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Applying the AD-AS Model to the Housing Market of Post-Socialist Economies

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Abstract: *We propose applying the standard aggregate demand and aggregate supply model (AD-AS) to the housing market. It is a very simple and intuitive tool that can help shed light on the major forces at play in the market and that can supplement the use of the general equilibrium and dynamic stochastic equilibrium models (DSGE). The latter models are very sophisticated and aim to cover many aspects of the economy, but they require a significant number of long time series to estimate the model parameters. However, in many countries, such as post-socialist countries, the time series are short. Those models moreover cover only real house prices, but in certain situations we should consider real and nominal prices at the same time.*

Keywords: aggregate demand and aggregate supply; comparison of the economy with the housing market.

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Introduction

In this paper we propose a simple model for analysing the housing market in light of the changes in the macroeconomy and monetary policy, with a special focus on post-socialist economies. These countries typically have relatively short time series and are subject to many more structural and policy changes than highly developed economies. This makes it difficult or nearly impossible to calibrate large dynamic stochastic general equilibrium (DSGE) models. A notable exception is the model by Rubaszek and Rubio (2020) for Poland, but to calibrate this model its authors applied information obtained from a dedicated survey conducted by Rubaszek and Czerniak (2017) and applied house price and rental data that had been collected by Narodowy Bank Polski (NBP 2022) over the course of more than 15 years. Moreover, while the full model requires a great deal of data that are not usually collected in many countries, we propose a simple 'sandbox' model that requires data that every national statistical office should be able to provide, or data published by private brokers and real estate advisory firms. The model is also intuitive.

After the global financial crisis, which was largely generated by the low interest rates and housing boom in the United States, a large amount of literature emerged to explain this phenomenon. Iacoviello (2005) and Iacoviello and Neri (2010) created models that explain how house prices affect consumption and the whole economy. Some researchers developed models that link the housing market to the whole economy and highlighted the importance of interest rates for house prices (Garriga et al. 2019).

Besides interest rates, other factors also affect house prices. Housing is a durable consumer good and an investment good (see Henderson and Ioannides, 1983), and buyers' decisions are affected by behavioural factors (see Mayer and Sinai 2007; Salzman and Zwinkels 2017). Moreover, house prices can have an unusual impact on housing demand. Purely from the perspective of consumption, higher prices decrease demand. But because housing is also an investment good, rising prices can also make it an attractive investment, as buyers expect further price increases; this is what happened, for example, in the United States between 2001 and 2006. Because of the lengthy construction process the housing market is cyclical, and interventions by policymakers can, even unintentionally, increase the pace of these cycles.

It is quite challenging to construct a computable model that covers all the above-mentioned factors and sudden changes in the housing market. Most of the fully-fledged DSGE models are calibrated and applied to the US, the Euro Zone, or other highly developed economies. For countries that have a rather short history of a market-based economy, it is good to have a simple, aggregate model that will help us to understand in what direction the housing market is most likely to move in the near future.

The reader might ask us to show how our proposed model outperforms others by comparing its results for Poland with the results generated by a DSGE model. The problem is that we do not have a model to compare to, so we created our own model. Although the fully fledged model of Rubaszek and Rubio (2020) shows how house prices react to different shocks, it says nothing about the production of new housing. We consider both the classical nominal and the real effect of house prices on the supply of housing and also the impact of nominal and real house prices together with nominal and real interest rates on housing demand. We hope to fill a gap in the literature by focusing on precisely these two measures, which in turbulent times and amidst high inflation can follow divergent paths in a given period and can provide market participants

