Residential real estate prices in Slovakia and forecast using the ARIMA model

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Abstract: The development of real estate prices varies depending on the country, region and city. However, in general, certain trends can be observed. Real estate prices have been growing for a long time. Property prices have increased in many countries and this growth is due to various factors such as rising incomes, low interest rates and a growing population. However, in many countries, property prices have slowed or even fallen in recent years. This is due to several factors such as rising interest rates, rising inflation and economic uncertainty. Property prices vary by location. In some areas, such as large cities or areas with high demand, property prices are significantly higher than other areas. The article describes the development and forecast of real estate prices intended for housing in Slovakia. It defines the factors that have a significant impact on the development of real estate prices. National Bank of Slovakia publishes quarterly data on real estate prices since 2005. Quantitative methods – ARIMA models – are used for prediction. The forecast of average housing prices in the Slovak Republic is carried out for five quarters.

Keywords: real estate market, housing prices, forecast, ARIMA model

Abstract: Vývoj cien nehnuteľností sa líši v závislosti od krajiny, regiónu a mesta. Vo všeobecnosti však možno pozorovať určité trendy. Ceny nehnuteľností dlhodobo rastú. V mnohých krajinách sa ceny nehnuteľností zvýšili a tento rast je spôsobený rôznymi faktormi, ako sú napríklad rastúce príjmy, nízke úrokové sadzby a rastúca populácia. V mnohých krajinách sa však ceny nehnuteľností v posledných rokoch spomalili alebo dokonca klesli. To je spôsobené viacerými faktormi, ako sú napríklad zvýšenie úrokových sadzieb, rastúca inflácia a ekonomická neistota. Ceny nehnuteľností sa líšia v závislosti od lokality. V niektorých oblastiach, ako sú veľké mestá alebo oblasti s vysokým dopytom, sú ceny nehnuteľností výrazne vyššie ako v iných oblastiach. Článok popisuje vývoj a prognózu cien nehnuteľností určených na bývanie na Slovensku. Definuje faktory, ktoré majú významný vplyv na vývoj cien nehnuteľností. Národná banka Slovenska zverejňuje štvrťročné údaje o cenách nehnuteľností od roku 2005. Na predikciu sú použité kvantitatívne metódy – ARIMA modely. Predpoveď priemerných cien bývania v Slovenskej republike je realizovaná na päť štvrťrokov.

1. Introduction

The Economic development and development on the real estate market are interconnected. During an economic expansion, rising incomes cause equilibrium prices in the real estate market to rise, which in turn will affect price expectations and capital gains, causing excessive price increases. The development of the real estate market is largely dependent on the state of the economy within the business cycle, while extreme pressures in the economy can lead to a crisis in the real estate market.

Residential real estate prices are influenced by many economic and social factors. On the demand side, these are mainly interest rates, demographic development, taxes and subsidies from

the state. The supply side is mainly affected by the availability and price of building land, construction costs, legislation.

A specific phenomenon on the real estate market is the emergence of the so-called real estate bubble. [1] describe the causes. Demand in the housing market is growing due to the increasing profitability of renting. Rapidly growing demand with limited short-term supply causes real estate prices to rise. The banking sector is able to accumulate a large amount of funds in a short time and offer them in the form of mortgage loans to finance even higher real estate prices. Speculative transactions, based on the expectation of a continuation of the rising price trend in the future, further increase the growth of the price level of real estate and the so-called real estate bubble.

Girouard, N. and S. Blöndal [2] proved the impact of real estate prices on the level of private consumption and investment in housing in OECD countries. They also noted that in many countries, movements in housing prices have a significant impact on the course of economic cycles.

A separate issue in the analysis of real estate prices is the collection of statistical data. The most common imperfections are insufficient data structure, e.g. according to the type of house or apartment, different time periodicity, data are not uniform, insufficient structure of data on the method of financing the purchase of real estate, [3] states. After joining the EU, Slovakia had to meet the requirements of the European Central Bank for quarterly data on real estate prices. The Statistical Office of the Slovak Republic (ŠÚSR) collects aggregate data on non-financial assets for the entire economy and for individual sectors in accordance with the ESA95 methodological guidelines. However, data on real estate prices are not subject to statistical investigation by the ŠÚSR or any other official national data source [3]. Since 2004, the NBS has been collecting data on real estate prices with the National Association of Real Estate Agencies of Slovakia (NARKS). It collects data for the purpose of processing a database of real estate prices for individual quarters in a structure that meets ECB requirements.

