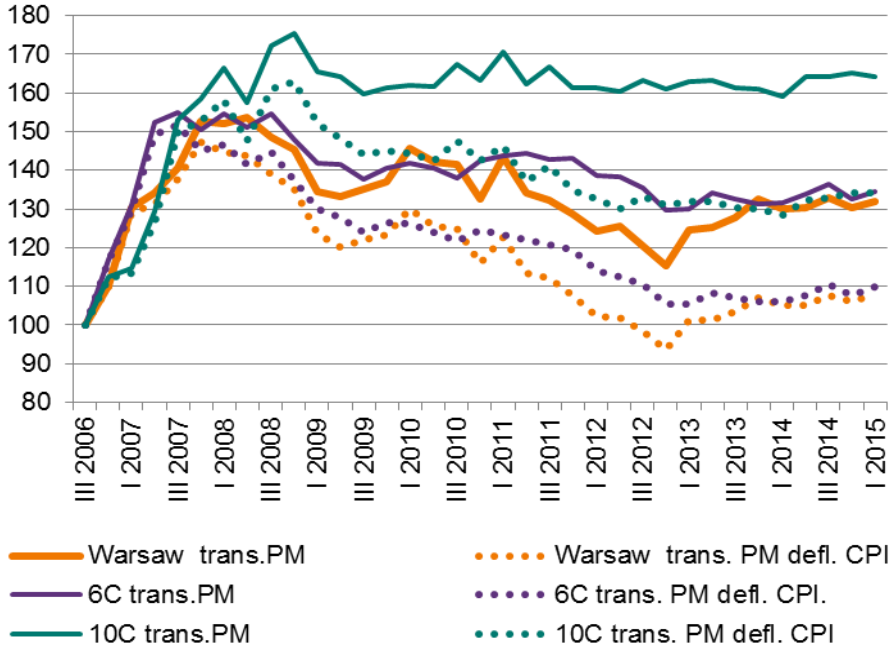
Transaction House Prices on the Primary Market (PM) in Poland
Source: NBP.



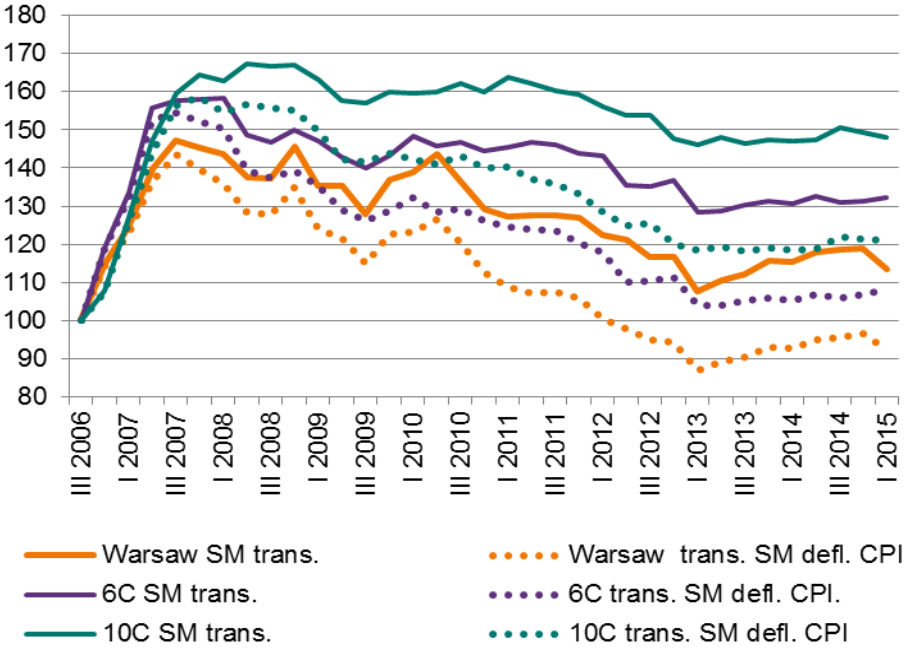
Transaction House Prices on the Existing Stock Market (SM) in Poland
Source: NBP.

PM = Primary Market; SM = Existing Stock Market; offer. = offerd prices; trans.= transaction prices

Narodowy Bank Polski
House Price Monitoring Program (BaRN) 2.



House Prices Growth on the Primary Market in Poland (2006Q3=100)
Source: NBP, GUS.



