THE APPLIED HIGH-ORDER SPATIAL WEIGHT MATRIX GSTARIMAX WITH PRINCIPAL COMPONENT ANALYSIS FOR GOOGLE TRENDS DATA ON GOLD PRICE

Dissertation

Fadhlul MUBARAK

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Dissertation

Department of Statistics

Programme in Applied Statistics

Supervisor: Assoc. Prof. Dr. Şükrü ACITAŞ

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Eskişehir Technical University

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FINAL APPROVAL FOR THESIS

This thesis titled THE APPLIED HIGH-ORDER SPATIAL WEIGHT MATRIX GSTARIMAX WITH PRINCIPAL COMPONENT ANALYSIS FOR GOOGLE FOR GOOGLE TRENDS DATA ON GOLD PRICE has been prepared and submitted by Fadhlul MUBARAK in partial fulfillment of the requirements in “Eskişehir Technical University Directive on Graduate Education and Examination” for the Degree of PhD in Statistics Department has been examined and approved on 03/07/2023.

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ABSTRACT

THE APPLIED HIGH-ORDER SPATIAL WEIGHT MATRIX GSTARIMAX WITH PRINCIPAL COMPONENT ANALYSIS FOR GOOGLE FOR GOOGLE TRENDS DATA ON GOLD PRICE

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This study aims to forecast gold prices with missing values in several G20 countries based on the best GSTARIMA model. Missing values have been handled by imputing last observation carried forward (LOCF) and moving average smoothing (MA). The results of the imputation then combined with the GSTARIMA model, principal component analysis (PCA), and dummy variables derived from Google Trends data to model and forecast gold prices in each country so 16 different models are considered in thesis study. In addition, Google Trends data also has been used to build a high-order spatial weight matrix on the GSTARIMA model. The eighth order is the highest order which is formed from the distance between countries. Based on the smallest MAPE value, the GSTARIMA model (1,0,0) with PCA and LOCF imputation is recommended for forecasting the next 1 month, the GSTARIMA model (1,0,0) with MA imputation for forecasting the next 1 year, and the GSTARIMA model (1,0,0) with PCA and MA imputation to forecast the next 2 years. The three best models explain that the gold prices in the future is relatively increasing.

Keywords: Forecasting, Google Trends Data, MAPE, Missing Value.

ÖZET

ALTIN FİYATI ÜZERİNE GOOGLE TRENDS VERİLERİ İÇİN TEMEL BİLEŞEN ANALİZ İLE UYGULANAN YÜKSEK DERECELİ MEKANSAL AĞIRLIK MATRİSİ GSTARIMAX

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İstatistik Anabilim Dalı

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Bu çalışma, en iyi GSTARIMA modeline dayanarak çeşitli G20 ülkelerinde kayıp gözlemlerle altın fiyatları için öngörü yapmayı amaçlamaktadır. Kayıp gözlemler, son gözlemin ileriye taşınması (LOCF) ve hareketli ortalama düzeltme (MA) imputasyonu ile ele alınmıştır. İmputasyonlu sonuçlar daha sonra GSTARIMA modeli, temel bileşen analizi (PCA) ve Google Trend verilerinden türetilen kukla değişkenlerle birleştirilerek her bir ülkedeki altın fiyatlarını modellemek ve öngörmek için kullanılmıştır; böylece, tez çalışmasında 16 farklı model ele alınmıştır. Buna ek olarak, Google Trendleri verileri de GSTARIMA modelinde yüksek dereceli bir mekansal ağırlık matrisi oluşturmak için kullanılmıştır. Sekizinci mertebe, ülkeler arasındaki mesafeden oluşturulan en yüksek mertebedir. En küçük MAPE değerine dayanarak, gelecek 1 ayı öngörmek için PCA ve LOCF imputasyonlu GSTARIMA(1,0,0) modeli, gelecek 1 yılı öngörmek için MA imputasyonlu GSTARIMA(1,0,0) modeli ve gelecek 2 yılı öngörmek için PCA ve MA imputasyonlu GSTARIMA(1,0,0) modeli önerilmektedir. En iyi üç model, altın fiyatlarının gelecekte nispeten arttığını açıklamaktadır.

Anahtar Sözcükler: Kestirme, Google Trend Verileri, MAPE, Eksik Değer.

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Fadhlul MUBARAK

03/07/2023

STATEMENT OF COMPLIANCE WITH ETHICAL PRINCIPLES AND RULES

I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific ethical principles and rules throughout the stages of preparation, data collection, analysis and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with “scientific plagiarism detection program” used by Eskişehir Technical University, and that “it does not have any plagiarism” whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

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GLOSSARY OF SYMBOLS AND ABBREVIATIONS