From the point of view of development, the prices of residential real estate gradually increased in 2020 to reach the values they had at the peak of the real estate boom in 2008. From the first quarter of 2020, prices rose faster, which was caused by increased demand for housing and low interest rates. The turning point occurred in the second quarter of 2022 – at the beginning of summer, since average prices have been falling. The reason is mainly the increasing interest rate, but also the general uncertainty in the economy, the growth of inflation and pessimistic estimates of GDP development as well as the current geopolitical situation. At the end of the year in the fourth quarter of 2022, the drop in prices was at the level of almost 2% compared to the previous quarter.

A real estate bubble is a condition where real estate prices rise beyond a level that can be justified by basic economic factors such as income, interest rates, or supply and demand. A bubble usually forms when demand for real estate is high and supply is low. This can be due to a variety of factors such as: low interest rates that reduce the cost of mortgages, a growing economy that leads to increased incomes, migration that increases the demand for real estate in certain areas

When the bubble bursts, real estate prices plummet. This can have serious economic consequences, as it can lead to bankruptcies, job losses and a drop in consumption. There are several signs that may indicate that a real estate bubble is developing:

- Rapid growth in real estate prices, which is not justified by basic economic factors
- Low supply of real estate, which is caused by various factors, such as construction restrictions or lack of land
- High demand for real estate, which is caused by factors such as low interest rates or a growing economy
- Increased real estate speculation, where people buy real estate with the goal of selling it quickly at a higher price

Falling property prices can have serious economic consequences. It can lead to bankruptcies, job losses and a drop in consumption.

The development of housing prices can be predicted, while creating a successful forecast can be quite complicated depending on the methods used. Raymond Y.C. [4] used the so-called Box-Jenkins methodology when analyzing the Hong Kong real estate market. ARIMA models.

2. Materials and Methods

The database of the National Bank of Slovakia [5] was used as the database of average apartment prices in Slovakia. Quarterly data are available from the 1st quarter of 2005 to the 4th quarter of 2022. The development prediction for five quarters ahead is realized using the ARIMA model.

ARIMA (AutoRegressive Integrated Moving Average) are time series models that have three parts: [6]

- autoregressive (AR) - part of the time series value can be explained as a linear combination of past values. The order of the AR component is denoted by "p" and expresses how many time periods back this component of the model is delayed.
- integrative (I) - means the difference of the time series before the application of the AR - MA models. The order of the integration component "d" means how many times in a row the difference is applied so that the series is stationary.
- moving averages (MA) expresses that part of the time series error can be explained as a linear combination of past errors (residuals). The order of the MA component is denoted by "q" and expresses from how many time intervals in the past the errors in the model are applied.

The model is then labeled ARIMA(p,d,q) according to the order. If necessary, the basic model can be supplemented with an ARIMA model of the seasonal component.

ARIMA models are estimated using the Box-Jenkins method, which has three steps:

• Model identification and selection, using the analysis of autocorrelations and partial autocorrelations of the examined time series,

• Estimation of regression coefficients (using the maximum likelihood method),

• Testing the stationarity of its residuals.

The ARIMA method is widely known, so we will not describe it in more detail.

3. Results

The forecast of average apartment prices was realized using the ARIMA model in the Statgraphics 18 Centurion software. The time series of apartment prices was non-stationary (according to ACF, PACF and periodogram). Stationarity was ensured after the first difference. The model whose random component indicated white noise and at the same time the value of the Box-Pierce test was the highest has the form ARIMA (2,1,2), while the process of moving averages of the second order MA(2) can generally be expressed as:

$$yt = at - \theta 1at-1 - \theta 2at-2 \qquad (1)$$

where *at* is a white noise process

The results of the analysis and the description of ARIMA (2,1,2) are shown in the output in Tables 1 and 2, and Figure 1.

