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FORECASTING THE NUMBER OF HOUSING UNITS DELIVERED IN POLAND IN THE YEARS 2010-2017 IN THE CONTEXT OF SOCIAL SECURITY

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Abstract

The article addresses the problem of forecasting the number of housing units delivered in Poland in 2010-2017 on the basis of primary data obtained from the Central Statistical Office in the context of social security. First, an analysis and evaluation of the time series in question was made. Subsequently, the analysed time series was divided into two segments. On the basis of the evaluation, forecasting was performed with various methods for the first part of the time series of the number of housing units completed in Poland, which consisted of 84 elements, and then the best forecasting method was selected. On the basis of that method, forecasting of the primary time series (consisting of 96 elements) of the number of housing units completed in Poland in 2010-2017 was performed retrospectively for 2018.

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Introduction

Analysis of the literature on the subject shows that increasing the annual economic growth rate by as little as 0.5% already allows to achieve an increase in production (Begg, Vernasca, Fischer, & Dornbusch, 2014). Economic growth also generates an increase in the number of housing units delivered, shortening the time of their construction and placing on the market, and allows to ensure social security. Social security is understood as a guarantee by the state to meet the social needs of individuals or social groups related to certain social risks, e.g. the accessibility of housing units (Redo, Wójtowicz, & Ciak, 2018). The issues related to the forecasting of the number of housing units delivered become, therefore, important in terms of ensuring social security.

The analysis of the available literature on the subject and the authors' own experience shows that various forecasting methods (although not always accurate) are used by institutions dealing with the forecasting of the number of housing units delivered in Poland. This prompted the authors to undertake research on this subject and examine the aforementioned methods.

The research problem focuses on the selection of methods for forecasting the number of housing units delivered in Poland in order to optimize the obtained results in terms of social security. The authors have formulated the following main research question: will the retrospective use of the analysis and evaluation of the time series of the number of housing units delivered in Poland allow for the selection of the optimal forecasting method? The problem is important in terms of the social security of citizens.

The available literature on forecasting is very extensive, but dispersed and fragmented. There is no detailed description of the methods of retrospective analysis and evaluation of time series, building prognostic models and methods of proceeding in order to calculate the forecast result. For the purposes of this article, the most useful publications on forecasting include (Dittmann, 2016; Dittmann, Dittmann, Szabela-Pasierbińska, & Szpulak, 2016a; Dittmann, Dittmann, Szabela-Pasierbińska, & Szpulak, 2011; Kozicki, Ślaski, Waściński, & Rusak, 2016; Kozicki, 2016; Kozicki, Brzeziński, Waściński, & Ślaski, 2017; Kozicki, 2018; Makridakis, Wheelwright, & Hyndman, 1998; Papież, Śmiech, 2015; Rabiej, 2018; Suchwałko, Zagdański, 2016). In the authors' opinion, however, they are not sufficient to carry out a detailed analysis and evaluation of the time series in question concerning the number of housing units delivered in Poland in 2010-2017. A correct analysis and evaluation, as well as a prognostic model based on them also requires intuition and experience in this type of research.

The main purpose of the research is an attempt to perform a forecast of the number of housing units delivered in order to assess the level of national social security. The research covers the years 2010-2017, and was conducted for the territory of the Republic of Poland.

The following research methods were used in the article: analysis and criticism of the literature on the subject of economic growth, forecasting, analysis of source documents, computer simulation methods, and comparisons. The basic research tool was the Statistica software. The following tools of statistical analysis were used for the interpretation of the research results: quartile chart, autocorrelation, partial autocorrelation, multiple regression, histogram, Shapiro-Wilk test, Grubbs test.