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with conflicting signals. Our intention was to follow Milton Friedman's idea that a good model 'explains a lot by little', so our model structure and variable choice are sparse and cover only necessary information (for a more recent discussion of Milton Friedman ideas, see Deichsel and Pyka 2009). We focus on explaining the aggregate behaviour of agents in the housing market, but do not try to forecast it. In our view, forecasting the market makes more sense at the country level, while we want to focus on cities. With our model in place, by moving and shifting demand and supply curves, decision-makers should be able to assess how the different groups of market participants will behave. In the housing market we usually look at decisions on a microeconomic scale, which sum up and affect the whole market. In doing so, we should be careful not to make the error that occurs when people consider that what is true for one individual will also be true for the whole. Income and interest rate levels are certainly an important driver of housing demand, but housing is both a consumer and an investment good. Some people consider housing more as an investment good, while others focus more on the consumer side, which can lead to very different buying behaviour when prices rise. Consumers might want to reduce the size of their house, while investors, expecting further price increases, might want to buy more housing. The housing market is strongly connected to the economy, but we should also focus on local economies whose housing markets behave similarly. Malpezzi (2017) showed for the US that during the last housing boom a large number of metropolitan areas observed significant house price increases, while in other metropolitan areas prices remained stable. In the case of Poland, our focus is on the aggregate housing market of the six largest agglomerations, in which the behaviour of house prices is similar and in which almost 50% of capital and sector activity are concentrated (see NBP 2022). Matysiak et al. (2021) showed that the analysis of house prices in Poland leads to different convergence clubs, that the convergence diverges at times, and that this fact also has an impact on new housing supply.

In this paper we focus on the impact of excess demand on the housing sector resulting from the COVID-related expansionary policy mix (which resulted in a payment tilt effect; see Barrull and Dorse 2022) and supply shocks, i.e. phenomena observed during and after the COVID-19 pandemic and during the Russian-Ukrainian war. We apply an AD-AS aggregate demand and supply model, as it can be used to analyse both shocks and cycles, i.e. the main characteristics of the sector.

The AD-AS model and its applicability to the housing sector

The AD-AS model is a macroeconomic model used to explain the impact of macroeconomic shocks, especially demand shocks, on the formation of GDP and inflation in the short and long run. Like any macroeconomic model, the AD-AS model is based on the microeconomic response of economic agents and its value added is that macroeconomic relationships can be explained by shifting or tilting lines. It is a tool for those who prefer graphical analysis over formalised mathematical notations, where learning the formal side of the model in particular can be time-consuming. The AD-AS model is usually applied to the entire economy, not to a sectoral analysis, but its application to the residential real estate sector seems to make profound sense. This sector produces housing services and accounts for a very significant share of the capital stock in the economy, and the banking sector is highly involved in this sector, too.

The model assumes that there is a potential output in the economy, and the amount of that output is what can be produced with existing resources. The economy strives for this state regardless of changes in aggregate demand, whereas changes in aggregate demand will in the

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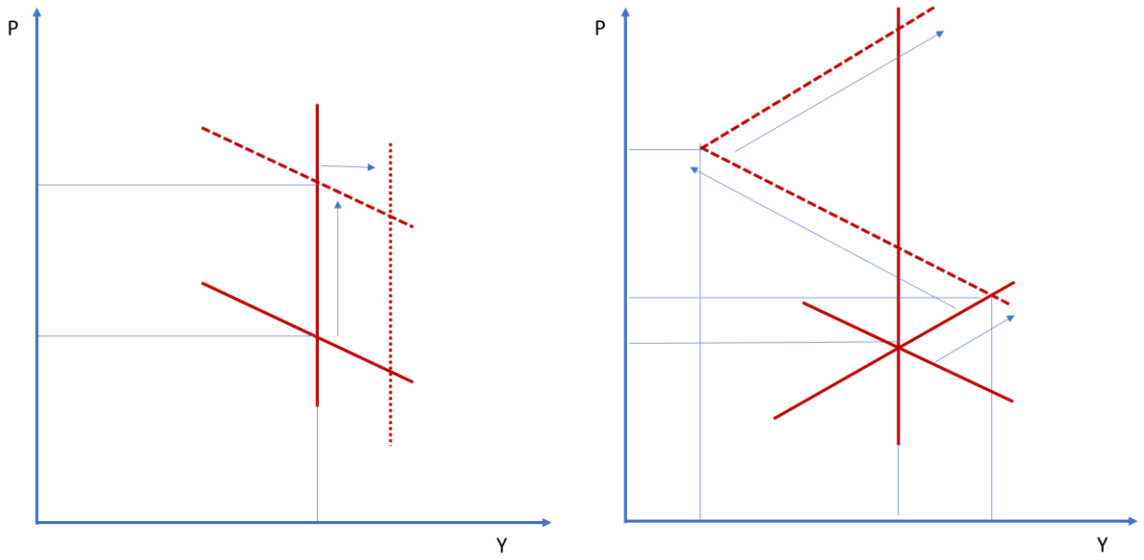
long run only result in changes in the inflation rate. The short-term analysis assumes supply to be elastic to changes in demand and to changes in prices and costs. However, starting from the old equilibrium, a reduction of output does not decrease prices (the Keynesian zone), while its increase leads to sharp price increases (neo-classic zone). The basic diagrams of the AD-AS model are shown in Figure 1: the left panel shows the long run, the right panel shows the short run. In the long run changes in aggregate demand do not cause long-run changes in GDP, they only cause price increases. Only significant technological changes can increase the potential output, and consequently the long-run supply curve. The mechanism is more complex and interesting in the short run. An increase in demand can lead to an increase in output in the short run, as producers may succumb to the so-called monetary illusion (equating nominal changes with real ones) and equate rising prices with an increase in profits. However, in the next period, rising costs will cause producers to reduce supply. Rising prices can trigger the mechanism we observed in the first step and the process repeats itself. In the long run the economy reaches an equilibrium close to the potential output, but at higher prices. During this adjustment process there is a risk that producers, remembering their underestimation of inflation, may overestimate future price increases. This causes inflation to rise, and this combined with a temporary decline in GDP will result in economic stagflation.

