Housing market cycles – a disequilibrium model and its calibration to the Warsaw housing market

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Abstract

This paper presents a simple disequilibrium model in the housing market, calibrated to the Warsaw market. We discuss the last cycle and show how a combination of slight demand shocks with short-term rigid supply leads to strong fluctuations. The cyclical character is a permanent feature of the property market and can be explained by the inelasticity of supply. Market participants form price and demand expectations based on past observations. This causes frequent cycles that, under specific conditions, can lead to economic crises. We believe that the model describes the reality of the real estate market better than equilibrium models do, so it can be useful for central banks and financial supervision institutions in the analysis of the impact of fiscal and monetary policy and regulations on the real estate market.

Key words: Cycles in the housing market, disequilibrium, imbalances, banking sector, banking regulations.

JEL Classification: E32, E44, E37, R21, R31;

1. Introduction

While modelling the real estate market one usually assumes it to be in equilibrium. However, as a result of a delayed response of supply and rapidly changing demand, largely determined by loan availability, the market oscillates around the equilibrium point, fluctuating in time. In this paper we propose a model that accounts for household needs, which are reflected in fluctuating demand. Supply, which is constant in a short-term, responds with price increases first. Only after a period of time, new homes are built. This allows us to analyze the response of the housing market to changes in nominal interest rates or household preferences.

Analysis of consumer goods requiring a long construction process was described in 1928 by Hanau on the example of a "hog cycle". The investment process

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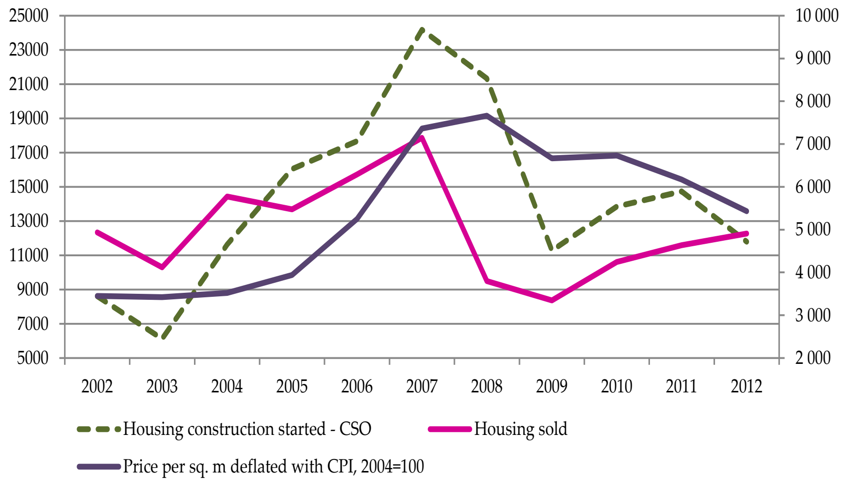
The paper presents the personal opinions of the authors and does not necessarily reflect the official position of the Narodowy Bank Polski or the Warsaw School of Economics.

and construction of new housing was described by Topel and Rosen (1988), while the price elasticity of demand is estimated for different countries by Phang, Kim and Watcher (2010). Our observations indicate that households purchase not only completed housing, but also real estate development contracts for home construction. When demand is largely unmet, real estate developers sell contracts to provide housing, whose construction has already begun. Typically, contracts are sold after approximately one year from the construction start date. Another two years elapse before the apartment is completed. However, after the housing has been constructed, it ceases to affect the housing market, as the contract had already been sold in the past. It should be noted that real estate developers have some of work in progress, which allows them to respond to the market needs relatively quickly[4]. In Western Europe, housing pre-sale contracts are not commonplace, while in Poland, as well as in Asia (see Chang and Ward, 1993), this system has had a long history. Such solutions increase the support elasticity, shorten the cycle and reduce the amplitude of fluctuations. This helps the supply side to respond faster to strongly rising demand, yet, it involves certain risk. The advantage for clients is that they buy housing at a fixed price, thereby financing the real estate developer's project. Consequently, the developer can continue construction without the need to borrow funds. Yet, the buyer bears the risk of the developer's bankruptcy. On the other hand, the producer of housing will not be able to increase home prices in the future, along with rising prices or costs.

Figure 1 Commenced housing construction, sold real estate development housing (units, left-hand axis) and real price per square meter (2004 constant prices in PLN, right-hand axis)



Source: GUS, NBP BaRN, PONT Info, REAS.

Our analysis focuses on Warsaw, the largest Polish market. Available data allow us to capture the last cycle in the Warsaw residential market. It began with stable prices (2002-2004), which then followed an upward trend with rising income,

[4] The number of building permits obtained by real estate developers usually exceeds the number of actually started constructions. Moreover, not all the constructions started are immediately sold. The real estate developer can extend this process when prices fall and speed it up when prices rise.

growing supply of credit and declining interest rates (2005-2008). In the subsequent period (2009-2011) prices slowly decreased as a result of economic downturn, oversupply of housing and limited supply of credit. The relationship between loan availability, growing housing demand and rising home prices in the primary market in Poland is discussed in detail in the NBP (2011, 2012a, 2012b) reports. Looking at real prices, deflated by CPI (2004 is the base year), it can be seen that the actual rise in sold housing and real estate development contracts, in response to growing demand, led also to a rise in transaction prices (see Figure 1).