1. Analysis of the literature on the subject

Economic growth is measured by the rate of real GDP growth, or real national income (Begg, Vernasca, Fischer, & Dornbusch, 2014). The consequence of economic growth was the increasing number of housing units delivered in Poland in 2010-2017, which contributed to an increase in the social security of the citizens of Poland. The housing units delivered were divided into three main groups: individual, cooperative, and for sale/rent. An important issue is to determine the number of housing units that will be delivered in the future. This will make it possible to forecast an extremely important indicator of social security, which is the number of housing units in the country.

P. Dittmann et al. define forecasting as a rational, scientific prediction of future events (Dittmann, Dittmann, Szabela-Pasierbińska, & Szpulak, 2016a). Its purpose is to reduce the risk of making mistakes. This becomes important when planning the Central Bank's minimum reserves.

There are many different classifications of forecasting methods in the literature, but one of the most frequently used is the classification into quantitative and qualitative methods. For the purposes of this article, the quantitative methods will be used. The selection of appropriate methods will be preceded by a thorough analysis and evaluation of the time series of the number of housing units delivered in Poland in 2010-2017 by month.

2. Analysis and evaluation of the time series of the number of housing units delivered in Poland in 2010-2017 by month

Figure 1 presents the data on the number of housing units delivered in Poland in 2010-2017 by month. The data was obtained from the official website of the Central Statistical Office (GUS).

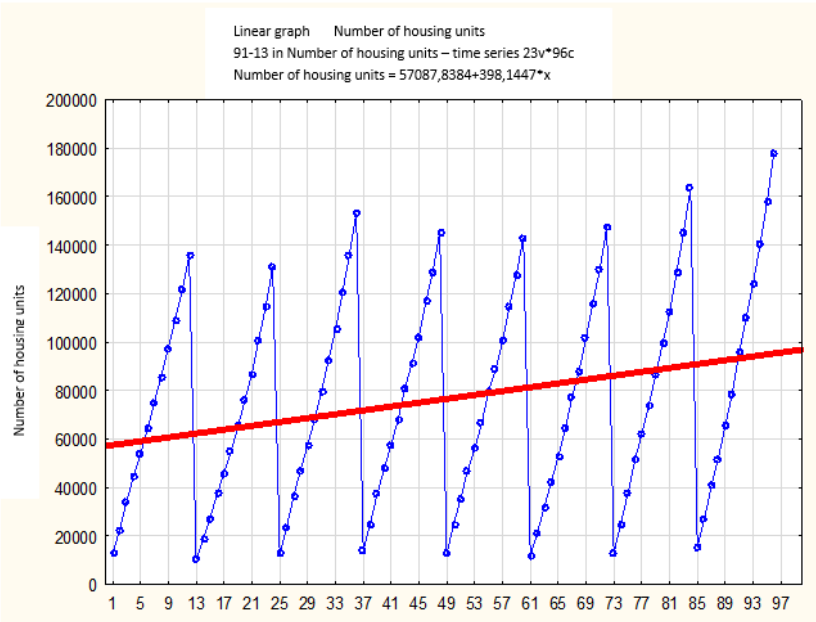
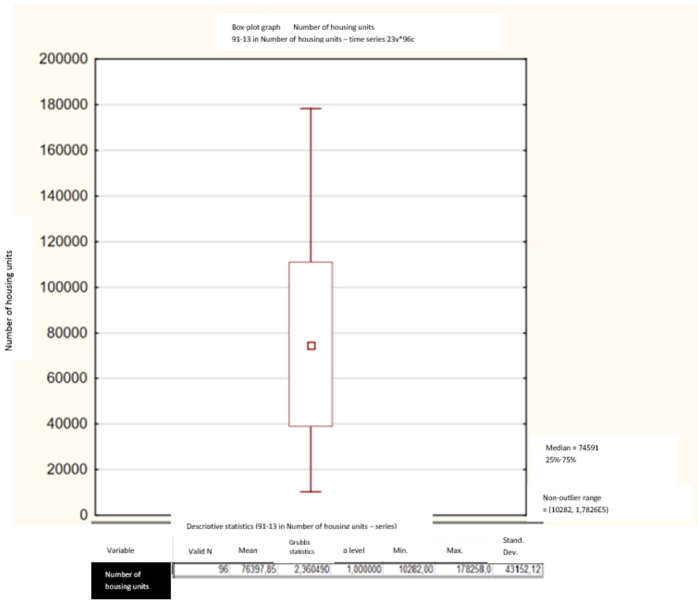