Figure 1: The AD-AS model in the long run (left) and the short run (right)



Source: Authors.

When we apply the AD-AS model to the housing market, we observe that the behaviour in the short run and the long run are exactly reverted. In the short run the supply of housing in the market is constant, as it results from the housing that developers have delivered. There is some housing that is sold on the secondary market, but it cannot satisfy the large demand increases that we usually observe on the housing market. Consequently, strong changes in demand will be reflected in price changes. In the short term, housing production growth is possible, but at the expense of rising prices, as developers have to purchase increasingly scarce input goods and skilled labour at higher and higher prices. During this process, demand can slump as a result of rising unemployment, falling incomes, or rising interest rates. This will exacerbate price declines. Developers might then reduce the number of new apartments put on the market in

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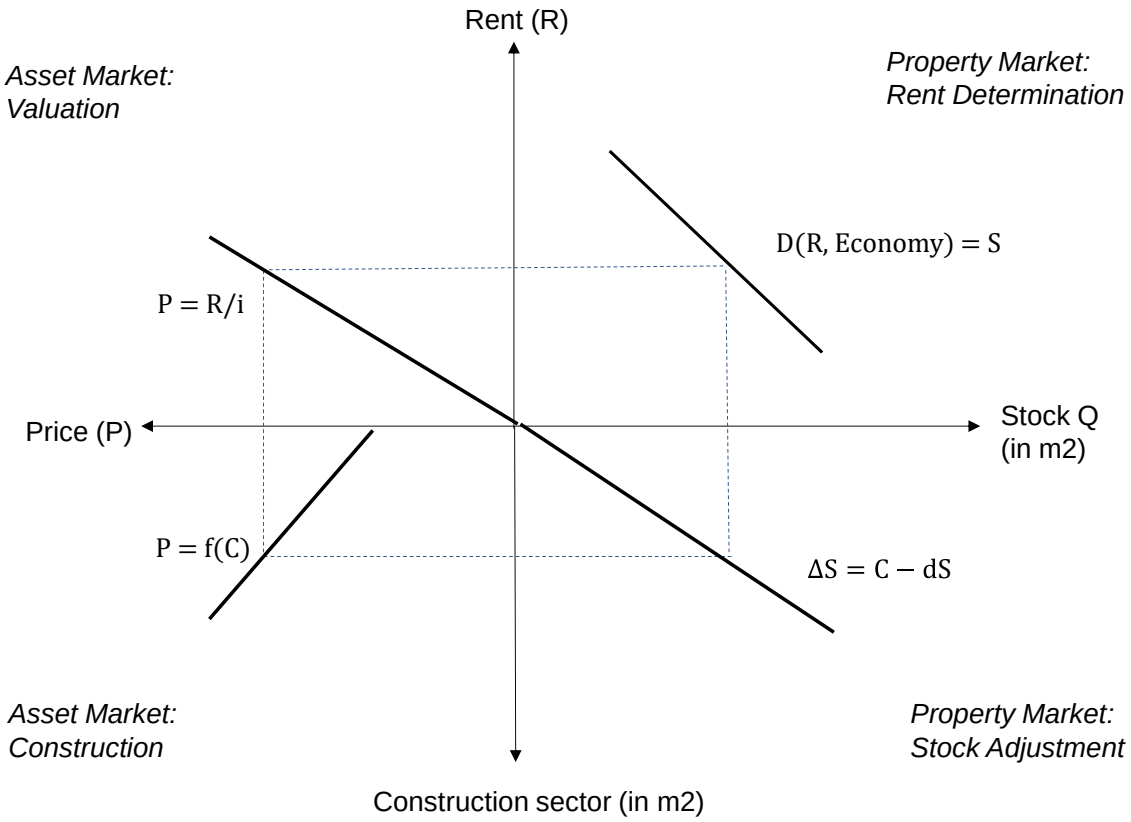
order to sustain the price level, despite them being under construction. Łaszek et al. (2016) provide empirical evidence for this behaviour. In contrast, in the long run, the construction and building materials industries can increase their capacity through investments and developers will be able to deliver much more housing. In the long run, housing supply will be perfectly elastic at the level of long-term production costs.