Very complex models constitute a problem in the world of economic science, which is encountered when analysing real estate market cycles. When solving those models, economists used to adopt assumptions which were inconsistent with the reality. In particular, the assumption of the market's rapid search for equilibrium is quite problematic. Such simplifications often led to trivial or even erroneous conclusions. The model presented by us is rather simple and can be replicated on a spread sheet. We show that fairly simple methods allow to analyze imbalances and cycles in the housing market. This requires, of course, relevant data, which, for most of the analysed period, are publicly available on the NBP and CSO website. In our model we get back to the tradition started by DiPasquale and Wheaton (1992), who in a rather simple way explain the working of the market.

Our article presents the non-equilibrium model, analyses cycles and the impact of shocks to the cyclical nature of the housing market. Chapter 2 presents the model of housing demand. In Chapter 3 we present the model of supply and calibrate it to the Warsaw residential market. Chapter 4 introduces shocks, and Chapter 5 concludes the article.

2. Housing demand

In this section we present a simple demand model. We focus on the primary market only and we assume that households finance home purchase with a loan. The cost incurred in a particular period by the household is loan repayment. Burnham (1972) quotes a Fed survey, according to which credit supply determines housing construction. Currently, we see that housing demand both in Poland and across the world is driven by credit supply (see NBP, 2012a,b). Moreover, demand is affected by consumer preferences as regards consumption of other goods C and housing services $k * p * H$. Like Bajari et al. (2013) we include the imputed rent in the utility function. It results from the size of the apartment H, its price p and the parameter k, which reflects the monetary value of the stream of housing services. Utility is described by the CES function, where θ is the weight of utility resulting from consumption, whereas the parameter μ denotes the elasticity of substitution between consumption and housing, $\varepsilon = 1 / (1-\mu)$. Accounting for appreciation, $A = \frac{p_t}{p_{t-1}}$, we take into consideration consumer expectations about future housing prices (see Dunsky and Follain, 1997 or Sommervoll et al., 2010). Such specification of the utility function takes into account the fact that housing is bought both for consumption and investment purposes (see Henderson and Ioannides, 1983 and Łaszek, 2013). It also reflects the fact that households extrapolate past prices and are prone to collective behavior. The utility of household is described by the following equation:

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

The consumer divides his income between the loan repayment and consumption of other goods. The income allocation problem is solved by taking into account the budget constraint (b), where $b = rpH + C$ (r – loan constant based on fixed loan instalments, p - price per square meter of housing), which gives us the optimal choice of the size of housing and consumption of other goods in each period.

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

By combining this equation with the budget constraint we get the optimum allocation of funds between consumption of housing services and consumption of other goods.

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

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

Lin and Lin (1999) argue that income elasticity of demand is approx. 1, consequently, income growth should lead to a commensurate increase in housing demand. The household is not limited by the budget only, but also by the loan availability and supervisory regulations. The bank calculates the loan availability based on household's income, nominal interest rate and prudential regulations, which determine, among other things, the longest possible period of loan repayment (the longer the maturity of the loan, the lower the loan constant and the higher the household loan). When buying an apartment, households usually look at the current market situation and credit granting criteria, without taking into account potential changes in interest rates or fluctuations in exchange rates, if they had taken out a foreign currency denominated loan.

In order to curb excessive debt and reduce the risk to the financial system, restrictions are imposed concerning the part of consumer's income which can go towards debt repayment (DTI – debt to income ratio) as well as restrictions on the loan to value ratio (LTV) For the ease of the analysis, we have considered DTI limits only, so that the household can devote only part of their income (x ∈ (0.1)) to repay the loan, and the monthly instalment payment is maximum b_H, whereas:

$$b_H = xb \leq b$$

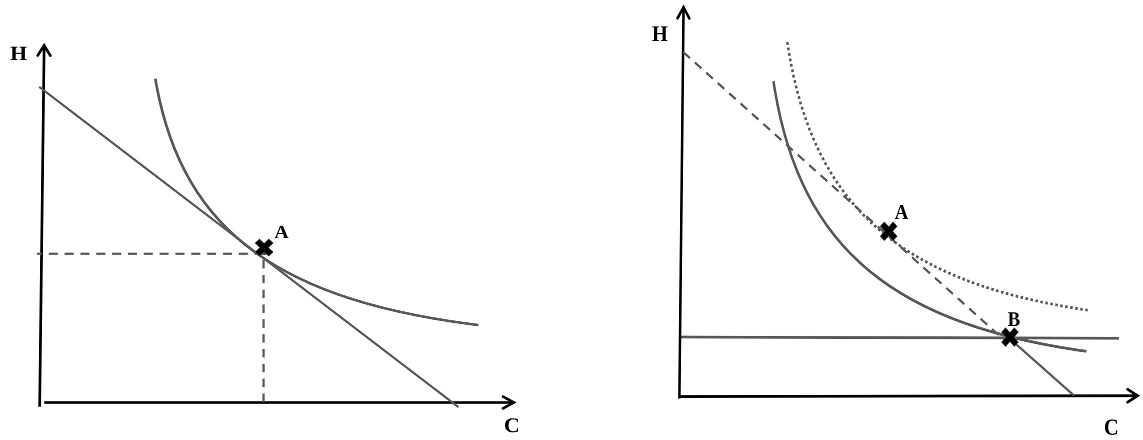
In this situation, the choice of the size of housing will not always be the optimum allocation of funds between C * and H *, but:

$$H = \begin{cases} H^*, & rpH^* \le xb \\ \dfrac{xb}{rp}, & rpH^* > xb \end{cases}$$

$$C = \begin{cases} C^*, & rpH^* \le xb \\ (1-x)b, & rpH^* > xb \end{cases}$$

Prudential limitations may result in the household's inability to consume a sufficiently large apartment. On the contrary, the household will be forced to consume more other goods than it needs. Figure 2 shows consumer's choice in the case of a normal budget (point A) and a budget limited by prudential restrictions (point B).

Figure 2 Consumer's choice without budget constraints (left-hand panel) and with budget constraints (right-hand panel)

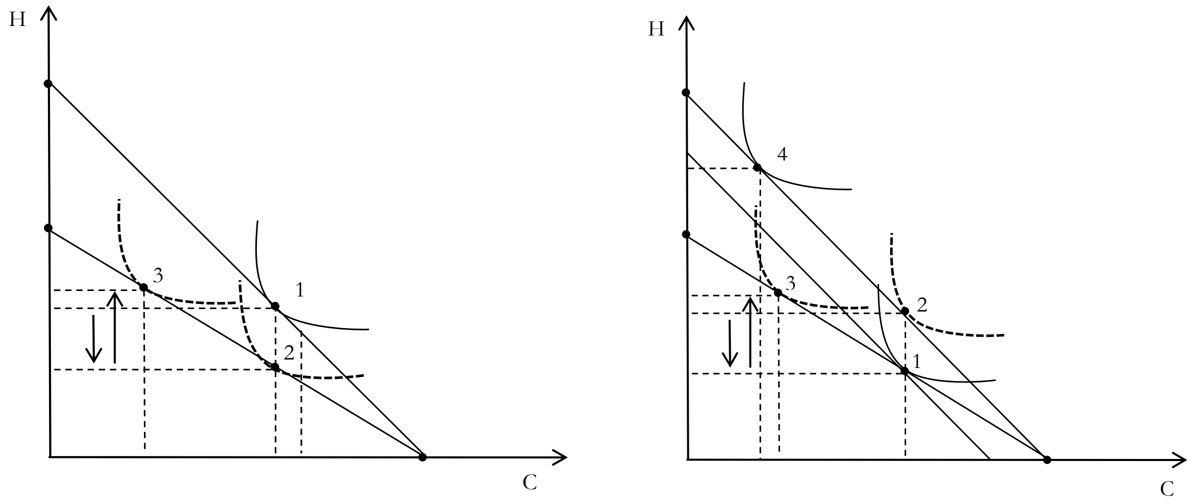


If prudential requirements are restrictive (the household would like to borrow a higher loan than it can), even a slight easing may trigger strong fluctuations in housing demand. Typically, the household is willing to give up some consumption of other goods only to buy more housing. This explains why the availability of foreign currency denominated loans caused a boom in housing demand in Poland.

In order to provide a more thorough explanation of the price bubble, we should present the response of demand to price increases based on a graphical analysis. With the classical utility function, when housing is considered as consumption only, rising prices would lead to a decline in residential consumption from point 1 to point 2 (see Figure 3). However, as housing is seen as both a consumption good and an investment good, the housing appreciation causes a significant shift of the utility curve. As a result, amidst rising prices housing becomes even a more desirable asset and the buyer will choose the allocation described in point 3 of the left-hand panel of

Figure 3. He will decides to sacrifice even a significant part of consumption of other goods, to buy more housing than he would buy at the former, lower price.

Figure 3 Consumer's choice amidst higher prices (left-hand panel) and an additional increase in revenue and interest rate cuts (right-hand panel)



It should be added that prices increased amidst rising incomes and considerable cuts in interest rates. Figure 3 right shows that, in the first place, as a result of rising income the budget line shifts to the right from point 1 to point 2, thus, the consumer can buy more housing and other goods. Yet, prices rise, so as previously explained, he will choose point 3. However, a significant decline in interest rates means that the price increase is, in budgetary terms, almost entirely offset, so the budget curve returns to its position before the price increase, and the buyer finally chooses point 4. The analysis presented in NBP (2013) shows that during the price boom, the loan availability calculated per square meter of housing was on the rise which allowed households to purchase increasingly bigger housing. Only a combination of changes in prices, income and interest rates makes it possible to explain a seemingly irrational behaviour of buyers who amidst rising prices expressed demand for increasingly bigger housing. In the aggregate, this translated into a growing demand for housing.

It is worth noting that in terms of the credit boom, households are able to exceed their budget by taking Ponzi loans. From the perspective of a household's individual decision this can be reasonable, as it optimizes its inter-temporal consumption and will repay the excessive debt in the subsequent period through capital gains on housing. This situation was not observed in the Polish market, thus we do not analyses this variant.