Figure 1. Summarised data on the number of housing units delivered in 2010-2017 by month and a trendline

Source: Główny Urząd Statystyczny (2018). Available at: http://stat.gov.pl/obszarytematyczne/przemyslbudownictwosrodkitrwale/budownictwo/budownictwo-mieszkaniowe-tablice-przegladowe-od-1991-roku,6,5.html.

Fig. 1. shows the phenomenon of seasonality, as well as a slight trend. The trendline is represented by the red line, which can be expressed as the following linear function: Y=57087,8384+398,1447•X. The slope of the line indicates an increasing trend.



Variable	Valid N	Mean	Grubbs statistics	α level	Min.	Max.	Stand. Dev.
Number of housing units	96	76397,85	2,360490	1,000000	10282,00	178258,0	43152,12

Figure 1. Comparison of the box plot and the Grubbs test

Source: Główny Urząd Statystyczny (2018). Available at: http://stat.gov.pl/obszarytematyczne/przemyslbudownictwosrodkitrwale/budownictwo/budownictwo-mieszkaniowe-tablice-przegladowe-od-1991-roku,6,5.html.

The next stage of the analysis was to check for outliers and any extreme values in the time series in question. For this a box-plot graph and the Grubbs test were used. The use of these tools confirmed no outliers or extreme values. Analysing Fig. 2, the distribution of the parameter is characterized by left-sided asymmetry, which means that more units have higher values of the parameter.

Table 1. Analysis of data on the number of housing units delivered in Poland in 2010-2017

Variable	Mean	Median	Sum	Min.	Max.	Lower quartile	Upper quartile	Percentile 10.00000	Percentile 90,00000	Stand. Dev.
Number of housing units	76397,85	74591	7334194	10282,00	178258,0	39005,00	111071,5	21241,00	135835,0	43152,12

Source: Główny Urząd Statystyczny (2018). Avaible at: http://stat.gov.pl/obszarytematyczne/przemyslbudownictwosrodkitrwale/budownictwo/budownictwo-mieszkaniowe-tablice-przegladowe-od-1991-roku,6,5.html.

The next stage of the research was a retrospective analysis of the so-called basic statistics of the entire time series. The results are presented in Table 1. The median shows that the number of housing units delivered in the middle of the entire time series was less than 74,591. The average number of housing units delivered in the analysed time series was 76,398. The standard deviation from the arithmetic mean was 43,152.12, the lowest number was 10,282, while the highest was 178,258.

Table 2. Analysis of the data on the number of housing units delivered in Poland in 2010-2017 by month