MAPE	:	Mean Absolute Persentege Error
LOCF	:	Last Observation Carried Forward
MA	:	Moving Average
PCA	:	Principal Component Analysis
GSTARIMA	:	Generalized Space Time Autoregressive Integrated Moving Average
G20	:	The Group of Twenty
Y_i	:	Dependent Variable
X_i	:	Dummy Variable
β_i	:	Parameter Estimator for Dummy Variable
ε_i	:	Error
p	:	Autoregressive Order
q	:	Moving Average Order
d	:	Differencing Order
λ_k	:	Spatial Order of the Autoregressive
m_k	:	Spatial Order of Moving Average
$\boldsymbol{\phi}_{kl}^{(i)}$	:	Parameter Estimator for Autoregressive Order
$\boldsymbol{W}^{(l)}$	:	Spatial Weighting Matrix
$\boldsymbol{\theta}_{kl}^{(i)}$	:	Parameter Estimator for Moving Average Order
$\mathbf{A}_{\mathrm{m}}^{(\mathrm{l})}$	:	Principal Component Coefficient

1. INTRODUCTION

In addition to forming statistical models that follow the assumptions of statistical theory, forecasting data is still very important in terms of marketing, business, and so on. One of the most frequently used forecasting methods is the ARIMA (autoregressive integrated moving average) model. Although the ARIMA model is one of the simplest forecasting models because it only uses univariate responses, it can still provide good forecasting values for some cases. The ARIMA model has been applied to various studies including well production forecasting (Fan, et al., 2021), visibility forecasting (Salman & Kanigoro, 2021), industrial fault detection scenarios (Glock, 2021), COVID-19 prevalence forecasting (Toğa, Atalay, & Toksari, 2021), and wind speed prediction (Liu, Ding, & Bai, 2021).

The ARIMA model is developed using an exogenous variable (X) known as ARIMAX. One of the goals of this development is to get better forecasting results. This model has also been widely used for research in various countries including Afghanistan, Bangladesh, India, Pakistan, and Sri Lanka, Indonesia, Thailand, Türkiye, Taiwan, etc (Anggraeni et al., 2017, 2019; Chiu et al., 2019; Hossain et al., 2021; Pektaş & Kerem Cigizoglu, 2013; Wongsathan & Chankham, 2016).

Furthermore, the GSTARIMA model (generalized space time autoregressive integrated moving average) is also a development of the ARIMA model that uses the influence of location in data modeling. Akbar et al. in 2020 has conducted research on pollutant water in Surabaya. Based on this research, it has been explained that the GSTARIMA model without ddifferencing (GSTARMA) can correct the prediction error of the GSTAR model on CO data. The GSTARIMA model using seemingly unrelated regression to estimate the parameters has also been applied to rainfall data by Nisak in 2016. Research comparing the GSTARIMA model and the VARIMA (vector autoregressive integrated moving average) model for forecasting has also been carried out by Setiawan et al. in 2015. In this study, it can be seen that the GSTARIMA model is better than VARIMA.

This study used an exogenous variable that will be applied to the GSTARIMA model, called GSTARIMAX. The theory related to the GSTARIMAX model with generalized least square parameter estimation has been discussed by Aulia and Saputro in 2021. The GSTARIMAX model has also been used in various fields including the impact of Covid-19 on the tourism (Prastuti et al., 2021), rice production (Choiriyah et al., 2020), etc. A comparison of the GSTARIMA and GSTARIMAX models been carried out for rice price data (Andayani et al., 2018).

The issue of the GSTARIMA model closely related to the spatial weight matrix. There are many forms of spatial weight matrix, both based on distance and boundaries. Research related to the spatial weight matrix has been carried out in several fields such as spatial autoregressive models (Qu & Lee, 2015), spatial hedonic (Seya et al., 2013), spatial lag models (Lam & Souza, 2020), block structure (Lam & Souza, 2016), etc. The application of high-order spatial weights to GSTARIMA was carried out by Mubarak et al. in 2017.

Also this study used many independent variables so that it violates the assumption of multicollinearity. One treatment that can be used for this assumption is principal component analysis (PCA). PCA has been widely used in several studies including cycles of COVID-19 incidence (Duarte & Riveros-Perez, 2021), genome materials (Boubchir & Aourag, 2020), spread rates of COVID-19 (Mahmoudi et al., 2021), flow fluctuation (Meng et al., 2021), routine blood test results with Parkinson's disease (Wang et al., 2021), etc. The use of this technique will indeed produce a biased but good enough accuracy model. This study will also reduce many variables into new variables used in the GSTARIMAX model.

Google Trend data has also been used in this study as an exogenous variable apart from the neighbor effect. This is one form of using big data, especially one that can be accessed by anyone for free. Google Trends data has been used for various types of fields such as seasonality of gout (Hwang & Hwang, 2021), Google Trends extraction tool (Raubenheimer, 2021), declining interest in clinical imaging (Adelhoefer et al., 2021), number of inbound tourists (Feng et al., 2019), tool for digital epidemiology (Cervellin et al., 2017), allergies and the grass pollen season (Kaidashev et al., 2020), etc. The keyword used in Google Trend data is the gold price. This study has predicted gold prices for some of the countries with the highest consumption levels. Research related to gold prices has been carried out in several countries including Türkiye, Mexico, Korea, Russia, India, Brazil, China, Indonesia, Saudi Arabia, South Africa, Argentina, Colombia, Venezuela, Thailand, Ukraine, Israel, Malaysia, Philippines, Peru, United States, Canada, Kuwait, United Arab Emirates, United Kingdom, France, Germany, Italy, Japan, etc (Bhalotra et al., 2020; Bildirici & Sonustun, 2018; Giannellis & Koukouritakis, 2019; Li et al., 2021; Morema & Bonga-Bonga, 2020; Raza et al., 2018; Tursoy & Faisal, 2018).