The two models of aggregate demand and supply thus present completely contradictory conclusions. In order to explain these discrepancies and choose the right model, it is necessary to look more carefully at how the housing sector operates. The canonical DiPasquale-Wheaton (1992) model is of great help. However, it was tailored to explain the investment and rental market, and we need to make a small adjustment for it to also explain the owner occupier housing market (OOH): instead of market rent, we look at imputed rent or the cost of a mortgage. The imputed rent is the amount of money an owner would be willing to pay for their house if they had to rent it. Alternatively, the cost of a mortgage is the actual money the mortgage holder has to pay monthly to the bank.

Figure 2: The DiPasquale-Wheaton model



Source: DiPasquale and Wheaton 1992.

The DiPasquale-Wheaton model, shown in Figure 2, consists of four quadrants. The first is the space market, where the entire stock of real estate meets the demand for space Q. The interaction between demand and supply leads to the equilibrium imputed rent level R. This imputed rent is transformed in the second quadrant through the financial market into the price P that a potential buyer is able to pay. It is assumed that the price is the discounted imputed rent, i.e. P=R/i. The lower the interest rate i, the more people are willing to pay for a house that

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has a given imputed rent. In quadrant three the developer sector is covered. Those firms compare construction costs CC with current prices P and decide how much new construction NC to start. Finally, quadrant four covers the depreciation of the entire stock and the inflow of newly constructed housing. When new construction exceeds depreciation, the housing stock grows. This is of course a very simplified DiPasquale-Wheaton OOH model, but it is sufficient to explain our approach. We should stress that in the real estate market the housing stock, i.e. the capital that generates housing services, is inelastic. Even small shocks in the demand for housing increase the imputed rent and lead to large increases in demand for new construction. The housing stock and housing services are inelastic to demand shocks in the short run, in contrast to the whole economy, which in the AD-AS model is elastic in the short run and inelastic in the long run.

Instead, we apply the model to the developer sector,[1] which shows similar behaviour in the short and long run as the economy in the AD-AS model. This sector is also the subject of the supply analysis in the housing market.

Estimation of the AD-AS model for the housing sector using data for Poland

The aggregate demand function for housing units in the six largest cities can be estimated with a simple linear regression, similar to the one applied by Augustyniak et al. (2021) to the Warsaw housing market.[2] The aggregate housing demand (HD_t) is determined by the house price Pt and its growth, the interest rate $Intrate_t$, and income $Income_t$. We also include two demand shocks that were exogenous: the Global Financial Crisis, which hit Poland in Q2–Q4 2009, and the COVID-related mobility restrictions, which made buying a flat in Q2 and Q3 2020 nearly impossible. The price and income data were deflated by the CPI and the natural logarithm was applied to the demand, price, and income data. We use nominal interest rates, which determine how big a mortgage a person can obtain at a given moment.[3] Our demand can be described by equation (1) and we estimate it in equation (2):

$$logHD_t = \alpha 1 + \alpha 2 * logP_t + \alpha 3 * \Delta logP_t + \alpha 4 * Intrate_t + \alpha 5 * logIncome_t + \alpha 6 * GFC\_2009 + \alpha 7 * COVID\_2020 + \epsilon_t \quad (1)$$

$$LHD = 0.496 - 1.001*LPRICE*** + 3.097*D(LPRICE)*** + 2.178*LINCOME*** - 8.888*INTRATE* - 0.157*PRODSHOCK\_2009*** - 0.615*COVID \quad (2)$$