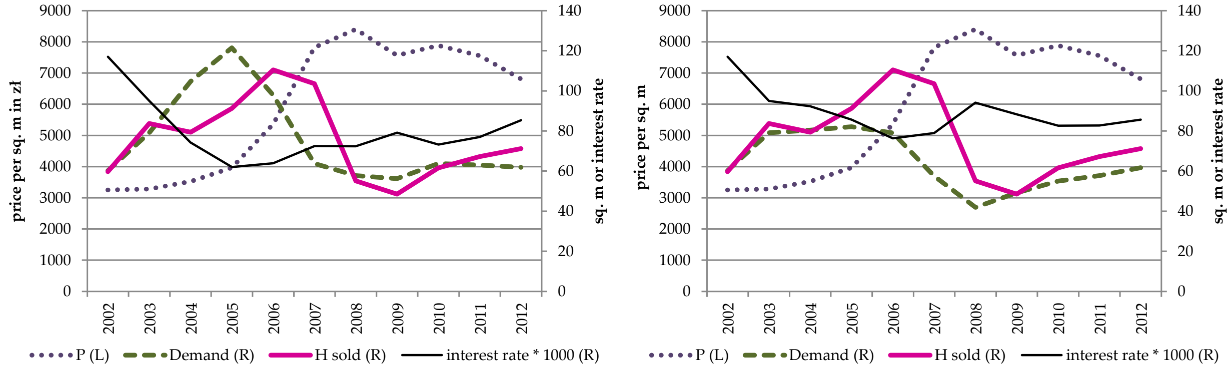
2.1 Calibration of the demand model and analysis of the impact of interest rates on demand

The housing demand model was calibrated in such a way so as to reflect, as accurately as possible, the actual rise in demand and prices in the Warsaw property market in the years 2002-2012. When calibrating the model, we adopted the parameters θ, μ k close to the values proposed by Bajari et al. (2013) ($\theta = 0.77$, $\mu = 1.32$, $k = 0.075$). We used an identical parameter to calculate the substitution elasticity $\mu = 1.32$, but modified the importance of utility to $\theta = 0.63$, as than the model is better suited to empirical data. The smaller parameter θ reflects a strong desire to own housing. The parameter k, necessary to calculate the imputed rent, was calculated as the average of the actual rental data and transaction prices (from the NBP BaRN database) and amounts to 0.065. Moreover, we choose the parameter, which determines the strength with which buyers react to housing appreciation as $\gamma = 0.5$. As the household budget we take the twofold value of the average net wage in the enterprise sector in a particular year. In total, the model replicates the last demand cycle in the Warsaw real estate market well, as shown in Figure 3. The demand for square meters of housing was calculated as follows: the model demand for one square meter of housing of an average household is multiplied by 13 000 - the average number of homes sold during the analysed period, and finally scaled down (by 10 000) in order to harmonize the scale. To calculate the total area of actually sold housing, the number of apartments sold by real estate developers was multiplied by their average size of 58 square meters, and then the score was scaled down (by 10, 000). The loan constant was scaled up by 10.

Along with a strong decline in the weighted interest rate, a rise was observed in housing demand. Growth in the model demand largely exceeded growth in actual transactions, which was driven by two reasons. At the beginning of the boom, real estate developers were unable to generate a sufficient number of contracts for housing construction. Only with one year's delay, did they put new contracts on the market. Although demand slowed down in the later phase of the cycle, real estate developers sold a lot of contracts – meeting the needs of clients who had expressed their demand a year ago. Moreover, growing income and declining interest rates failed to directly translate into bank lending, which began to pick up with some delay.

The demand model allows us to analyse household behaviour in the boom period. Although the price of a square meter of housing began to increase rapidly, demand continued to grow. This was driven by three major factors: falling interest rates (weighted with the currency structure of housing loan increase), growing income and expectations of further strong appreciation of transaction prices. This overlaps with the desire to own housing (see Augustyniak et al. 2013) and banks' very lenient lending criteria. A longer crediting period, despite the price growth and a slight increase in the average weighted interest rate was a factor behind rising demand. In this way, the loan instalment remained at a low level for a relatively long time. However, if banks had refused to lend for longer periods much earlier, demand would have probably been lower. Figure 4 shows the development in housing demand, under the assumption that both foreign currency denominated and PLN loans were granted (left-hand panel) or under the assumption that only PLN loans were granted (right-hand panel).

Figure 4 Housing demand, home prices, interest rates and the number of purchased housing units (left-hand panel- under the assumption that both PLN and foreign currency denominated loans were granted, right-hand panel- under the assumption that only PLN loans were granted)



Source: GUS, NBP BaRN, PONT Info, REAS.

The presented model is a partial equilibrium model in which we assume that prices were fixed by real estate developers, and households chose the size of housing only. In fact, reduced demand, resulting from rising interest rates in the absence of foreign currency loans should not lead to such a strong price increase (see Figure 4, right-hand panel). It is worth noting that the panel analysis presented at NBP (2013) suggests that real estate developers were quick to raise prices during the boom, yet reluctant to cut them down during demand slump.

3. Supply of real estate developer housing

Although the price elasticity of housing was already analysed in 1960 by Muth for the United States, the supply side was given relatively little attention in the literature[5]. One of the more extensive publications on this subject is the article by DiPasquale (1999). While analysing housing supply, we must take into account the situation in the local real estate markets. Stover (1986) pointed out that the aggregation of data from individual, distant cities leads to significant errors in the estimation of the price elasticity of housing supply. A detailed analysis of the real estate development sector, as well as the profit and cost accounting may be found in Augustyniak et al. (2012), but here we focus on the supply curve only.

