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# The impact of the COVID-19 pandemic on the assets and reserves of the banking sector

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**Abstract**

The banking sector is a very important part of the financial market. That is why banks, along with the spread of the pandemic, began to implement various strategies and solutions to protect people's finances against the negative effects of the coronavirus crisis (Flotyński, 2020, 20). Today, it is clear that the pandemic has surprised everyone and the solutions used so far have not been perfect. Therefore, the banking sector requires corrections in current forecasts as well as the preparation of new forecasting models for the financial market. This is particularly important in times of economic, social, and financial instability caused by random events such as the COVID-19 pandemic. The present article examines the distribution mechanisms shaping and influencing the selection of the appropriate class of models depending on the current economic situation of chosen processes important for the banking sector, that is assets and reserves. The author recognizes the mechanisms shaping both processes during a stable period as well as the way in which the pandemic changed these mechanisms, thus affecting the prognostic abilities of the models used. The analysis shows that the Polish banking sector was well prepared for the economic slowdown, but despite this, the COVID-19 pandemic caused some perturbations.

## Introduction

The pandemic caused by the SARS-CoV-2 virus has changed a lot in the modern world. People were forced to reshape their lives to protect themselves from a dan-

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gerous disease. The changes which took place during this time mainly concerned interpersonal relationships, ways of doing work, studying, and communication. Financial markets have also started taking action to limit the negative effects caused by the pandemic — most of all, the banking sector, whose assets constitute about 75% of the entire financial system in Poland. The central bank took quick and radical measures to maintain the liquidity and stability of banking in Poland. The Polish National Bank (Narodowy Bank Polski, hereinafter: NBP) began to implement the policy of quantitative easing and asset purchases, which resulted in a significant increase in the assets of the entire financial sector (Zaleska, 2021, 38–46). However, not all activities undertaken by the banking sector enjoy a positive reception from specialists. A reduction in interest rates was considered unnecessary and contributed to the negative effects of monetary policy, including an increase in demand for credit. This reduction also did not help recover the weakened economic growth, as was initially assumed (Sieroń, 14.03.2020). At the end of 2021, interest rates began to be significantly raised, which also indicates a withdrawal from previously-made decisions (www3).

The coronavirus pandemic has come as a surprise to most people around the world. However, at the start of the crisis, the Polish banking sector was in a very good shape. The banks had effective safeguards, a high level of equity, assets, and reserves, and the overall financial situation was evaluated as stable (Łasak, 2020, 80–93). Typical financial crises are very different from ones caused by a pandemic. In the case of the former, the activities of banks are limited by financial losses and the size of capital, while in the case of the corona crisis, banks can conduct free lending activities, provided that this does not lead to a financial crisis (Hryckiewicz and Olszak, 2021, 153–183).

The pandemic has significantly affected various economic sectors around the world. People thought first and foremost about their health and their families. However, with the continuously uncertain situation, more and more people began to also focus their attention on the condition of the financial sector.

The aim of the article is to analyse the impact of the pandemic on the situation occurring in the Polish banking sector during the COVID-19 crisis by means of verifying econometric models imitating the mechanisms of shaping assets and reserves in the period of stable economic situation and maintaining their forecasting properties during the pandemic. To verify the hypothesis that the models correctly imitating the mechanism of shaping assets and reserves in a period of stable economy retain their prognostic properties during the pandemic, a study was conducted. The article has been divided into two parts; the first includes a theoretical part and a description of the banking sector in times of crisis in Poland. Then, the author describes and analyses variables which were used to create econometric models. The second part presents the modelling and forecasting of the analysed processes, divided into a period of calm — that is, before the pandemic — and a period during the pandemic. It also includes an analysis of the research conclusions.

## Stability of the Polish banking sector in a period of unstable economic situation

The economic situation reflects the circumstances prevailing in a given country or market sector. These are all changes in the indicators of economic life, such as the basic components of, e.g., the Gross Domestic Product, inflation, unemployment rate, or investment (www2). Stability of the financial sector is understood as a state in which this system performs its functions in a continuous and effective manner, even when unexpected and unfavourable disturbances of a significant scale occur (www4). The NBP conducts ongoing analyses of the stability of various segments comprising the financial system, including the banking sector. These analyses are carried out for preventive purposes, in order to identify the factors which may cause the instability of the financial system and to assess its resilience to shocks caused by real threats. The period of unstable economic situation is primarily a time of crisis. The first half of the twentieth century, shortly after Poland regained independence, was a challenge for the national economy. Both the rising inflation and the reconstructions necessary to rebuild the destroyed country contributed to the deepening financial crisis. During this period, the Polish banking sector began to take shape (Skrzyński, 2004, 73–76). The second important and at the same time difficult time for the Polish financial sector occurred in the 1980s. The regulations introduced by the government during the times of the People's Republic of Poland (PRL) were aimed at subordinating the country's emission and credit policy to the NBP and in particular, thanks to the bank's support, financing the budget deficit (Kaszubski, 1994). Since that time, the main objectives of this sector were primarily to strengthen the Polish currency, support the country's economic policy, as well as supervise and manage monetary and credit policy (ustawa z dnia 31 stycznia 1989 roku o Narodowym Banku Polskim, Dz.U. z 2022 r. Nr 4, poz. 22). The purpose to be implemented primarily by the NBP was to prevent a crisis — that is, to reduce inflation (Leszczyńska, 2010, 54–61).

The financial crisis of 2008 affected many economies around the world. Poland during this period was described as a "green island" of sorts. The situation in our country did not seem too dire, as the Polish economy was slightly stronger than in the neighbouring countries. However, at the beginning of 2009, GDP growth decreased by about 4–5% compared to the period from 2007 to June 2008, which is about 2% in 2009. A decline in investment was also recorded as a result of fears regarding the near future (Wierzba, Gostomski, Penczar, Liszewska, Górski, Giżyński and Małecka, 2014, 58–62). In particular, the weakened economy has affected many aspects of the banking sector, which, until that time, was in a proper financial condition. According to the Polish Financial Supervision Authority, as a result of the crisis, there has been a decrease in mutual trust among financial institutions (Komisja Nadzoru Finansowego, 2010). This situation proves that issues

in the banking sector affect both businesses and individuals (Wierzba et al., 2014, 62–66). It is worth considering how the current pandemic, which has had an impact on the whole world, will affect the Polish banking sector.