House Prices Growth on the Existing Stock Market in Poland (2006Q3=100)
Source: NBP, GUS.

PM = Primary Market; SM = Existing Stock Market; offer. = offerd prices; trans.= transaction prices

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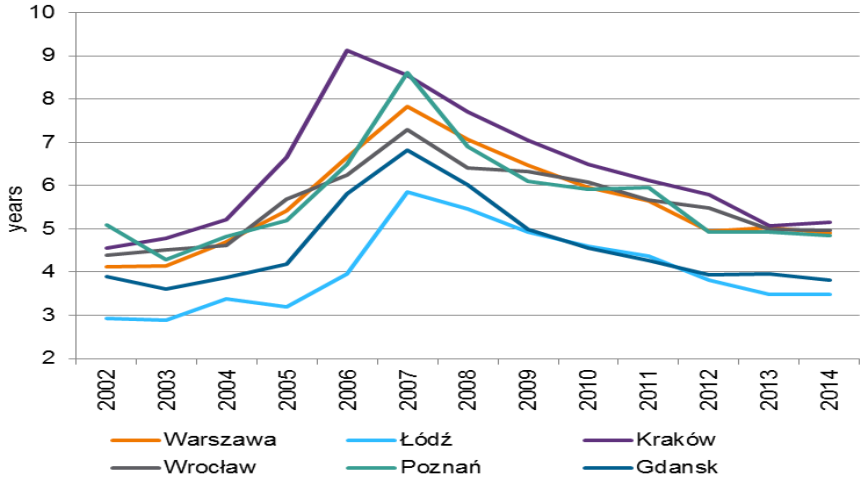
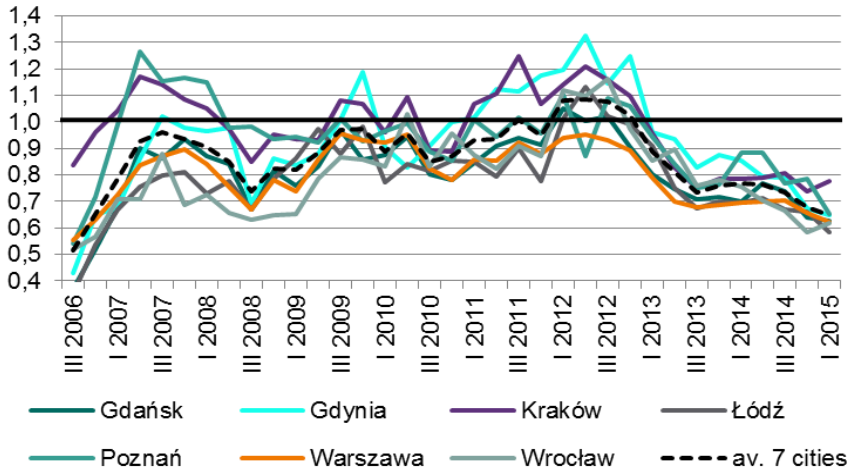
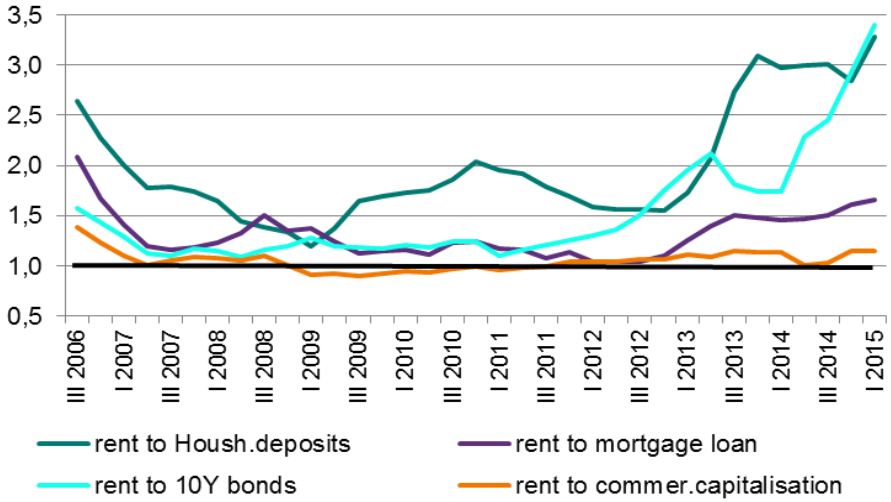
House Price Monitoring Program (BaRN) 3.