Variable	Mean	Median	Sum	Min.	Max.	Lower quartile	Upper quartile	Percentile 10,00000	Percentile 90,00000	Variance	Stand Dev.	Var. coeff.
January	12748,1	12641,0	101985	10282,0	15355,0	12108,0	13425,0	10282,0	15355,0	2247610	1499,20	11,76019
February	23488,3	24378,0	187906	18329,0	26899,0	21948,0	25013,0	18329,0	26899,0	7276713	2697,54	11,48463
March	35033,6	35927,0	280269	27500,0	40587,0	32875,0	37289,0	27500,0	40587,0	15962001	3995,25	11,40404
April	46163,3	47292,5	369306	36973,0	51853,0	43495,0	49452,5	36973,0	51853,0	23516267	4849,36	10,50480
May	56330,3	56755,0	450642	45726,0	65499,0	53193,0	59760,5	45726,0	65499,0	36026238	6002,19	10,65535
June	67082,0	67130,5	536656	54568,0	78379,0	63872,5	70851,5	54568,0	78379,0	50139767	7080,94	10,55565
July	80001,4	79696,5	640011	65064,0	95719,0	76146,5	83771,0	65064,0	95719,0	77967216	8829,90	11,03719
August	91547,3	90100,5	732378	75965,0	110126,0	87028,5	96014,5	75965,0	110126,0	100088929	10004,45	10,92818
September	103656,6	101716,5	829253	86839,0	124343,0	98908,0	108411,0	86839,0	124343,0	119706148	10941,03	10,55507
October	118363,5	116418,0	946908	101027,0	139898,0	112140,0	124433,5	101027,0	139898,0	139034759	11791,30	9,96194
November	132698,9	129580,0	1061591	114443,0	157483,0	124751,5	140501,0	114443,0	157483,0	182753281	13518,63	10,18745
December	149661,1	146423,5	1197289	130954,0	178258,0	13500,5	158114,5	130954,0	178258,0	231797661	15224,90	10,17292

Source: Główny Urząd Statystyczny (2018). Avaible at: http://stat.gov.pl/obszarytematyczne/przemyslbudownictwosrodkitrwale/budownictwo/budownictwo-mieszkaniowe-tablice-przegladowe-od-1991-roku,6,5.html.

Then, for research purposes, the data on the number of housing units delivered in Poland by month was compiled and a trend analysis was carried out (Table 2). Increasing variance and standard deviation indicate the existence of seasonality. The highest number of housing units was delivered in December, while the lowest - in January.

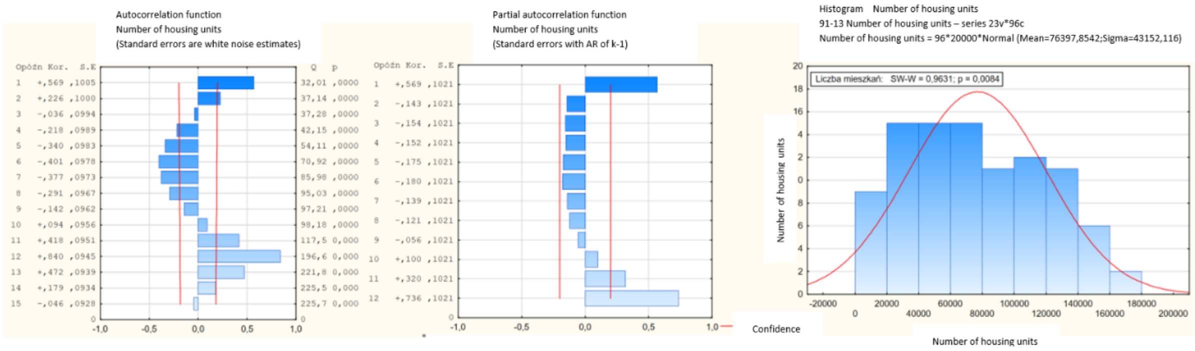


Figure 2. Application of research tools: autocorrelation, partial autocorrelation, histogram and Shapiro-Wilk test

Source: own elaboration.

The next stage of the analysis was the application of the following research tools: autocorrelation, partial autocorrelation, histogram and Shapiro-Wilk test for the time series in question. Autocorrelation and partial autocorrelation indicate the existence of a correlation, a trend and seasonality. The autocorrelation is slowly decreasing, taking the shape of a damped sinusoid. It can, therefore, be assumed that we are dealing with a non-stationary process. On the other hand, the normal probability plot shows a distribution close to the normal distribution with left-sided asymmetry (Table 3).