Banks, like businessmen, are obliged to publish information about their economic and financial situation in the form of a balance sheet. An important part of it are financial assets, which testify to the capital and potential of the banking sector — and are, above all, the basis for its functioning (Zaleska, 2007, 594–596). In times of an economic crisis, asset quality is a key issue, as many borrowers are not repaying their liabilities and the volume of non-performing loans is increasing. Banks' assets include, i.a., money in hand and funds intended for trading; an important part are also loans granted to companies and households, which are designed to bring profits. However, sometimes, when the risk of non-payment of loans by consumers increases, banks can generate losses. When asset quality declines, banks need to maintain more capital to cover the existing credit risk and create higher reserves to prepare for expected losses (www1). According to Art. 3 point 1 para. 21 of the Accounting Act, reserves are liabilities whose date or amount is uncertain (ustawa z dnia 29 września 1994 roku o rachunkowości, Dz.U. z 2021 r. poz. 217). Bank reserves are cash which banks are required to deposit in dedicated accounts with the central bank. They also often serve as a monetary policy tool. When a central bank lowers the reserve requirement, banks have the opportunity to take out new loans and in this way increase economic activity. In contrast, when they increase their reserves, the economic growth slows.

In June 2021, a report was published on the stability of the financial system during the COVID-19 pandemic in Poland. At the very beginning, we can learn that, although the coronavirus had a significant impact on the country's economy, these effects do not threaten the stability of the domestic banking sector. However, the legal risk regarding the portfolio of mortgage loans denominated in foreign currencies is high and may pose a significant threat to the financial system. A noticeable increase in reserves and write-offs for credit risk contributes to a continuous decline in the profitability of banks in the European Union (NBP, 2021). According to a study by Deloitte (2020) on the impact of the pandemic on the banking sector in Eastern Europe, banks have significantly improved their asset quality since the global financial crisis in 2008. They built larger capital buffers and strengthened their liquidity, thus entering the economic slowdown in a better condition than during the previous financial crisis. Although the COVID-19 pandemic is still ongoing, several publications have already described its effects on the financial market in Poland. Professors Hryckiewicz and Olszak (2021) in their article analyse the quality of the loan portfolio during two different crises. They noted that, both during the Great Recession and the corona crisis, the quality of the total credit portfolio for enterprises and households has been gradually deteriorating. Professor Waliszewski (2021, 209–227) in his article attempted to analyse the impact of the pandemic on the financial sector, in particular the credit market.

Loans constitute a significant part of the banking sector's assets. The author noted that the pandemic had a negative impact on the financial situation of Poles and increased the level of uncertainty as well as credit risk.

## Methods and materials

The empirical analysis of the banking sector in Poland was based mainly on econometric models. The first one used in the article is the model with delays — autoregressive distributed lag model (ADL). An ADL(p, q) model assumes that a time series can be represented by a linear function of p of its lagged values and q lags of another time series :

$$Y_t = f(Y_{t-1}, Y_{t-2}, \ldots, \quad Y_{t-p}, X_t, X_{t-1}, \ldots \ , X_{t-q}, \varepsilon_t) \tag{1}$$

The model parameters are estimated using the least squares method. Like many statistical analyses, ordinary least squares (OLS) regression has underlying assumptions. When these classical assumptions for linear regression are true, ordinary least squares produces the best estimates. However, if some of these assumptions are not true, one might need to employ remedial measures or use other estimation methods to improve the results. Therefore, it is always necessary to verify the assumptions for OLS regression:

1. The independent variables should not be correlated to residuals.
2. The expected value of the residuals is zero.
3. The residuals have homogeneous variance.
4. The residuals have autocorrelation equal to zero.
5. The residuals follow a normal distribution.

The model is used when there are reaction delays in the process under test. The autoregressive process is one in which the present value results from the values in previous periods (Kufel, 2022, 91–97). Another autoregressive model considered in the paper is the autoregressive integrated moving average model (ARIMA), used for non-stationary processes which that can be reduced to a stationary form following the structure:

$$Y_t = \alpha_0 + \alpha_1 v\, Y_{t-1} + \alpha_2 Y_{t-2} + \ldots + \alpha_p Y_{t-p} + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \ldots + \beta_q \varepsilon_{t-q} + \varepsilon_t \tag{2}$$

The AR part of ARIMA indicates that the evolving variable of interest is regressed on its own lagged values. The MA part indicates that the regression error is actually a linear combination of error terms whose values occurred contemporaneously and at various times in the past (Box, 2015). In this case, the model parameters are estimated using the maximum likelihood method (Stock and Watson, 2020, 607). The ARIMA model was estimated by setting its initial parameters p = q = 1 and d = 1, which will be presented in detail further.

Two main variables which play an important role in the banking sector, i.e., assets and reserves of the entire banking sector in Poland, were adopted for the empirical analysis. These variables were captured respectively in the period before and during the pandemic. The assets and reserves of banks are processes whose mechanism and formation depends on the situation prevailing in the economy. Because of that, their development in the Polish banking sector was examined, with the distinction of two periods: from 2011 to November 2019 (December 2019 marking the coronavirus outbreak in the world) and from December 2019, assuming March 2020 as the moment of the outbreak in Poland (Figure 1).[2]

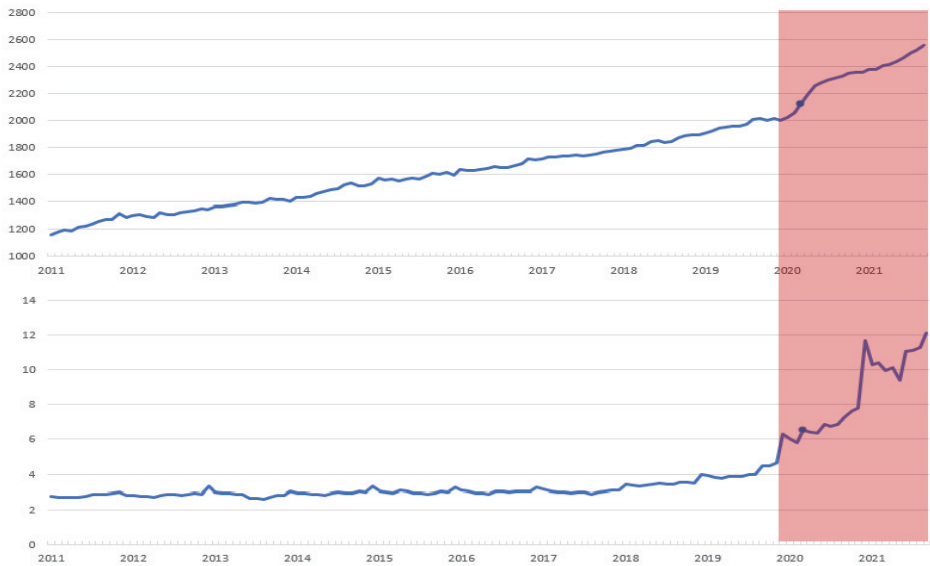


**Figure 1.** Assets and reserves of the banking sector in Poland (in bln PLN)[3]

Source: own study.