Price to Income Ratio in Poland
Source: NBP.



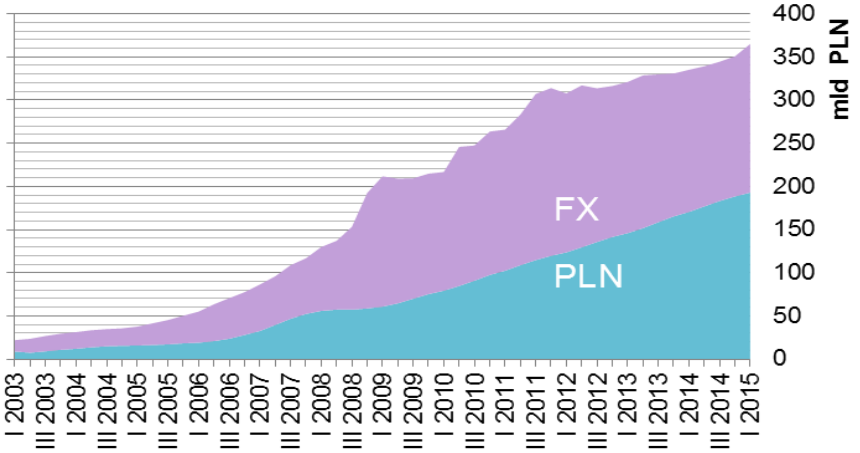
Price to Rent Ratio in Poland
Source: NBP.

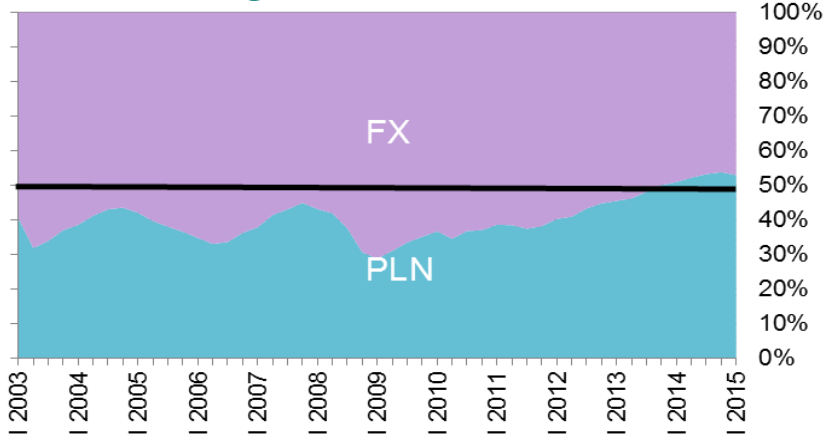


Profitability of rental housing in Poland
Source: NBP.