	Dependent Variable Regression Summary: Number of Housing Units(91-13) **R=,99193507 R^2=,98393518 Corr. R2=,98138832** **F(13,82)=386,33 p<0,0000 Stand. Err. of estimation: 5887,0=**					
N=96	b*	Stand. error z b*	b	Stand. error z b	t(82)	p
Intercept			144674	2757,224	52,4711	0,000000
January	-0,866453	0,019015	-134573	2953,305	-45,5670	0,000000
February	-0,798405	0,019004	-124004	2951,619	-42,0123	0,000000
March	-0,725225	0,018994	-112638	2950,111	-38,1811	0,000000
April	-0,654776	0,018986	-101697	2948,768	-34,4878	0,000000
May	-0,590578	0,018978	-101697	2947,580	-31,1190	0,000000
June	-0,522669	0,018971	-91726	2946,542	-27,5504	0,000000
July	-0,440857	0,018966	-81178	2945,650	-23,2450	0,000000
August	-0,367941	0,018961	-68472	2944,905	-19,4053	0,000000
September	-0,291451	0,018957	-57147	2944,311	-15,3743	0,000000
October	-0,198291	0,018954	-30797	2943,873	-10,4616	0,000000
November	-0,107575	0,018952	-16708	2943,600	-5,6761	0,000000
December	-0,122593	0,056579	-190	87,646	-2,1667	0,000000
t	0,268259	0,056553	-190	87,646	-2,1667	0,033157
t^2	0,268259	0,056553	4	0,875	4,7435	0,000009

Table 3. Structure and application of a multiple regression model to verify the existence of a trend and seasonality

Source: own elaboration.

The next stage of the analysis was building a zero-one multiple regression model in order to verify the existence of a trend and seasonality in the time series in question. For this purpose, fourteen predictors were used. Thirteen predictors turned out to be significant as a result of applying backward regression (Fig. 4).

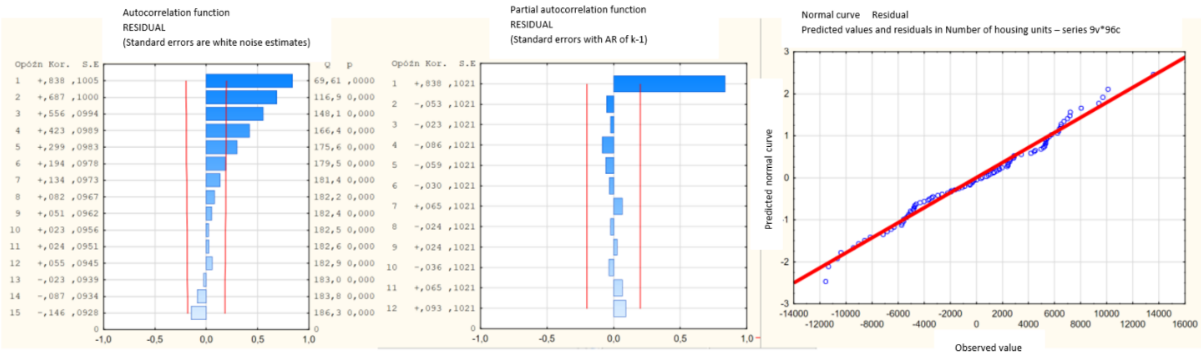


Figure 4. Evaluation of the residuals of the constructed multiple regression model through the use of the following research tools: autocorrelation, partial autocorrelation and the normal probability plot

Source: own elaboration.

The significant predictors presented in Figure 4 confirm the existence of a trend and seasonality. Subsequently, distribution of the residuals of the constructed model was examined (Fig. 5).

The distribution of the residuals is similar to the normal distribution. Correlations are visible for the residuals of the constructed model (Fig. 5).

Next, for analytical purposes, the time series in question was divided into two segments. On the basis of the first segment, a forecast was made in the third substantive point, while the evaluation of the forecast was based on the second segment of the time series (Fig. 6).