[2] The data on the basis of which the analysis was conducted come from the Polish Financial Supervision Authority website. Data by the PFSA are obtained from banks through the NBP. "Dane finansowe sektora bankowego prezentowane są na podstawie sprawozdawczości FINREP jednostkowy (FINPL) przekazywanej przez banki i oddziały instytucji kredytowych zgodnie z załącznikiem nr 4 Uchwały nr 52/2017 Zarządu Narodowego Banku Polskiego z dnia 14 grudnia 2017 roku."

[3] Assets and reserves of the banking sector in Poland in the entire period covered by the analysis, highlighting the pandemic period (December 2019–2021).

Analysing the above charts, it can be seen that in the period before the COVID-19 outbreak, both processes were characterized by a stable long-term upward development trend with minor disturbances (fluctuations). In the case of assets, the outbreak of the pandemic affected the greater growth dynamics, while in the case of reserves, the volatility of the analysed process increased further. When analysing the chart of time series regarding assets, it is possible to notice, above all, their sudden increase since the end of 2019. This was when the world began to hear about the first cases of SARS-CoV-2. The first cases in Poland appeared in March 2020 — the time series chart shows a continuous dynamic increase in the assets of the banking sector during this period. If we also look at the reserve time series graph, we can observe a sudden increase and more significant fluctuations since the beginning of the pandemic. Since March 2020, the reserves of the banking sector in Poland have increased significantly and one can notice greater volatility, which indicates the uncertainty which prevailed in the financial market. The fluctuations observed during the COVID-19 pandemic are accidental and a consequence of an unstable situation. The above results confirm that while the Polish banking sector entered the pandemic period well capitalised and liquid, the outbreak caused significant perturbations in this area, particularly regarding the need to maintain higher reserves. Table 1 and Figure 2 show how the pandemic has affected the basic statistics and distribution of assets.

**Table 1.** The impact of the pandemic on the basic statistics of the distribution of the analysed processes: assets and reserves of the banking sector in Poland (in bln PLN)

| | Assets | | Reserves | |
|---|---|---|---|---|
| | stable period | COVID-19 | stable period | COVID-19 |
| Average | 1577.00000 | 2316.50000 | 3.10170 | 8.55200 |
| Median | 1572.60000 | 2351.60000 | 2.97470 | 7.71850 |
| Standard deviation | 233.35000 | 155.22000 | 0.40477 | 2.17440 |
| Skewness | 0.12373 | -0.65073 | 1.79070 | 0.25521 |
| Kurtosis | -1.05910 | -0.39360 | 3.06370 | -1.55190 |

Source: own study.

The above results confirm that the existing mechanisms shaping the processes of the banking sector have lost their validity. Due to this, the financial and credit plans of banks as well as their strategies need to be reformulated. The COVID-19 pandemic has changed long-term trends, increased the dynamics of processes, and, above all, affected their variability. This means that risk is a huge problem for the banking sector during the pandemic, which is why banks will be forced to make further adjustments, especially in terms of reserves.

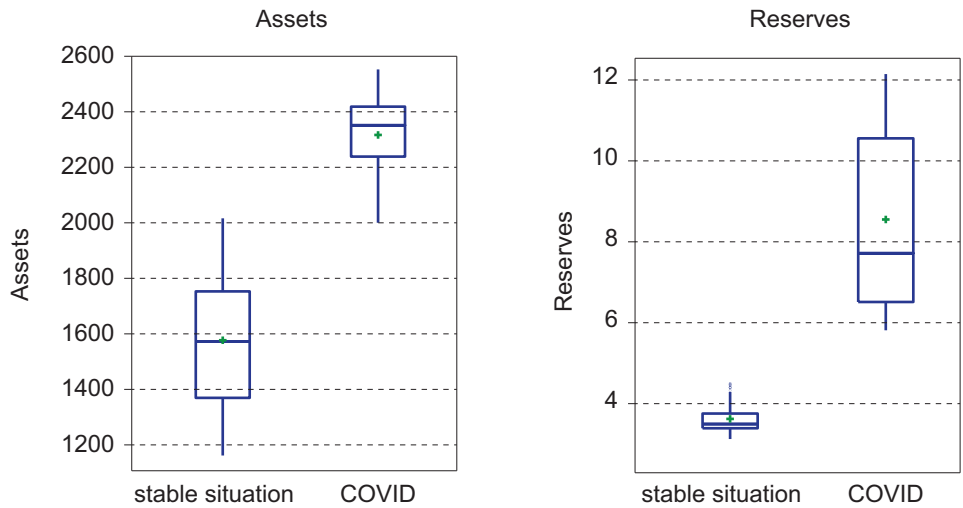


**Figure 2.** The impact of the pandemic on the change in the distribution of assets and reserves in the Polish banking sector (box charts)

Source: own study.

## Results of modelling and forecasting of the analysed processes in a period of calm

The observed mechanisms shaping the two main processes of the banking sector covered by the analysis: assets and reserves, form the basis of macroeconomic forecasts. Because of the changes taking place in the economy and in the market have a significant, albeit somewhat delayed impact on the banking sector, the use of dynamic autoregressive models has been proposed. The occurrence of the autoregressive component in the econometric model manifests itself in the form of delayed processes that play a double role in the model as:

— a casual factor,

— a factor determining the harmonic structure.

In the case of the banking sector, it can be suspected that delays in reactions are the result of, i.a., the action of institutional factors, and this is a signal indicating that models should be considered ADL(p, q). The paper takes into consideration a linear model of the following form:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \ldots + \alpha_p Y_{t-p} + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_q X_{t-q} + \varepsilon_t \quad (3)$$

In order to recognise the frequency and intensity of fluctuation, a periodogram of the so-called process spectrum was used. To correctly determine the delay order, a correlogram was used in the identification phase (Figures 3 and 4).