[5] The modelling of housing supply causes many problems, including analytical ones. Eg. Epple, Gordon and Sieg (2010) estimated the home production function based on the price of land. The main problem was that housing consists of attributes that are difficult to valuate objectively, separately, qualitatively or quantitatively (e.g. quality of housing). It should also be noted that housing features are the result of complex decisions made by real estate developers and home owners (see DiPasquale, 1999). In the case of Poland, the problem is also to gain access to full and accurate data series.

Short-term supply of developer housing is rigid because it usually takes 4-5 years from the start to completion of construction. Supply becomes more flexible in the medium term as real estate developers sell contracts, if this is permitted by the law and approved by market participants. Thus, real estate developers put onto the market contracts for home construction, which has only just begun (see Augustyniak et al., 2012) and the whole project will take two more years to complete. During the price boom, the sale of construction contracts began even earlier and the so-called "holes in the ground" were bought. Then, after a period of 3-4 years, completed apartments were delivered to the buyer.

Basing on the relationship between the cost of production and the supply curve of real estate developers, we know that in the medium term the real estate development sector is able to build more housing units at a higher cost. The cost curve will be located close to the marginal cost curve. According to our observations, the mid-term curve of real estate developers' supply may differ significantly from the cost curve, as developers plan future investment based on current prices. They erroneously underestimate the rise in production costs, driven by growing demand and respond only to nominal changes in home prices.

In the medium term, the capital inflow to the residential construction sector pushes the cost of capital down to the level of the minimum average cost (long-term cost). As a result, the supply curve will become even more flexible, as new real estate development companies will enter the market, while the existing ones will increase their production. However, if supply rises too much, the average cost will rise as a result of the negative scale effects (infrastructure, costs of transport, materials, land, etc.).

Moreover, real estate developers often fund their operations using financial leverage, which changes profitability indicators, as increased production financed in this way offsets the growing unit costs. In some countries, it is possible to finance construction with buyers' pre-payments, enabling developers to save the equivalent of interest they would have to pay on the loan, thus increasing the return on investment. Therefore, due to higher prices, the supply of development contracts may be more flexible in the short-term than suggested by marginal costs.

In the long term, supply of housing will be more flexible thanks to a wider range of possibilities of increasing production. The whole economy will be subject to structural adjustments aimed at adjusting the supply of housing to meet the society's needs[6].

3.1 Real and virtual supply curve

As in most productive sectors, the supply curve is affected by marginal costs and the price. Firms involved in home construction have generally in place similar,

[6] It is worth noting that the economy may be subject to erroneous, socially expensive and excessive adjustments made to match new housing supply with demand. We have observed this recently, for example in Spain. Too many factors of production (capital and human resources) were transferred to the real-estate development sector, which generated huge costs: a high vacancy rate and mismatches in the labour market.

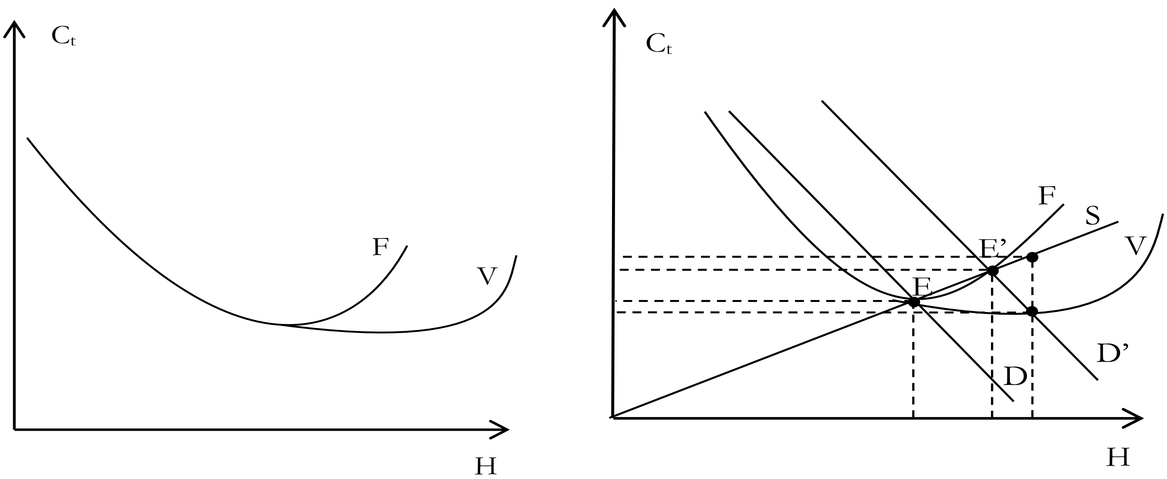
standardized construction methods, so that the aggregate supply curve is the sum of supply curves of individual real estate developers. We can determine two supply curves: the virtual and the real one.