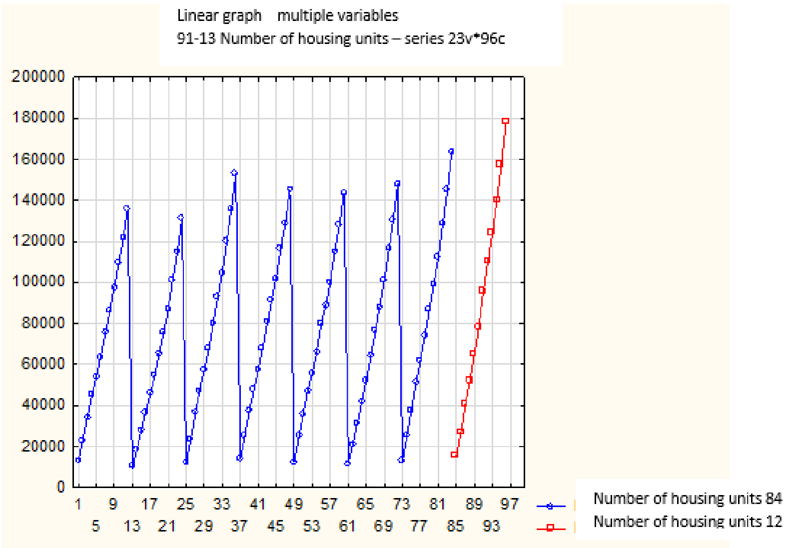


Figure 5. Division of retrospective data on the number of housing units delivered in 2010-2017 into two segments consisting of 84 and 12 elements

Source: own elaboration.

3. FORECASTING

Winters' exponential smoothing was used as the first forecasting method. The results of the forecast are shown in Figure 7. The forecast was made for twelve future periods. A vector of constant variables was used (Alpha = 0.978 Delta = 0.00 Gamma = 0.00).

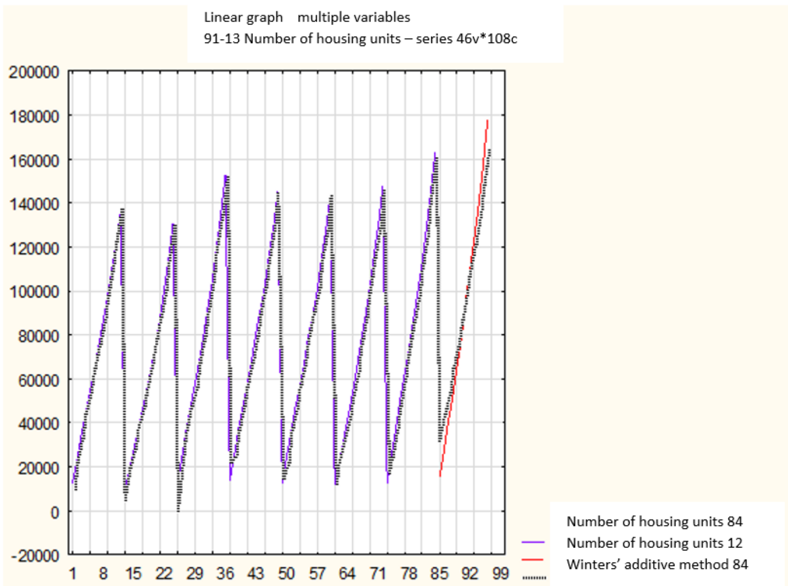


Figure 3. Forecast using Winters' method and retrospective data on the number of housing units delivered in Poland in 2010-2016 for 2017 - for 12 periods (months)

Source: own elaboration.

The relative forecast error for the applied Winters' method was 23.96 (Fig. 8).

	91-13
	APE Winters' 84
MEAN 1-106	23,9646776

Figure 8. Application of the relative forecast error to the evaluation of the forecast performed with the Winters' method

Source: own elaboration.

The second forecast used was one based on the SARIMA model (2,2,0)(1,0,0) (Fig. 9).