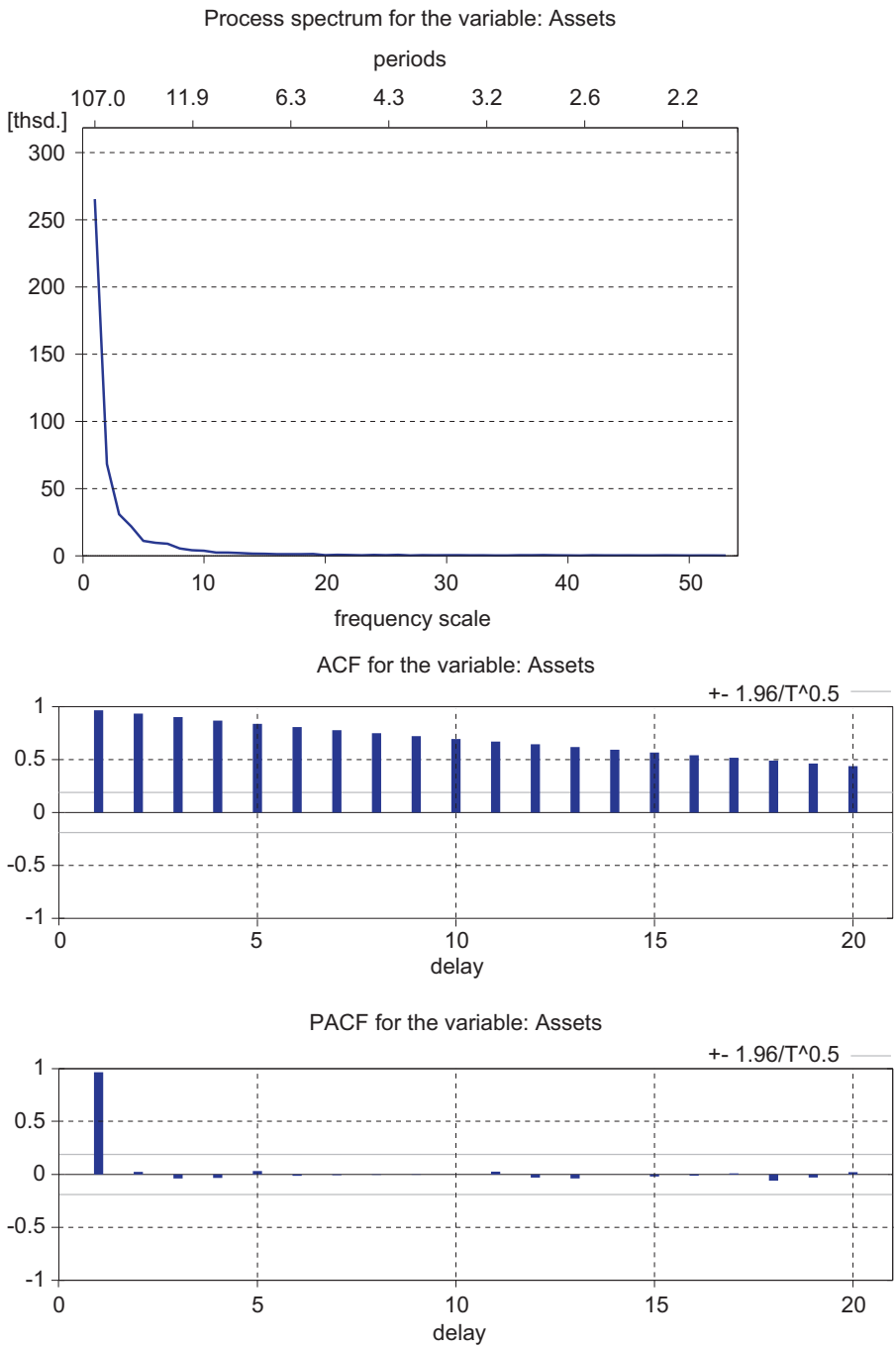


**Figure 3.** Periodogram and correlogram of the assets process in a period of calm (before the COVID-19 pandemic)

Source: own study.

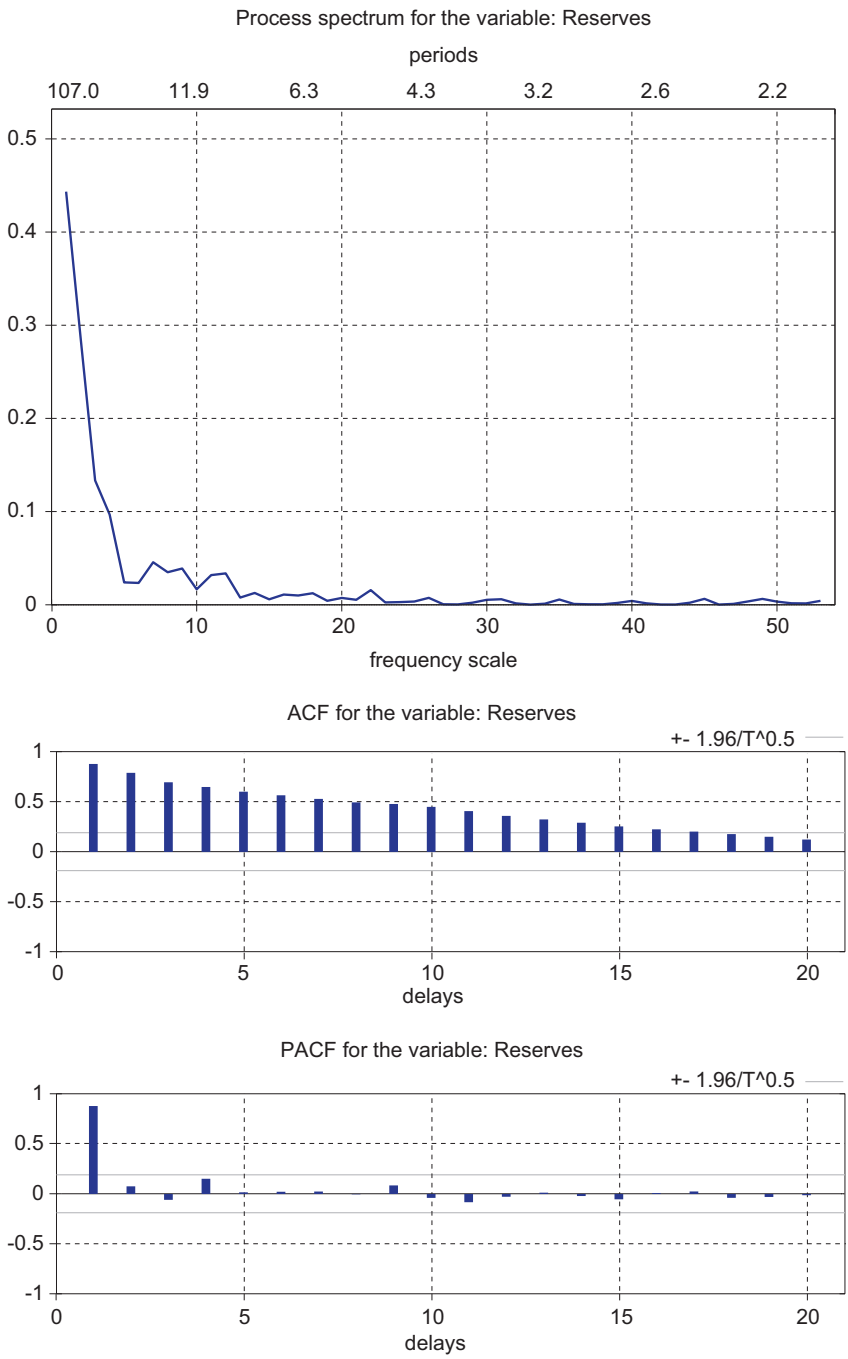


**Figure 4.** Periodogram and correlogram of the reserves process during the period of calm (before the COVID-19 pandemic)

Source: own study.