The virtual supply curve (V) is the result of real estate developer's calculation of future return on investment. This calculation is an estimate based on current housing prices, cost of materials and labour. In contrast to the production company, which has a fixed capital stock and an optimal production level above which costs rise substantially, the real estate developer relies on outsourcing of construction services and buys a lot of production factors in small batches. For this reason, the individual cost curve is flat and rises with a considerable delay (see Figure 4, left-hand panel). The real estate developer usually operates as a holding, which allows it to create a special purpose vehicle to start new investment projects.

Furthermore, the number of housing units in a particular location can be adjusted to meet current market needs. Its supply is limited by the access to capital generated by the stock and bonds market and by loans. We should also mention another restriction in the form of limited number of qualified people who can conduct the construction process and the availability of production factors. Consequently, real estate developers supply curve (S) will be less inclined. It will move to the left, if the real estate developer expects the cost of land, materials and labour to increase or the diseconomy of scale starts to emerge.

Furthermore, the real estate developer can continue a project that was already started and then stopped, should demand increase. In this case, the supply curve of the developer is virtual and subjective as it is based solely on self-estimates and usually does not take into account the behaviour of the competition.

Figure 5 The virtual and actual supply curve (left-hand panel) and changes in the market in response to rising demand (right-hand panel)



The real supply curve (F) of the entire development sector reflects the actual changes in investment profitability, taking into account diseconomies of scale and increasing costs of production factors, when production reaches too high levels. For example, real estate developers will buy less attractive plots of land and will have to adapt them to meet the actual needs or will have to pay more for work and materials. This gives a curve that shows how flexible the response of demand to housing prices is. However, its importance at the planning stage seems to be limited to the individual developer. It will play a major role in the final phase of the project and will determine the number of housing units that are currently being constructed.

If housing prices are stable, growing costs mean that profit margins are lower and, consequently, the expected future profits decline and the virtual supply curve goes up. This results in the suspension of new investments, slowing construction of the existing real estate investments, or even abandonment of the current projects. The virtual and the actual supply curve is shown in the left-hand panel of Figure 5. Rising demand for housing, as shown in the right-hand panel of Figure 4, as a shift in the demand curve to the right (from D to D '), will urge real estate developers to increase housing production. As a result of rising factor prices and the negative scale effects (average costs of production factors begin to grow), the real cost of production of such a large number of dwellings is higher (see curve F) and exceeds the price that consumers are ready to pay. This, in turn, creates a surplus in the housing market.

4 Aggregate demand and supply, model calibration and shock analysis

Taking into account the previously described model of individual demand for housing space H_t, we proceed to the aggregate demand D_t. Each household reports demand for a certain number of square meters of housing, which in the aggregate translates into a growing number of desired housing units. The aggregate demand can be described by the following equation[7], where the parameter a captures the constant demand, and the parameter b shows how strongly demand responds to price increases:

$$D_t = a - bp_t$$

The aggregate supply side can be described in a similar way, whereas housing production started in a particular period will be available with delay. The supply responds to the price of the previous period, as described with parameter d, whereas the parameter c means autonomous supply[8], independent of the price level.

$$S_t = c + dp_{t-1}$$

To determine the equilibrium of such a system (equilibrium price P* and the number of sold housing units ($q^* = S_t = D_t$) we combine these two equations and get the following result:

$$p^* = \frac{a - c}{b + d}$$

$$q^* = \frac{ad - bc}{b + d}$$

[7] This is a simplification of the previously described demand function, where the parameter a accounts for the autonomous demand, which is independent of income, demographics and housing preferences. The parameter b determines, how strong the demand reacts to price changes.

[8] Given high fixed costs, the developer produces a certain amount of housing, irrespective of the current prices and construction costs. We call this production autonomous (see also Augustyniak et al. 2012).

To describe real phenomena in the market, the following two conditions concerning the parameters a, b, c and d must be met. First, we want to avoid negative prices in equilibrium, thus $a > c$. Moreover, the system has to be stable, and to converge towards the equilibrium, which is possible only if $d < b$.

Changes in home prices are driven by differences in the levels of supply D_t and demand S_t (see Tse Ho and Ganesan, 1999), and the price adjustment can be described by the following equation:

$$\Delta P_t = \rho(D_t - S_t)$$

The parameter ρ is responsible for the speed of price adjustment. On the basis of empirical observations we conclude that the response of real estate developers is asymmetric, which means that prices are flexible upwards and not flexible downwards. Price of housing is fixed by the developer and the buyer can negotiate it, yet has a small amount of information and little bargaining power[9]. Typically, developers have price expectations and are ready to wait for a client who is willing to pay their price[10]. When demand exceeds supply, the developer may demand a higher price. However, in the case of oversupply, the developer lowers his price expectations slowly, hoping to find a buyer who would be willing to pay the price. This has been observed in the Polish real estate market in the recent years. It may change when a developer uses high financial leverage and has to raise funds quickly. Then he is forced to cut prices in order to sell housing as soon as possible. However, when his construction is financed with a loan, the loan agreement may prevent him from lowering prices below a certain threshold.