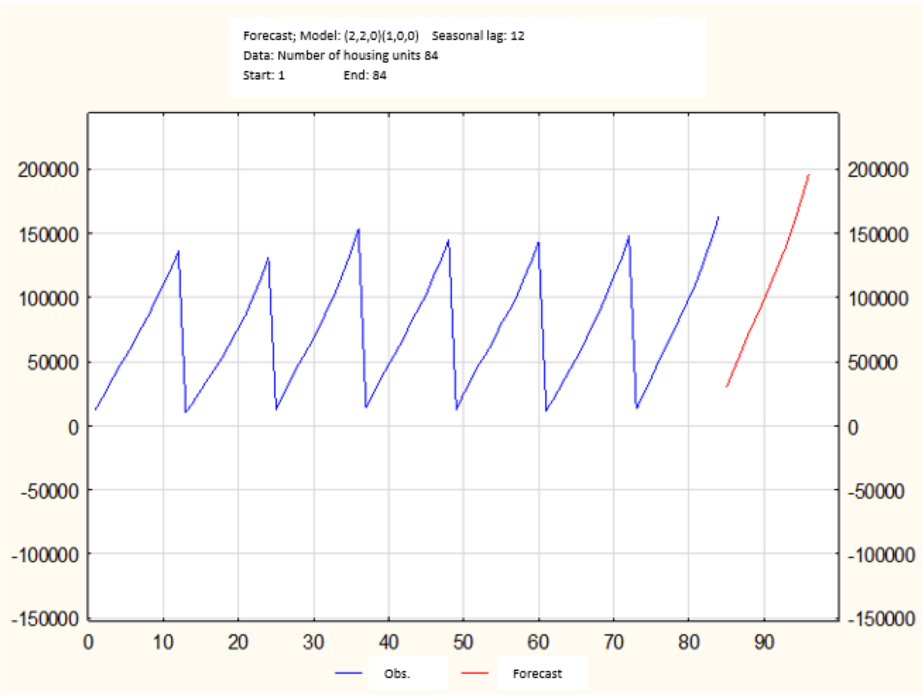


Figure 9. Forecast performed with the SARIMA method using retrospective data on the number of housing units delivered in Poland in 2010-2016 for 2017 - for 12 periods (months)

Source: own elaboration.

The results in the form of the relative forecast error for the SARIMA model used (2.2.0)(1.0.0) are shown in Figure 12. The relative forecast error was 31.59.

	91-13
	APE SARIMS' 72
MEAN 1-106	31,5942796

Figure 10. Application of the relative forecast error to the evaluation of the forecast performed with the SARIMA model

Source: own elaboration.

Out of the analysed forecasting methods, the Winters' method turned out to be the best one, as the relative forecast error was the lowest in this case. The exponential smoothing method was used to forecast the entire time series of data on the number of housing units delivered in Poland in 2010-2017 for 2018 by month.

The results of the forecast performed with the Winters' method of the time series in question for 2018 are shown in Figure 11. The vector of constant variables was used: Alpha =, 984 Delta = 0.00 Gamma = 0.00.

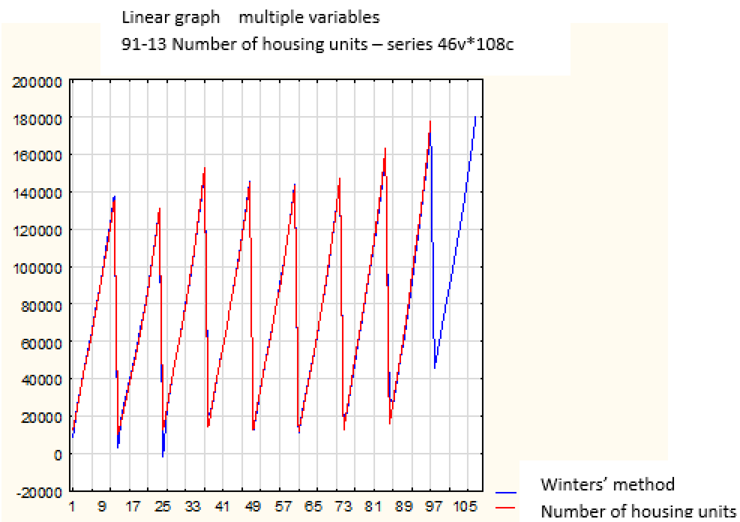


Figure 11. Winters' method forecast of retrospective data on the number of housing units delivered in Poland in 2010-2017 for 2018 - for 12 periods (months)

Source: own elaboration.