The graphs above indicate that both processes in the period of calm (before the pandemic) are characterised by a long-term development trend without random fluctuations and a delay in the reactions of processes of row 1 and 4, respectively. This suggests a short memory of the asset process and a long memory of the reserve process. In addition, in the case of reserves, fluctuations are also observed, which may be of a different nature than harmonics. In order to confirm these conclusions, in both cases ADL(1, 0) and ADL(4, 0) models were proposed as the correct model classes. The results of estimating model parameters are presented below.

Model 1. Least squares method (LSM) estimation, observations used February 2011 – November 2019 (N = 106)

Dependent variable (Y): assets

| | Factor | Standard error | t-Student test | p-Value |
|---|---|---|---|---|
| Assets_1 | 1.00502 | 0.000859404 | 1169 | < 0.0001 |

| | | | |
|---|---|---|---|
| Arithmetic mean of the dependent variable | 1580.893000 | Standard deviation of the dependent variable | 230.898700 |
| Uncentred R-square | 0.999923 | Centred R-square | 0.996290 |
| Logarithm of the likelihood function | -430.127300 | Akaike information criterion | 862.254700 |
| Autocorr.rest — rho1 | -0.318576 | Durbin h statistics | -3.280074 |

Model 2. LSM estimation, observations used March 2011 – November 2019 (N = 105)

Dependent variable (Y): reserves

| | Factor | Standard error | t-Student test | p-Value |
|---|---|---|---|---|
| Reserves_1 | 0.776431 | 0.0961723 | 8.073 | < 0.0001 |
| Reserves_2 | 0.231330 | 0.0967643 | 2.391 | 0.0186 |

| | | | |
|---|---|---|---|
| Arithmetic mean of the dependent variable | 3.108649 | Standard deviation of the dependent variable | 0.405372 |
| Uncentred R-square | 0.998466 | Centred R-square | 0.907406 |
| Logarithm of the likelihood function | 71.248670 | Akaike information criterion | -138.497300 |
| Autocorr.rest — rho1 | -0.007789 | Durbin h statistics | -0.469963 |

Finally, eliminating the irrelevance of the parameters, the ADL(1, 0) and ADL(2, 0) models were obtained as the correct asset model. In both cases, the used autoregressive model reflects the variability of the analysed processes in 99%, which means a very good match. In order to confirm the correctness of the models, a verification of the properties of the model residues — i.e. the assumptions of the least squares method (LSM) — was carried out. The results of the verification are presented in Table 2.

**Table 2.** Verification of the assumptions of the LSM for autoregressive models (p-value)

| Assumption | Test | Assets Model 1 — ADL(1, 0) | Reserves Model 2 — ADL(2, 0) |
|---|---|---|---|
| $\rho(\varepsilon, X) = 0$ | correlation significance t-test | 0.401000 | 0.2405 and 0.2116 |
| $E(\varepsilon) = 0$ | t-test for dependent tests | 0.902200 | 0.8861000000 |
| $\rho(\varepsilon_t, \varepsilon_{t-1}) = 0$ | Durbin-h test | 0.361619 | 0.9399260000 |
| $\sigma^2 = \text{const}$ | White test | 0.593315 | 0.2974070000 |
| $\varepsilon \sim N(0, \sigma^2)$ | Shapiro-Wolf test | 0.457537 | 3.83573e-007 |

Source: own study.

On the basis of the obtained p-values, it can be concluded that in the case of the asset model, the assumptions of the LSM were met, therefore the ADL(1, 0) model is correct and can be the basis for macroeconomic forecasts. However, in the case of reserves, the assumption of the normality of the distribution was not met, which means that the model requires modification and checking whether other important components of the process apart from the deterministic trend should be distinguished. For this purpose, an augmented Dick–Fuller unit root test (ADF) was performed for the reserve process, and the results are shown below:

Test without constant term (const): asymptotic p-value = 0.9888.
Test with constant term (const): asymptotic p-value = 1.
Test with constant term and linear trend: asymptotic p-value = 0.996.

In all variants of the ADF test, the value of $p > 0.05$ indicates no grounds for rejecting the null hypothesis, which means that the reserve process is non-stationary — this can result from not only the deterministic trend, but also the stochastic one. This means that the successive values of the variable are sums of the disturbances realized up to the moment marked as t, so that each disturbance is permanently present in the value of the variable.

In this case, the ARIMA class model should be used as an autoregressive model, and the maximum likelihood estimation method (MLE) — to estimate its parameters. Therefore, in order to verify the validity of this approach for the reserve process, an estimation of the ARIMA(p, d, q) model was carried out, setting its initial parameters as: $p = q = 2$ once $d = 1$, because the reserve process is integrated in level 1. In the end, the model with the relevant parameters and the lowest Akaike criterion was chosen as the best — the ARIMA(1, 1, 0) model taking the form:

Finally, the ADL(1, 0) and ARIMA(1, 1, 0) respectively were obtained as correct models of the processes of assets and reserves in the pre-pandemic period, describing the mechanism shaping these processes in the period of calm, as illustrated by the charts in Figure 5.

Model 3. ARIMA estimation, observations used February 2011 – November 2019 (N = 106)
Estimation using method AS 197 (proper ML)

Dependent variable (Y): (1-L) reserves

| | Factor | Standard error | Z | p-Value |
|---|---|---|---|---|
| const | 0.017539 | 0.009793 | 1.791 | 0.0733 |
| phi_1 | -0.220357 | 0.095022 | -2.319 | 0.0204 |

| | | | |
|---|---|---|---|
| Arithmetic mean of the dependent variable | 0.017621 | Standard deviation of the dependent variable | 0.12654 |
| Arithmetic random disorders | -0.000168 | Standard deviation of the random disorders | 0.12284 |
| Determination coefficient R-square | 0.909223 | Corrected R-square | 0.90922 |
| Logarithm of the likelihood function | 71.838280 | Akaike information criterion | -137.67660 |
| Schwarz's Bayesian criterion | -129.686300 | Hannan-Quinn criterion | -134.43800 |

## Results of modelling and forecasting of the analysed processes during the pandemic

As was shown, the period of the COVID-19 pandemic has caused a change in the characteristics of the processes in the banking sector. It is therefore necessary to learn about their specificity in new conditions, the most important characteristic of which is uncertainty. In this context, correct modelling and forecasting is particularly important during unstable situations, which is why an attempt was made to investigate the impact of the COVID-19 pandemic on the correct way of modelling these processes. So, the hypothesis was verified — models which correctly imitate the mechanism of formation of assets and reserves in a period of stable economy retain their prognostic properties during the pandemic. Hence, autoregressive models considered to be correct during the calm period were evaluated. Again, a periodogram and a correlogram were used to recognize the frequency and intensity of fluctuations and delays (Figures 6 and 7).