4.1 Model calibration to the Warsaw property market

To calibrate the model, we use the aggregate housing demand. We assume that it is equal to the product of the average size of housing (58 square meters) and the average number of households that buy an apartment every year. According to our data, during the analyzed period, the average number of transactions in the Warsaw housing market amounted to approx. 13 000 housing units, while during the period of stabilization (2002-2004) this number reached approx. 12 600 units. Let us assume that such an aggregate demand determines the equilibrium point. Starting from this point, demand has increased significantly due to the increased supply of credit. This has led to higher prices, as described in Chapter 2.4. As a result, real estate developers embarked on new investment projects that supplied the market with approx. 1-2 years of delay. Until 2007, we observed price rises and increased production of new housing, yet, due to the global economic crisis, demand for housing fell. The result was a reduced number of new constructions and minor price changes. This example reflects the greater price elasticity in the case of price rises and the lower price elasticity in the case of price declines.

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[9] There is a strong asymmetry of information, the developer can put a smaller number of housing units on the market to create the appearance that housing is a rare good. The housing developer has also marketing tools to convince the client that housing is worth as much as expected by the developer.

[10] Compare the offers presented in Figure 4 in NBP (2013).

The market was in equilibrium in the period 2002-2004, in which the price was approx. PLN 4 200 per square meter (in constant prices of 2004), and approx. 12 600 housing units were sold each year.

$$p^* = 4{,}2, \qquad q^* = 12{,}6$$

We look for such parameters as a, b, c and d, which will make it possible to reconstruct the market cycle. For simplicity, we neglect the autonomous production of housing, so we set $c = 0$. By dividing the price equation by the equation of the number of sold housing units, we get the following equation:

$$\frac{4{,}2}{12{,}6} = \frac{a - c}{ad - bc}$$

Since we assumed that $c = 0$, we get the parameter $d = 3$. Then, from the price equation we get the equation describing the parameter a depending on the selected parameter b and d:

$$a = p(b + d)$$

Taking into account the previously discussed requirements concerning the parameters ($a > c$, $d < b$), we chose the following set of parameters[11]: $a = 29{,}4$, $b = 4$, $c = 0$, $d = 3$. We also see that real estate developers are more likely to raise prices than to lower them, which we reflect in the model by setting the parameter $\rho = 0{,}05$ if $D_t > S_t$ and $\rho = 0{,}02$ if $D_t < S_t$. The calibrated model reflects the observed market behavior. In the next section, we apply shocks to the model economy.

4.2 Analysis of the impact of shocks

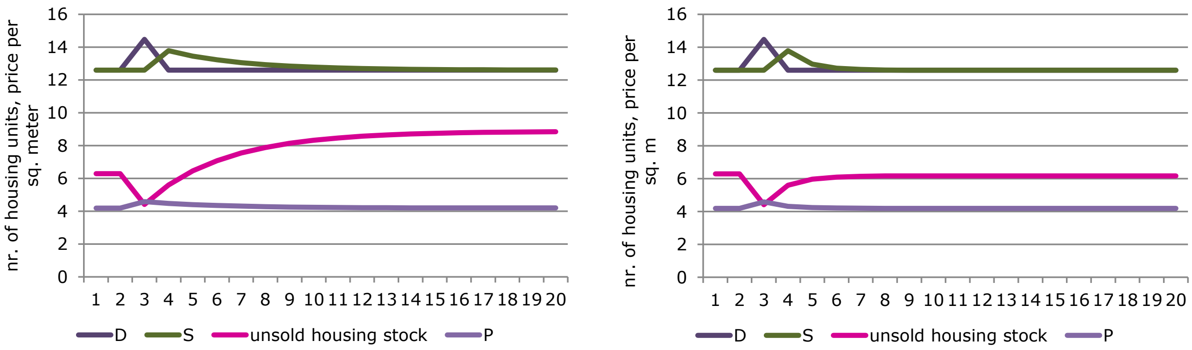
In this section we analyze the impact of a demand shock amidst symmetric and asymmetric upward and downward price elasticity of real estate developers. For simplicity, we assume that the economy is close to the equilibrium point when price changes are small and supply and demand vary only slightly (2002-2004). The shock is the variation in demand by the size determined on the basis of the actual deviations calculated on the basis of empirical data (2004 year is the base year). Due to a large supply of loans denominated in foreign currency and rising incomes, the availability of credit has increased. In consequence, the demand for housing increased rapidly, but real estate developers supplied a greater number of new housing units with a certain delay. When current demand exceeds supply, home prices rise, encouraging developers to build more housing in the future. The home purchase decision is limited by credit supply, which depends on interest rates. At some point, the economy was in a situation when households wanted to buy less housing, but real estate developers continued to bring new offers to the market. This led to a reduction in prices, and developers should have cut down production in the medium term, moving to a new equilibrium point. However, developers were too slow in reducing their prices and production levels. As a result, the number of unsold housing rose considerably.

[11] The exists an infinite number of combinations of a and b, however we want to use a simple notation of demand. Our choice of parameters allows us to generate quite realistic cycles.

In order to close the model, we assume, according to market observations, that there is a stock of unsold developer housing, with which the developer can satisfy a portion of short-term demand. This stock ($\widehat{S_t}$) was selected as 50% of the average volume of sales transactions (6 500). This is an important simplification, as otherwise in the case of large shocks, demand would not be satisfied to a large extent, and price shocks would be even larger. On the other hand, real estate developers would have to sell the entire production at the time of demand decline and therefore prices would fall drastically. This stock consists of overproduction from the current and the previous periods and can be described as $\widehat{S_t} = \widehat{S_{t-1}} - (D_t - S_t))$.