[1] The production of developers can be described with the Y=AK production model, known from macroeconomics. The final output Y, in its simplest form, is generated with technology or efficiency parameter A and capital stock K. We can apply the same reasoning to the housing market: Y are newly constructed houses (more housing services) and K denotes the capital stock of developers (land, in some cases machines). Parameter A captures the efficiency of housing production in the third quadrant. Better technology allows a developer to build better houses or build them faster.

[2] The data on house purchases (units) are drawn from REAS/JLL, and the house price and the interest rate are from Narodowy Bank Polski (NBP 2022), while data on wages (income) come from Statistics Poland. The demand equation is estimated for the period 2007 to 2021 on quarterly data.

[3] We are aware of the importance of real interest rates, as they decline with inflation. Inflation also makes outstanding mortgages decline in real terms. The real effect is important in the long run, but during the purchase decision the nominal rate is the important variable.

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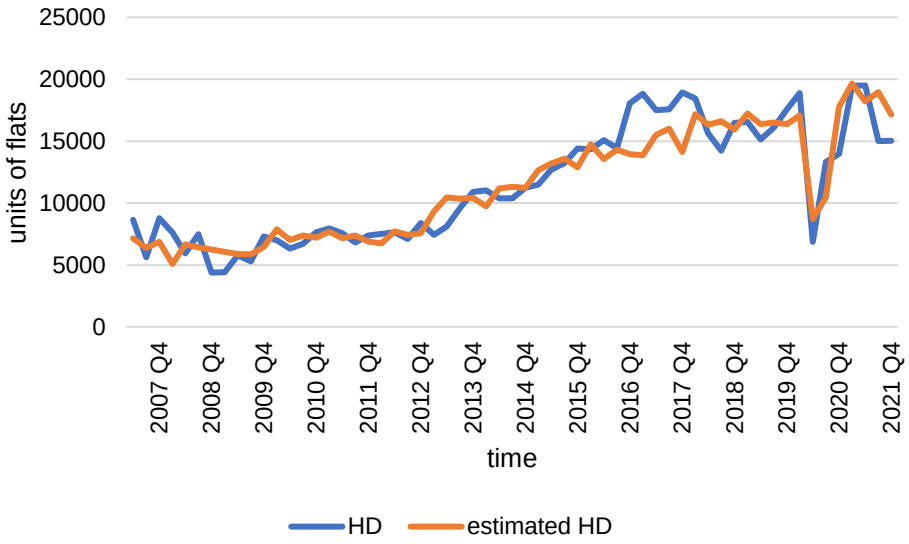
We estimate[4] that aggregate demand reacts negatively to price levels, but positively to price increases. This fact means that when people expect higher prices, they want to buy housing before it becomes too expensive, or they hope to make speculative gains. Income increases housing demand, while nominal interest rates decrease it. Figure 3 shows the observed and estimated housing demand, after the exponential value of the fitted housing demand was calculated.

Figure 3: Estimated and observed aggregate housing demand in housing units



Source: Authors' calculations.

To draw the AD curve, we use the results of the additive, linear housing demand equation (2), and we draw the demand curve not on a timeline but in relation to house prices. We consider only the intercept, the price, and its growth and ignore wages and interest rates. The effective demand curve in relation to prices is calculated as: $logHD_t = \alpha 1 + \alpha 2 * logP_t + \alpha 3 * \Delta logP_t$. We take the exponential of the estimated demand curve and plot the aggregate demand function of the AD-AS model in Figure 4.

[4] The estimation results are presented in equation (2), and asterisks indicate the significance levels: *, **, and *** mean significance at the level of 10%, 5%, and 1%, respectively. The adjusted R-squared is 0.85.