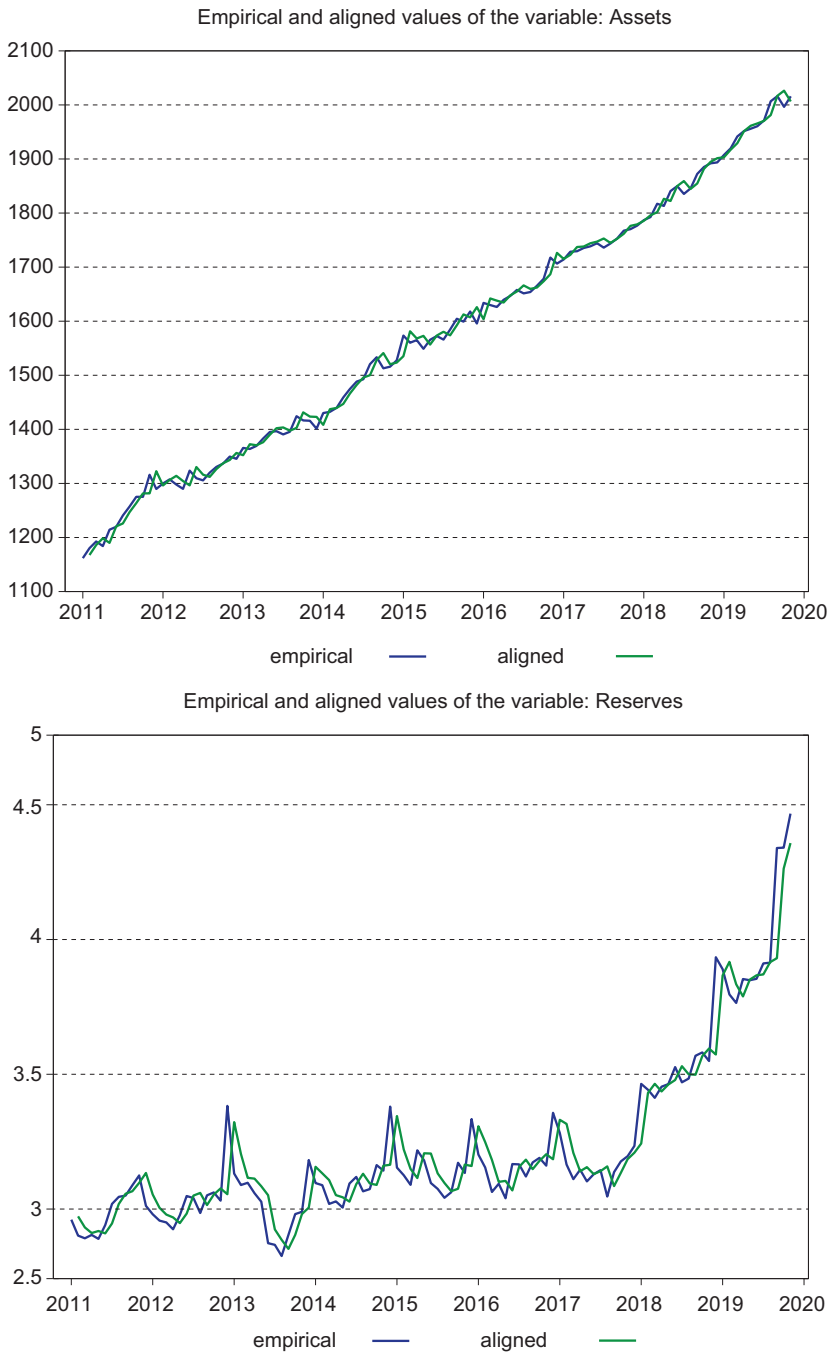


**Figure 5.** Correct recognition of the pattern of analysed processes and implementation resulting from their models (2011–2020)

Source: own study.