A single, fading demand shock driven by the actual growth in demand at the turn of 2004/2005, presented in Chapter 2 is analysed in the first place. Demand for housing increased in this period by approx. 15 % only as compared with the average demand. We assume that in the next period, demand returns to its long-term average. As a result of demand exceeding supply, real estate developers increase prices, and in the subsequent period put more housing onto the market. The excessive demand is partly satisfied with the stock of unsold units. In period t +1 the demand returns to the average demand value recorded before the shock and real estate developers gradually reduce the price. Households buy as many housing units as before the shock, and developers, misled by excessively high prices, produce too many housing units. As a result, the surplus of unsold homes rises (left-hand panel of Figure 6). If, however, real estate developers cut prices as quickly as they raised them, they would not generate oversupply of housing for too long, and the market would quickly return to the long-term equilibrium (right-hand panel of Figure 6).

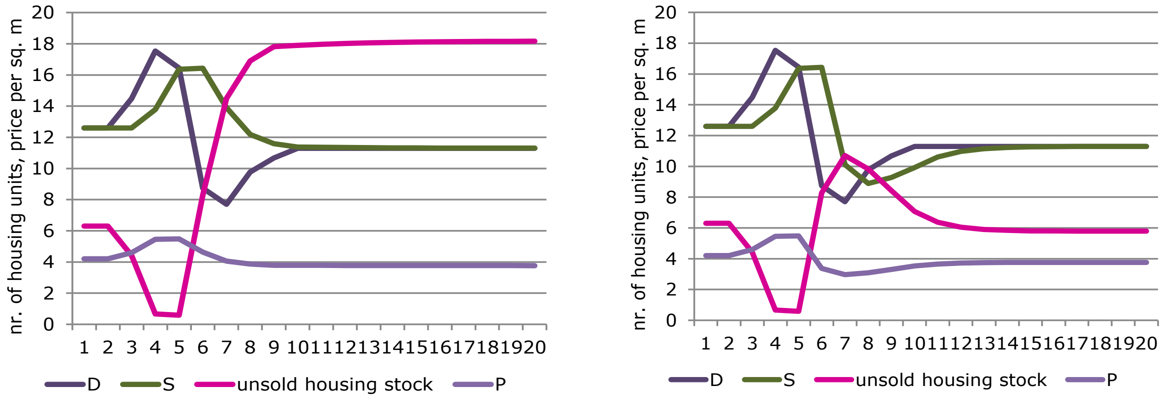
Figure 6 Analysis of single demand shock (left-hand panel- the price elasticity of real estate developers is higher upward than downward, right-hand panel – the price elasticity of real estate developers is symmetrical)



Source: Own calculations.

The same analysis is performed for a longer lasting shock. Demand grows from period to period, in accordance with the empirical growth in demand (see Chart 4). In this case, as previously, real estate developers observing excessive demand, raise prices and produce more housing with a delay. This behavior is repeated as long as demand grows, yet, real estate developers cut down production of housing too late. If they lowered prices more rapidly in response to falling demand, they would produce less housing, and the market would quickly return to equilibrium (see Figure 7). The stock of unsold housing, which increased considerably with asymmetric price changes, decreases relatively fast and almost returns to its equilibrium level.

Figure 7 Analysis of the long-term demand shock (left-hand panel- the price elasticity of real estate developers is higher upward than downward, right-hand panel – the price elasticity of real estate developers is symmetrical)



Source: Own calculations.

Based on the foregoing considerations, we may conclude that regardless whether the demand shock is a one-time or long-term one, if real estate developers had adjusted prices to excessive demand to a larger extent, the market would reach equilibrium faster.

To sum up, the model helps to explain the price dynamics and the volume of real estate transactions, which lead to significant fluctuations. The model suggests that the only way to achieve an market equilibrium and ensure small fluctuations around this point, is to stabilize and control demand, among others by slowing down the credit boom. Such a strong demand boom would probably not be possible, should only zloty denominated loans be granted. Moreover, the regulations related to the existence of the government-subsidized housing scheme sustained the demand (see: NBP, 2013). If, however, a programme aimed to support the rental housing market was introduced, the demand shock caused by rising incomes and low interest rates could be limited.

5. Summary

We have presented a relatively simple model that helps to understand the cyclical nature of the housing market. After calibrating the model to the Warsaw market, we showed how changes in interest rates affect the demand. Then, we demonstrated that a very slow price reduction by real estate developers amidst oversupply, caused that imbalance persisted for a considerable time. If real estate developers had adjusted prices downwards quickly, the market would return to the equilibrium level faster, and the unsold housing stock would be sold relatively fast.

Moreover, the model shows that demand shocks, especially those repeated, substantially interfere with prices and housing production. It may be concluded that only the reduction in demand, for example, by prudential regulations limiting the availability of loan-financed housing can help to smooth out the housing market cycle.

An important assumption of the discussed current model is, in accordance with empirical approach, the fact that the market is in constant disequilibrium. Delayed adjustments of supply to the continuously changing demand lead to permanent cycles. We wish to emphasize that the assumed equilibrium, on which most of the known housing models are based, gives erroneous results and misleading indications to decision makers. We believe that our model is useful for policy makers, central banks and regulators for analyzing the impact of various factors on the housing market.

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