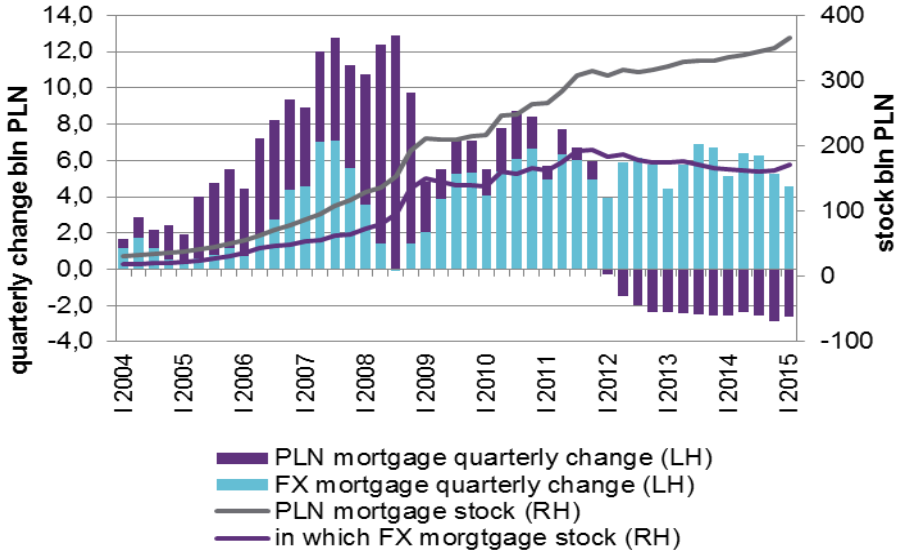
Narodowy Bank Polski

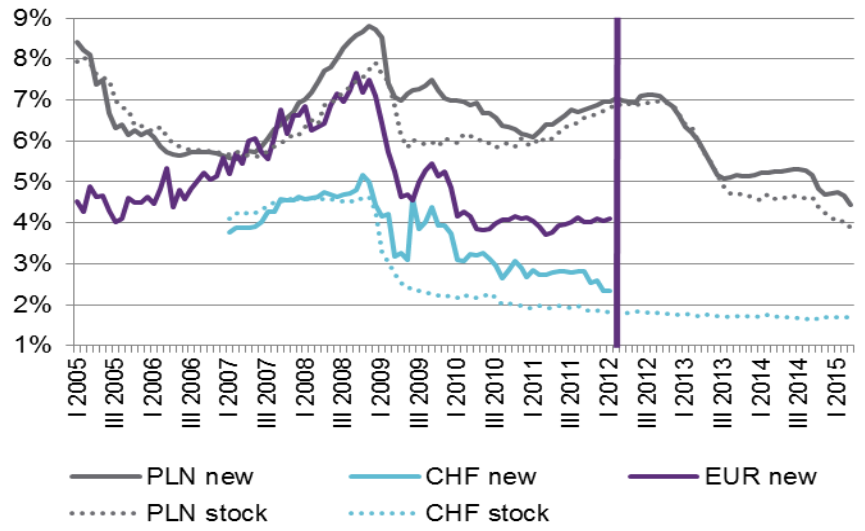
Housing Loans Monitoring





Housing loan outstanding on households in Poland
Source: NBP.





Housing loan outstanding on households in Poland
Source: NBP.

Housing loan interest rate for households in Poland
Source: NBP.

Housing forecast model

- Motivation
- Housing dynamic model
  - Housing demand
  - Housing supply
  - Empirical estimation
- The forecast of house prices
- Conclusions

Motivation

- The cyclical character is a permanent feature of the housing market and can be explained by the constrained elasticity of supply. Ciarlone (2012) claims demand shocks are mainly caused by regulations.
- We can find complex economic models in the literature, where the housing market is taken into account, but it usually plays a minor role.
- The aim of our article is to forecast house prices in and explain the influence of regulations on the real estate market.

Housing market development factors

Market participant	Factors
Consumers	House price Housing mortgage avaliability Housing avaliability
Investors	House prices Interest rates Inflation Profits
Developers	Profits Construction costs Unsold dwellings
Banks	Outstanding mortgages ROE FX mortgages

A simple housing model

- Household utility
  - $U(C,H) = (\theta C^{\mu} + (1-\theta)A^{\gamma}(kpH)^{\mu})^{\frac{1}{\mu}}$
  - With $A = \frac{p_{t+1}}{p_t} \in (0,1)$
- Budget constraint
  - $b = rpH + C$
- Solution:
  - $\theta C^{\mu-1} rp = (1-\theta)A^{\gamma}(kp)^{\mu} H^{\mu-1}$
  - $C^{*} = \frac{b}{1+rp\left(\frac{\theta}{1-\theta}\frac{rp}{A^{\gamma}(kp)^{\mu}}\right)^{\frac{1}{\mu-1}}}$
  - $H^{*} = \frac{b}{rp+\left(\frac{1-\theta}{\theta}\frac{A^{\gamma}(kp)^{\mu}}{rp}\right)^{\frac{1}{\mu-1}}}$

Supply of housing from real estate developers I

- We base on a housing production function developed by Smith (1976)
  - Assumptions:
    - house producers have a constant returns to scale production function, thus they can produce any amount of housing if they increase their production capacity.
    - developers create a good which is not homogenous but is of varying quality *(Q*), which depends on: the land (*L)* and materials (*K)*
    - Housing of a given quality is produced with the following production function *Q=Q(L,K)*
    - We set the price of land as *R* and normalize the price of capital k=1, P - prices

Supply of housing from real estate developers II

- 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 a 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:
  - $\mathcal{L} = PQD - KD - R - \mu(q(D,K) - Q)$
- We obtain two first order optimality conditions:
  - $PQ = K - D(q_D/q_K)$
  - $P = 1/q_K$

Supply of housing from real estate developers III

- In equilibrium developers choose a type of housing where 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 profits of the developers should be zero and all profits go to the land owners.
  - $R=PQD-KD$.