Table 1. Statistical estimates of errors

	Estimation
Statistic	Period
RMSE	24,5118
MAE	20,7253
MAPE	1,23654
ME	3,40623
MPE	0,30221

Table 2. Estimates of ARIMA model parameters (2,1,2)
ARIMA Model Summary

Parameter	Estimate	Stnd. Error	t	P-value
AR(1)	-0,200369	0,152369	-1,132513	0,023648
AR(2)	0,458263	0,12333	2,63251	0,000221
MA(1)	-1,23658	0,1456983	-5,51123	0,000000
MA(2)	-0,203658	0,124269	-1,102363	0,047256

Source: Own calculations, output from Statgraphics 18 Centurion

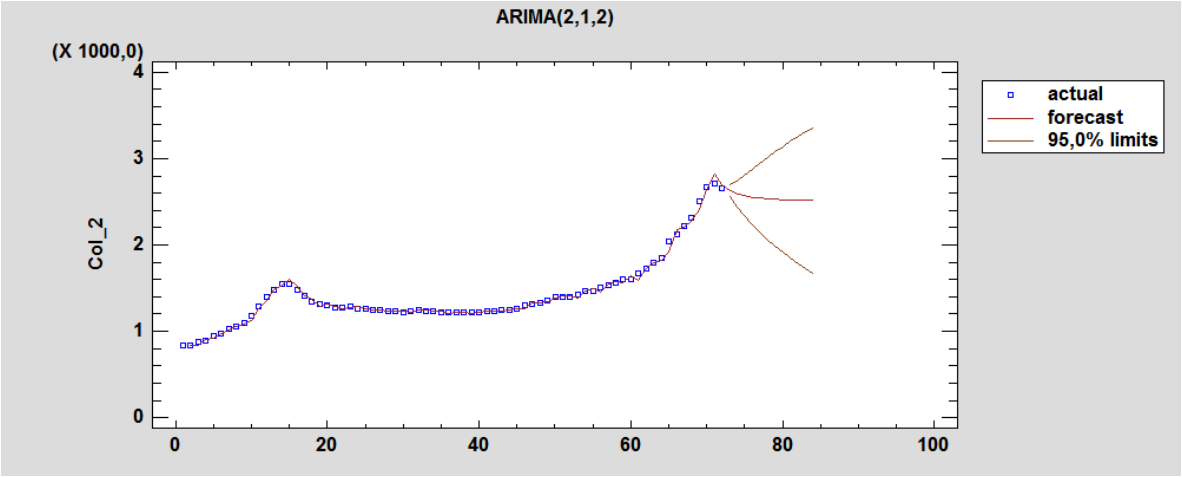

Figure 1. ARIMA model and forecast for 5 quarters ahead
Source: Own calculations, output from Statgraphics 18 Centurion

4. Discussion

The ARIMA model satisfactorily describes the real observed values (ex-post). The forecast for 2023 indicates a persistent decline in prices over the next five quarters, which is also in line with the expectations of several experts. We can observe certain reserves in the width of the forecast area. We assess the area interval in which future development can move as wide, therefore future development can be even more extreme than described by the model. Among the advantages of the model, we consider flexibility and low demand for inputs, there is no need to estimate the shape of the regression curve, and the problem of non-linearity is also eliminated. The advantage is also the possibility of effective forecasting even in the case of a shorter time series.

5. Conclusion

Residential real estate prices reflect the state of the economy within the economic cycle. The development of real estate prices is a complex and dynamic process that is influenced by various factors, while the relationship between economic and real estate cycles is dampened because the real estate market includes non-standard assets that differ qualitatively and are regionally differentiated. In general, property prices tend to rise over time, which is driven by factors such as interest rates, inflation, and rising demand for housing and rising GDP. Price fluctuations cause significant changes in interest rates, changes in government policy, and changes in the overall economy. There is no central real estate market, resulting in imperfect price information and a lack of transparency. The offer on the residential real estate market may be insufficient due to lagging construction production and a lack of suitable land. We assume that the prices of residential real estate will continue to fall, while in the case of new buildings, this decline will be only moderate, due to rising input costs,

especially building materials and energy. The situation may be different in the Bratislava region and especially in the capital, where the construction of residential properties is still very lucrative for many developers.

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