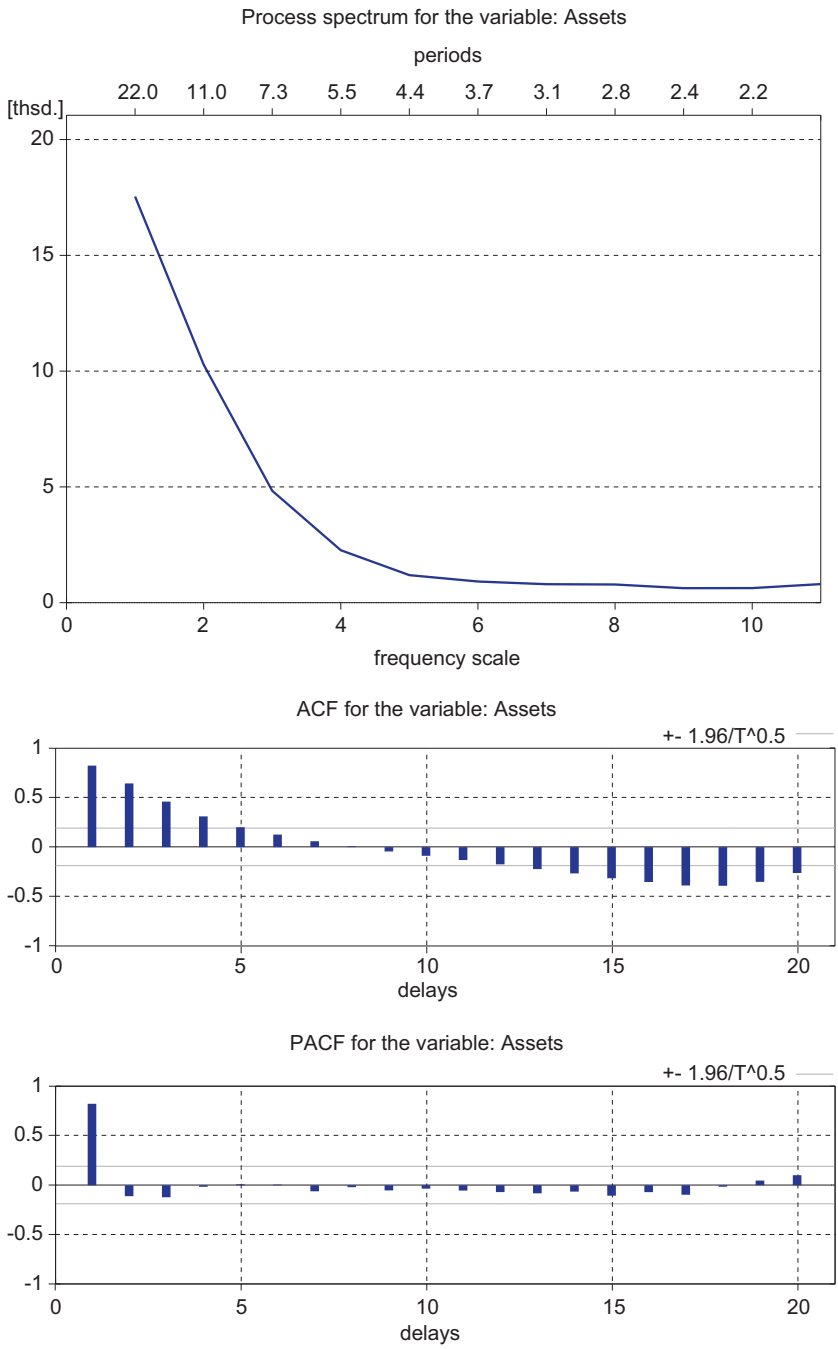


**Figure 6.** Periodogram and correlogram of the asset process during the COVID-19 pandemic (monthly data)

Source: own study.

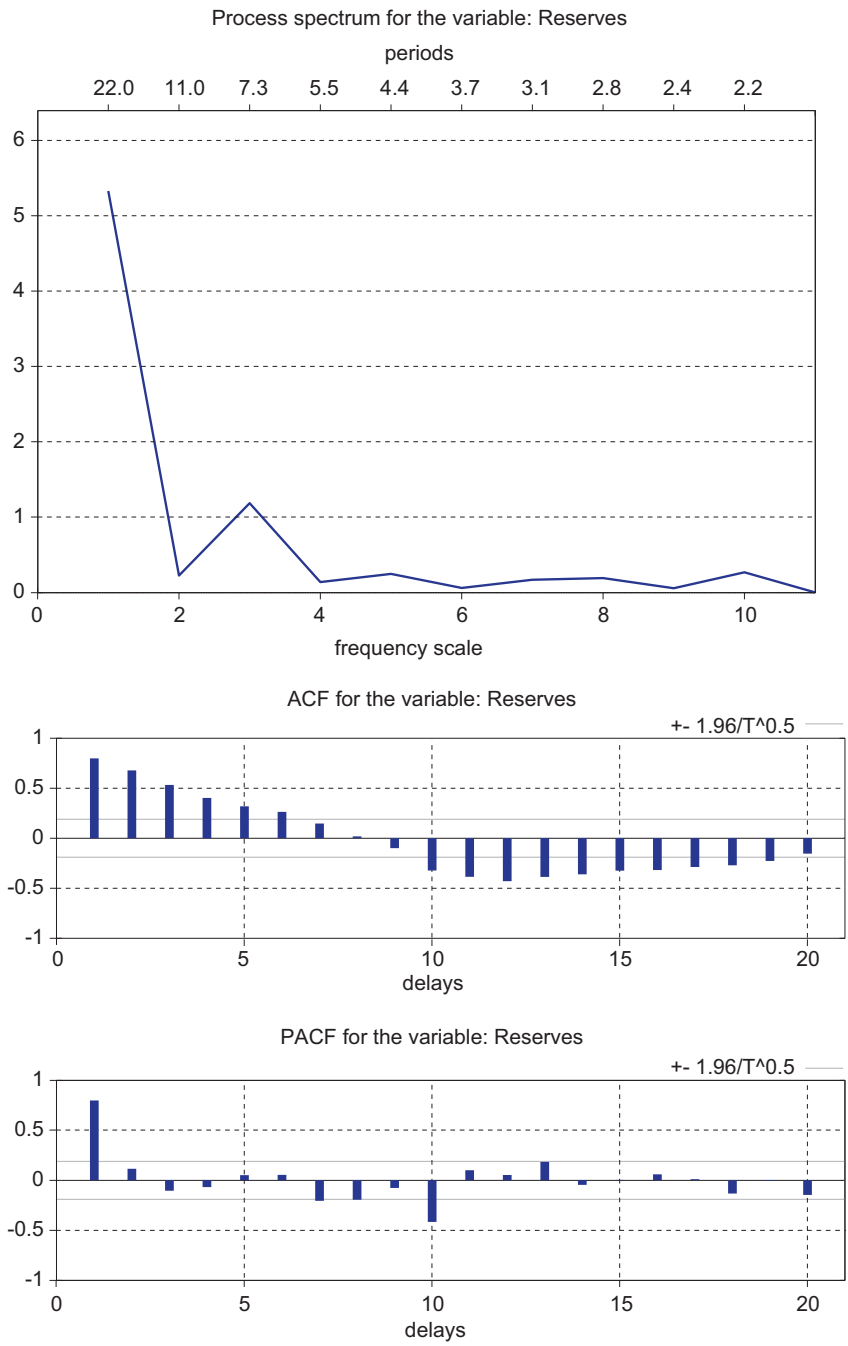


**Figure 7.** Periodogram and correlogram of the reserve process during the COVID-19 pandemic (monthly data)

Source: own study.

Based on the graphs above, it can be seen that the pattern of development of both processes is changing, as there are significant fluctuations of a short and medium-term nature, which were not observed during the calm period. In addition, in the case of the reserve process, a significant delay of 10 is observed, which may indicate the impact of the pandemic on the "memory" of the process. Therefore, variability and the "long memory" resulting from the uncertainty emerging in the banking sector is becoming an important component of processes during the pandemic. In order to confirm the hypothesis, the correctness of the following model classes was verified:

— for assets: the ADL(1, 0) model;

— for reserves: the ARIMA model, but with a higher latency reflecting the observed effect of long memory.

The results of estimating the parameters of the ADL(1, 0) model are presented below.