Regression results of the determinants of aggregate supply, demand, prices and production costs using quarterly data for the Warsaw primary housing market (data 2005Q1-2014Q3)

	LHDt	LHSt	D(LPt)	D(LPCt)
LPt	-0.894 *** (0.189)			
D(LPt)	7.714 *** (1.465)			
D(LPt-1)			0.835*** 0.089	
D(LPt-4)		9.922 *** (1.966)		
Intratet	-13.301 ** (6.065)			
Intratet-4		-12.770 * (6.670)		
LIncomet	1.164 *** (0.339)			
D(LPCt-1)				0.977 *** (0.103)
D(LPCt-4)		-14.377 *** (2.033)		
D(LHSt-1)				0.022 *** (0.007)
LHSt-1 – LHDt-1			-0.022 * (0.012)	
C	6.925 *** (2.365)	8.857 *** (0.382)	0.001 (0.003)	0.0003 (0.001)
Adj. R^2	0.82	0.71	0.69	0.89

Theoretical and empirical values of demand, supply, prices and construction costs, Warsaw primary housing market

Figure 1. Housing demand

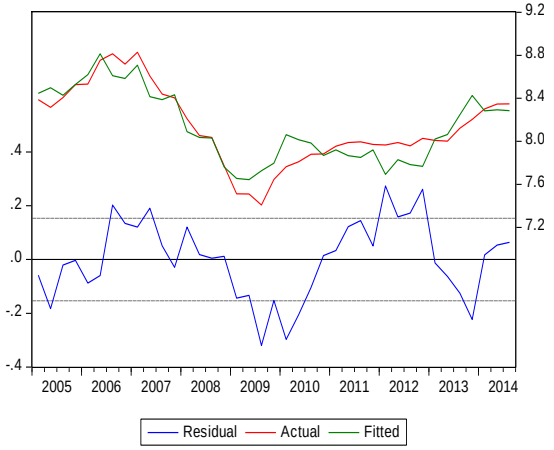


Figure 2. Housing supply

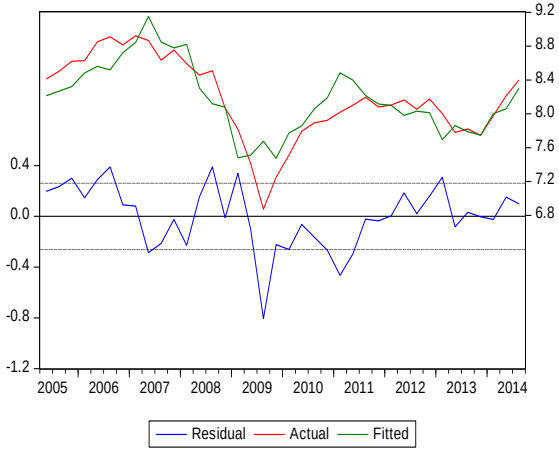
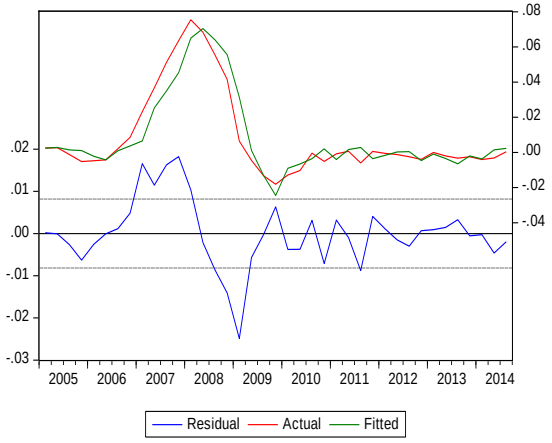