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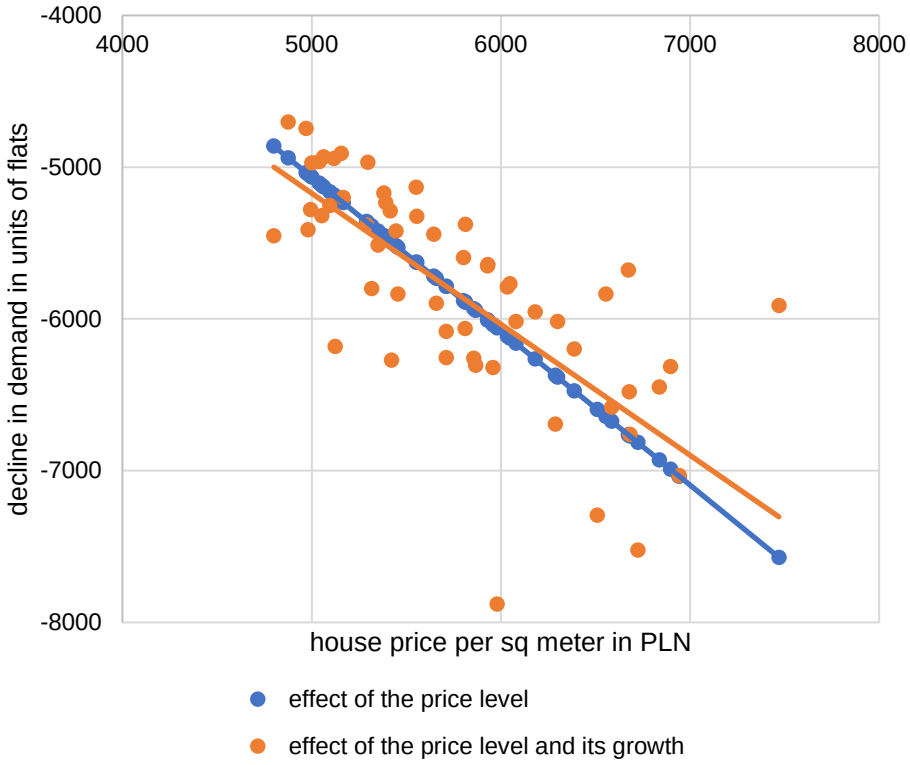
Figure 4: The estimated AD curve (effect of the price in PLN per square metre[5] and its growth on demand)



Source: Authors' calculations.

Next, we estimate the AS curve. We start with ordering pairs of data on housing production and its costs in a given year, starting with the lowest amount of produced housing. To be able to compare values for different years, we use CPI deflated prices, and we chose Q4 2021 as the reference point. The construction costs for different amounts of delivered housing can be found in the NBP (2022). We aggregated the quarterly data to annual data, because the number of delivered flats in a given quarter fluctuates, and this can be explained not by seasonal factors but by some strategic reasons on the part of developers, while the costs change continuously. We observe that costs increase in a nonlinear way with the amount of production, and we obtain a classical aggregate supply curve, shown in the left panel of Figure 5. We estimated it with a polynomial of degree 2 and found a good fit (equation 3). This polynomial is used to calculate the aggregate supply curve for even larger amounts of newly constructed flats, and this can be seen in the right panel.

$$\textit{Construction costs in PLN per sqm} = 0.0000019986x^2 - 0.0939420522x + 6458 \quad (3)$$
$$R^2 = 0{,}975$$

[5] In recent years the PLN/EUR exchange rate has been around 4.5:1.