Model 1A. KMNK estimation, observations used December 2019 – September 2021 (N = 22)

Dependent variable (Y): assets

| | Factor | Standard error | t-Student test | p-Value |
|---|---|---|---|---|
| Assets_1 | 1.01046 | 0.00197 | 512 | < 0.0001 |

| | | | |
|---|---|---|---|
| Arithmetic mean of the dependent variable | 2316.525000 | Standard deviation of the dependent variable | 155.217500 |
| Sum of squares rests | 9495.705000 | Standard error of rests | 21.264440 |
| Uncentred R-square | 0.999920 | Centred R-square | 0.981232 |
| Logarithm of the likelihood function | -97.959720 | Akaike information criterion | 197.919400 |
| Autocorr.rest — rho1 | 0.560772 | Durbin-h statistics | 2.630364 |

In order to confirm the correctness of the above models, the assumptions of the LSM were verified, the verification results of which are presented in Table 3.

**Table 3.** Verification of the assumptions of the LSM for autoregressive models (p-value)

| Assumption | Test | Assets<br>Model 1 — ADL(1, 0) |
|---|---|---|
| $\rho(\varepsilon, X) = 0$ | correlation significance t-test | 0.92820000 |
| $E(\varepsilon) = 0$ | t-test for dependent tests | 0.18350000 |
| $\rho(\varepsilon_t, \varepsilon_{t-1}) = 0$ | Durbin-h test | 0.00852935 |
| $\sigma^2 = \text{const}$ | White test | 0.04513100 |
| $\varepsilon \sim N(0, \sigma^2)$ | Shapiro-Wolf test | 0.05904540 |

Source: own study.

In the case of the asset model, we can see that the ADL(1, 0) model, which correctly described the mechanism shaping the analysed phenomenon — bank assets during a period of calm — is unfortunately not a correct model during a pandemic. This is due to the fact that the LSM assumptions were violated in terms of non-autocorrelation and homoscedasticity, and because of it the model was verified negatively.

In the case of the reserves process, the ARIMA model was assessed, and the results of the LSM estimation of its parameters in the pandemic period are presented below.

Model 2A. ARIMA estimation, observations used December 2019–September 2021 (N = 22)
Estimation using method AS 197 (proper ML)

Dependent variable (Y): (1-L) reserves
Standard errors based on Hessian

| | Factor | Standard error | Z | p-Value |
|---|---|---|---|---|
| const | 0.317492 | 0.145621 | 2.180 | 0.0292 |
| phi_1 | -0.386918 | 0.200333 | -1.931 | 0.0534 |

| | | | |
|---|---|---|---|
| Arithmetic mean of the dependent variable | 0.341201 | Standard deviation of the dependent variable | 1.03552 |
| Arithmetic random disorders | 0.019086 | Standard deviation of the random disorders | 0.93339 |
| Determination coefficient R-square | 0.812446 | Corrected R-square | 0.81245 |
| Logarithm of the likelihood function | -29.781100 | Akaike information criterion | 65.56220 |
| Schwarz's Bayesian criterion | 68.835320 | Hannan-Quinn criterion | 66.33330 |

Model 2B: ARIMA estimation, observations used December 2019–September 2021 (N = 22)
Estimation using method AS 197 (proper ML)

Dependent variable (Y): (1-L) reserves
Standard errors based on Hessian

| | Factor | Standard error | Z | p-Value |
|---|---|---|---|---|
| const | 0.312327 | 0.0261434 | 11.950 | 6.76e-033 |
| theta_1 | -1.000000 | 0.1603510 | -6.236 | 4.48e-010 |

| | | | |
|---|---|---|---|
| Arithmetic mean of the dependent variable | 0.341201 | Standard deviation of the dependent variable | 1.03552 |
| Arithmetic random disorders | -0.032822 | Standard deviation of the random disorders | 0.83167 |
| Determination coefficient R-square | 0.847716 | Corrected R-square | 0.84772 |
| Logarithm of the likelihood function | -28.729440 | Akaike information criterion | 63.45890 |
| Schwarz's Bayesian criterion | 66.732010 | Hannan-Quinn criterion | 64.22990 |

Based on the above results, it should be concluded that the ARIMA(1, 1, 0) model, which was the correct model of reserves during the calm period, is not the appropriate model during the pandemic. Since uncertainty has proven to be an important component, the ARIMA(0, 1, 1) model is a better one, which confirms that during the pandemic, disturbances over time affect the value of the dependent variable more and more significantly. Therefore, the hypothesis has been verified negatively, which means that models which correctly imitate the mechanism of shaping assets and reserves in the period of a stable economy do *not* retain their forecasting properties during the pandemic.

## Conclusions

Analysing the results, it can be seen that the mechanisms which shape the processes of the banking sector in Poland have lost their relevance and differ significantly depending on the situation in the economy. During the development of the corona crisis, there were mainly changes in long-term trends, increased dynamics of processes, and their variability. Predictions and actions made in the initial phase of the COVID-19 pandemic have changed. New solutions are currently being introduced to contain the negative impact of the crisis on the banking sector. The analysis conducted in the article and the inability to confirm the hypothesis indicate the instability of prognostic properties depending on the period. The time of the pandemic is characterised primarily by uncertainty and risk, and because of it the banking sector has undergone considerable changes in the characteristics of processes.

At the end of 2021, we were on the threshold of another wave of coronavirus. We still do not know what exact effects the pandemic has brought and what awaits us in the near future. The long-term development of the pandemic and the emergence of new coronavirus variants bring a lot of uncertainty. A great unknown is also the current situation on the financial markets, above all in the banking sector and in the economy, where an increase in inflation is still noticeable. What is certain at present is that we still know too little about these processes.

The article analysed the situation of the banking sector during the corona crisis on the basis of two main processes: assets and reserves, which form the basis of macroeconomic forecasts. In the first part, a review of the most up-to-date literature presented the influence of the pandemic on the banking sector and proposed solutions to reduce the negative effects. The author also described the visible symptoms of the crisis in Poland as well as the ways in which the banking sector coped in times of unstable economic situation. Finally, a preliminary analysis was launched using the two processes demonstrating the health of the banking sector. The detailed study covered a stable period and the times of COVID-19, respectively. The hypothesis presented earlier has been verified negatively — while the autoregressive model of the ADL class correctly describes the mechanism shaping bank assets in the period of calm, unfortunately it is not a correct model in the

pandemic period and thus loses its prognostic properties. However, in the case of reserves, the correct prognostic model in the period of calm is the autoregressive model of the ARIMA class, which, in order to maintain its prognostic properties during a pandemic, required modification consisting in taking into account a higher delay reflecting the observed effect of long memory. This is undoubtedly confirmed by the fact that in times of instability, such as the COVID-19 pandemic, disruptions over time increasingly affect the values of the analysed processes and thus the entire banking sector. The results of the conducted analysis confirmed the usefulness of ADL and ARIMA autoregressive models in analyses and forecasts in periods of calm. At the same time, ADL models lose their prognostic properties in periods of unstable economy, while ARIMA models taking into account the long memory effect retain their properties and can be used.

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