Figure 3. House price dynamics

Figure 4. Construction cost dynamics



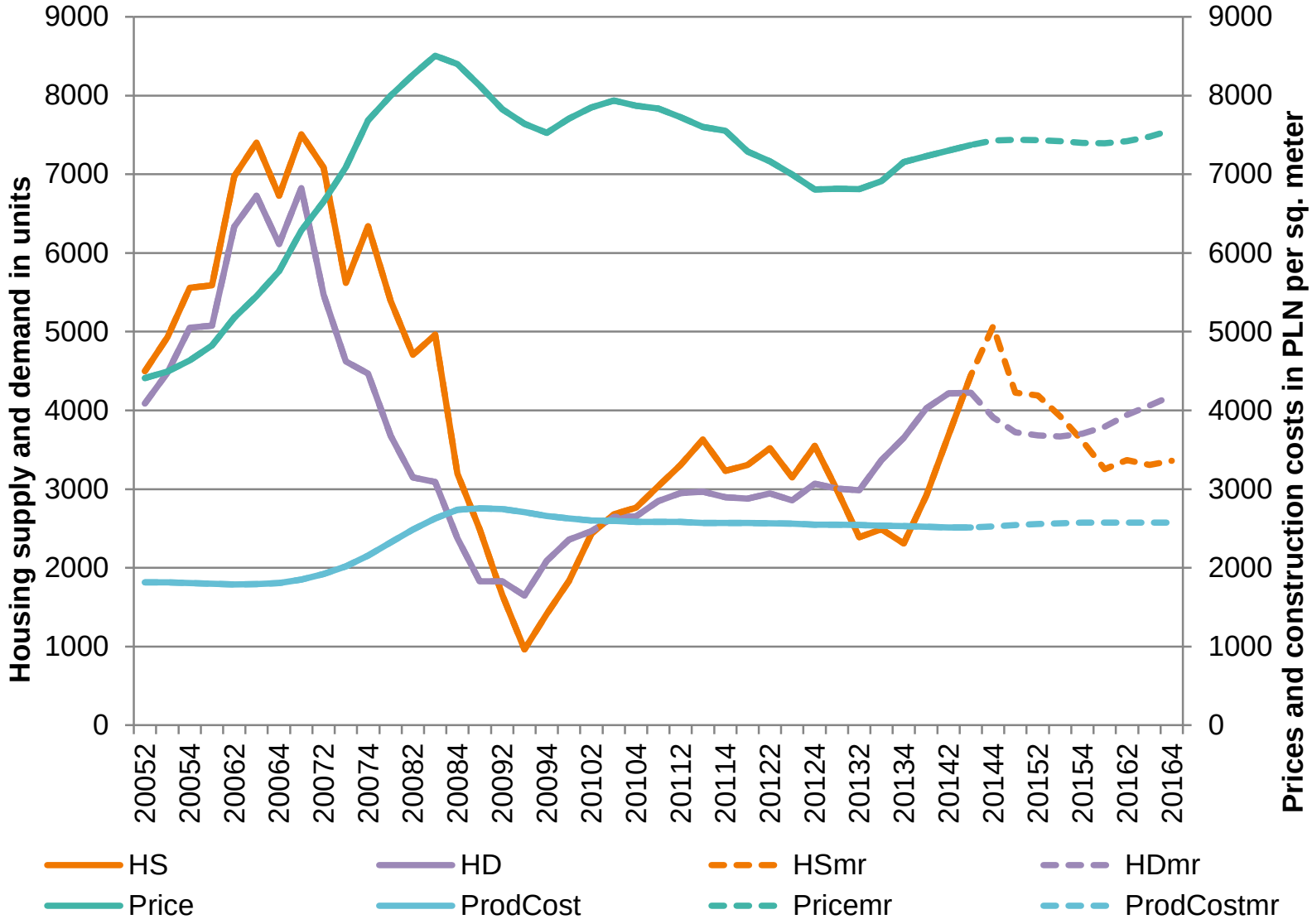
Forecasting of housing prices

- To forecast the house prices we use the housing cycle model which is recursive and has four equations.

- We use: four endogenous variables from the model:
  - Demand
  - Supply
  - Costs
  - Prices
  - two exogenous variables:
    - Interest rates - 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).
    - Income – it is assumed to grow at the same pace as GDP growth and interest rates are constant over the forecast period.

- Our housing forecast covers the next 2 years on quarterly basis until the end of 2016.

Forecast of housing demand, supply, house prices and costs



Conclusions

- We determined the main drivers of housing demand and supply in the primary housing market in Warsaw
  - demand is mainly driven by rises in income and interest rate declines, and unlike usually expected, the appreciation of housing boosts its demand
  - supply is driven by increases in prices if they are higher than the construction costs
- Our housing model 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
- 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

We protect the value of money