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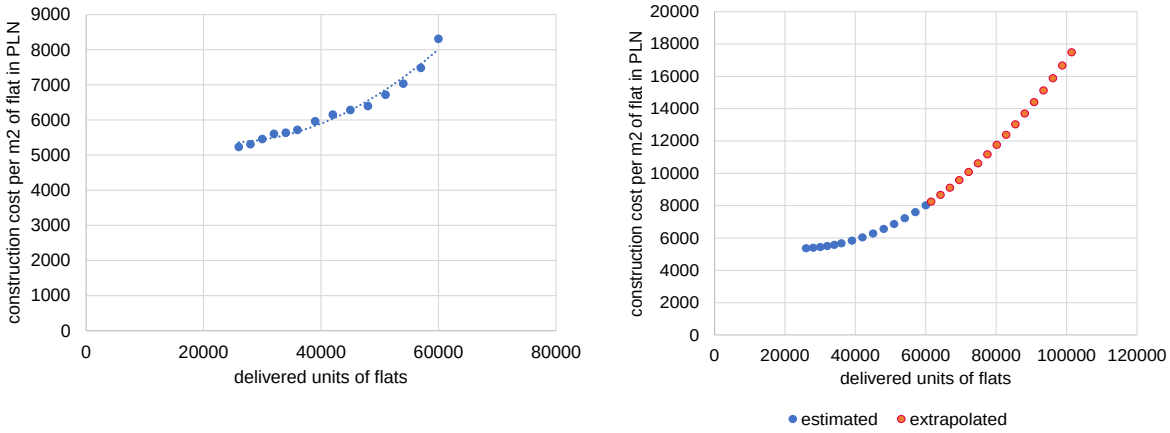
Figure 5: Aggregate construction costs (left panel) and the estimated and extrapolated AS curve (right panel)



Source: Authors' calculations.

Applicability of the analysis

A synthetic and easy-to-understand analysis of possible long-term and short-term scenarios can be made by combining the estimated aggregate medium-term demand and supply curves with knowledge of microeconomic models of the sector.

We analyse the Polish OOH sector, which, after many years of a construction boom, rising prices, and production volumes, is reaching the point of cycle reversal. The main factors behind the sector's boom were low interest rates and structural features like housing shortages, economic development, rising incomes, and urbanisation processes. An inhibiting factor was the increase in construction production costs resulting from the sector's boom (the same boom can be observed in the commercial property sector) and ongoing infrastructure programmes. The main factors influencing the potential trend reversal are rapidly rising inflation, including in the construction market, and in consequence rapidly rising interest rates at the end of the cycle.

We begin our analysis with a snapshot of the short term outlook, and the basic question is whether a rapid decline in demand will cause a sharp drop in housing prices.

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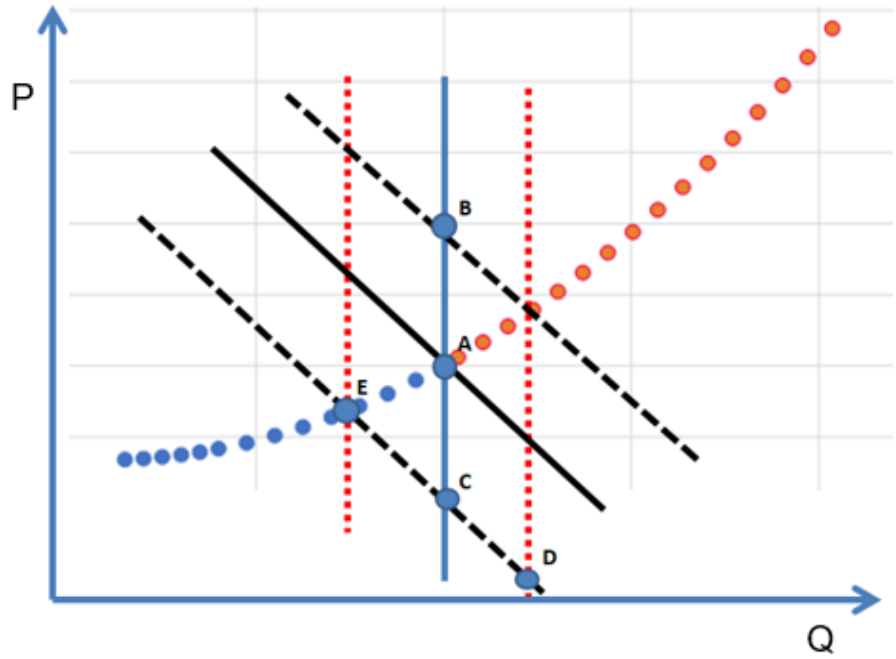
Figure 6: An AD-AS analysis of the housing sector in the short run



Source: Authors' calculations.