Subsequently, the residuals of the delivered model were examined. The results are shown in Figure 12.

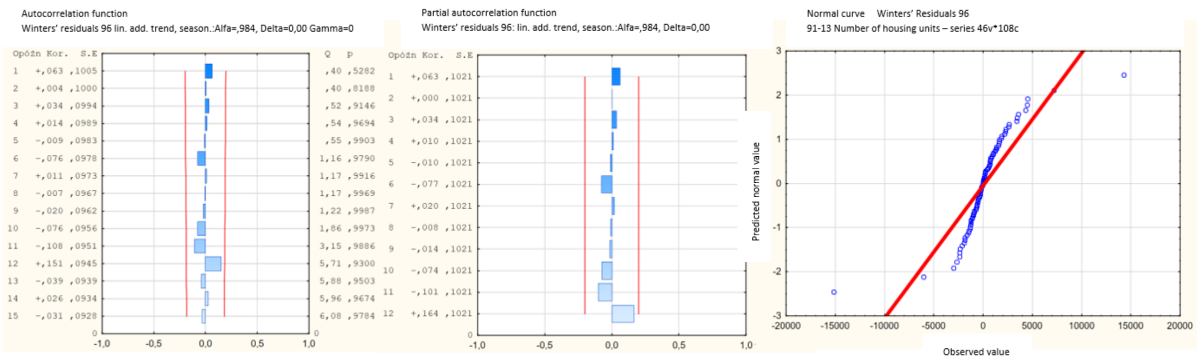


Figure 12. Analysis of the residuals of the Winters' method forecast, through the use of the following research tools: autocorrelation, partial autocorrelation and the normal probability plot

Source: own elaboration.

When using the autocorrelation tool (Fig. 12), it was noticed that the residuals of the constructed model are uncorrelated, and the Q test proves that the model was well adjusted to empirical data. The use of partial autocorrelation (Fig. 12) indicates that all values of the partial autocorrelation are insignificant. Therefore, the resulting residuals must be considered purely random. In other words, the constructed model filtered out all regularities from the series. The distribution of the residuals was then checked by using the normal probability plots, which showed that the series is close to the normal distribution.

CONCLUSIONS

The analysis and evaluation of the time series of data on the number of housing units delivered in Poland in 2010-2017 indicates the existence of seasonality and an upward trend. This is due to Poland's economic growth (measured by the real GDP growth rate or real national income (Begg, Vernasca, Fischer, & Dornbusch, 2014)).

As a result of the conducted research, the answer to the main research question substantiates the analysis and evaluation of the time series of data on the number of housing units delivered in 2010-2017 in order to select an appropriate forecasting method and perform a forecast.

The detailed results Winters' method forecast of the time series of the number of housing units delivered in Poland in 2010-2017 by month (96 elements) for 12 future periods are presented in Table 3.

Table 4. Results of the Winters' method forecast based on the data on the number of housing units delivered in Poland in 2010-2017 by month (96 elements) for 12 future periods

No.	Winters' method forecast of the number of housing units delivered in 2018 (12 months) in Poland
January	45 406
February	56 254
March	67 759
April	78 842
May	89 040
June	99 705
July	112 572
August	123 654
September	135 636
October	150 369
November	164 381
December	180 885

Source: own elaboration.

The application of the Winters' method, with the correlations observed in the time series in question regarding the trend and seasonality, may improve the effectiveness of planning fund allocation to future investments for housing construction projects in Poland in the context of ensuring social security.

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