The starting point of the analysis is point A. The rapid rise in interest rates and associated inflation causes a rapid decline in demand for loans and, consequently, for housing. In the six major cities we analyse in Poland in 2021-2022, loans account for only about 50% of demand (see NBP, 2022), so the impact of this factor will be smaller. On the other hand, rising inflation may induce increased investment demand and more cash purchases. In general, it seems that the variant of increasing demand (point B) is less likely than decreasing demand (point C). Positive supply shocks (point D) are also unlikely, as developers are in a good financial position and after the global financial crisis will prefer to wait for a client and not offer price reductions. It is also unlikely that households will try to sell their flat to pay back the mortgage more quickly. For this reason, the withdrawal of offerings by developers may be more likely. Consequently, the risk of a short-term, rapid price decline (points C and D) is low.

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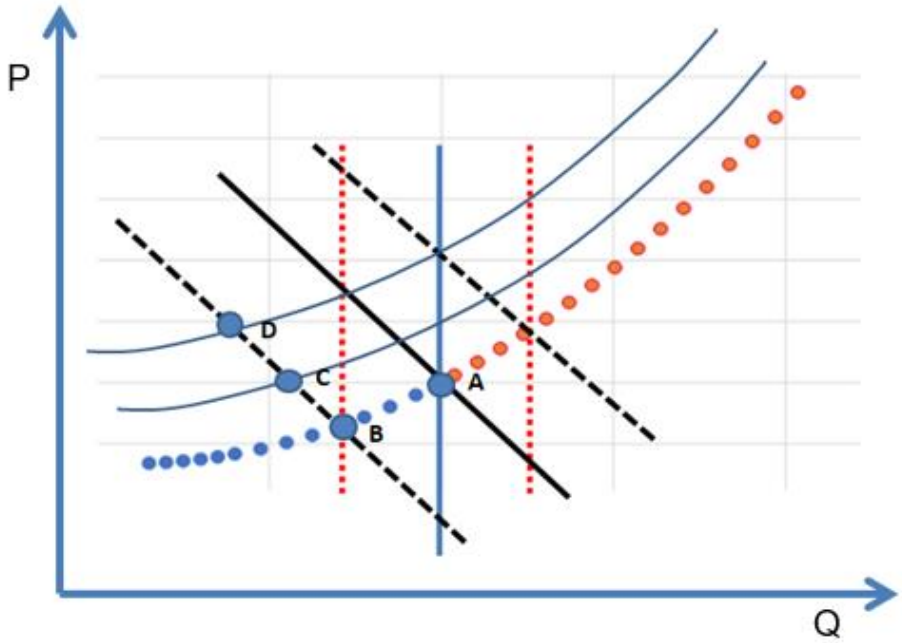
Figure 7: An AD-AS analysis of the housing sector in the long run



Source: Authors' calculations.

In the long run, a decline in demand will result in a reduction in production (point B), which will entail a decline in real production costs. However, this process will take place under conditions of high inflation, including sectoral inflation, which will lift the long-term supply curve upward (points C and D). A sectoral stagflationary situation is likely to emerge, with demand and housing construction falling, while nominal house prices will increase. Interestingly, it seems that such a situation is indeed occurring in the primary housing market in Poland right now. We do not suggest that our model could have predicted such changes, since that would require saying when and how much the demand declines. However, as stated in the introduction, our model allows us to conclude, on the basis of empirical observations in Western economies and a simple demand and supply function calibrated for Poland, that such a situation will occur once high inflation becomes noticeable.

Conclusion

We propose applying a slightly modified version of the canonical aggregate demand and aggregate supply (AD-AS) model to the housing market. We consider this a simple model that can be used to supplement the rich and complicated dynamic stochastic general equilibrium models that cover the whole economy and the housing market. Those models are very good at explaining what we observed in the past, but they are less useful for explaining sudden changes when they appear. Those models are too big; it takes researchers too long to adjust them to current problems. There is an old joke that says an economist is someone who explains to you tomorrow, why the prediction he made yesterday is wrong today. We propose a simple model in which we can shift the major elements, which, as economic history tells us, can lead to complex sudden fluctuations in both aggregate demand and supply. Our model should be useful for explaining what we observed during the COVID-19 pandemic, which is that housing demand remained high despite the high risk in the economy.

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