The evaluation model that has been used in this study is the mean absolute percentage error (MAPE). MAPE was chosen for this study because it is expressed as a percentage so it is easy to explain, does not depend on the scale and can be used to compare forecasts at different scales.

Based on the explanation that has been written, in this study several forms of analysis have been carried out which have the following objectives:

1. Performing imputation techniques on missing value data.
2. Applying the GSTARIMA model to the existing data.
3. Performing differencing techniques on the data and apply the GSTARIMA model to the data.
4. Entering Google Trends data as an exogenous variable and applying the GSTARIMA model to the data (GSTARIMAX).
5. Using the data that has been obtained with differencing techniques and applying the GSTARIMAX model to the data.
6. Performing PCA and apply the GSTARIMA model to the data.
7. Using data that has been obtained with differencing techniques and principal component. Then apply the GSTARIMA model to the data.
8. Using data that has been obtained with differencing techniques and principal component. Then apply the GSTARIMAX model to the data.
9. Evaluating the best model for all models that have been applied based on the smallest MAPE.
10. Forecasting the gold price based on the best model for January 2022 to December 2023.

In the second part, it introduced Google Trends and gold with relevant research. In addition, there are basic theories from PCA, ARIMAX, spatial weight matrix based on distance, and GSTARIMA. In the distance-based spatial weight matrix, there are illustrations of radius and spatial order which are one of the newest contributions to the field of spatial statistics.

In the third chapter, it explained data of this research, especially the reasons these data were used in this study. The data comes from 2 main sources, namely the World Gold Council and Google Trends data. Furthermore, there are procedures ranging from data splitting to the results of gold price forecasting in each country based on the best model. Also in this section, there is a table that displays the country, official language, keywords, and currency.

In the fourth chapter, a graph of gold prices in one country has been shown. Furthermore, based on the graph there is a dash dot line indicating that the data has a problem with missing values. So that the LOCF imputation technique and MA smoothing have been carried out to solve this problem. After that, parameter estimation of 16 models based on the imputation results has been described in this section.

In the fifth chapter, in general, if aggregation is carried out, the results of the best models for forecasting 1 month, 1 year, and 2 years have been shown. As an alternative, the best model for gold price forecasting in each country is available. Furthermore, based on the best model, the results of gold price forecasting in each country have been shown. These results have been displayed in graphs and tables.

In the conclusions and recommendations chapter, there are evaluations, findings and recommendations for future research. Specifically, evaluations and findings have been described regarding missing values and their solutions, the application of Google Trends, all models used, the best models, and forecasting results from the best models. Furthermore, it has been recommended the development of a more complex GSTARIMA model, the use of other keywords in Google Trend data, and the development of a spatial weighting matrix, and others.

2. LITERATURE REVIEW

This section discusses the introduction of the data that has been used and the literature on statistical theories as well as those that have been used in this study.

2.1. Google Trends

Google is one of the most popular search engines and has many benefits for many people. Google Trend data is a service from Google that provides data openly and can be freely utilized. Google Trends analyzes the popularity of the top search terms on Google Search and provides the relative search volume for the selected terms over a given time range and geographic area (Hwang & Hwang, 2021; Kamiński et al., 2020; Pullan & Dey, 2021). Additionally, research using Google Trends has increased dramatically in the last decade (Jun et al., 2018).

Google Trends data can be used from 2004 to now. Even Google Trends provides data from the last few hours. The data selected on Google Trend is a sample that has represented the search population. The data contained in Google Trends is a number representing search interest based on the highest points on the chart for a certain region and time. The numbers listed on Google Trends are between 0-100. A value of 0 indicates that there is not enough data available for that keyword. While the value of 100 indicates the keyword is at the peak of popularity. On Google Trends there are also many categories including shopping, business, books, literature, etc.

2.2. Gold

Gold is a “safe haven” in a risky market environment (Beckmann et al., 2015; Hood & Malik, 2013; Nguyen et al., 2016). When external shocks result in economic volatility, the associated uncertainty or risk will increase, and asset prices will be affected. Unlike ordinary assets, gold plays a role in maintaining value, so investors prefer gold assets when the risk is greater (Li et al., 2021). For a long time, gold has been the basis of the monetary system and the monetary authorities have sufficient gold reserves to convert all money into any amount of gold on demand (Akbar et al., 2019).

In 2021, Sui et al. explained the advantages of investing in gold include investing in gold which provides flexibility for the holder of this investment to be able to cash it into cash in a relatively easy way and in a relatively short time and is more flexible compared to other types of investment.. With the tendency of its value to increase relatively for a certain period of time, then gold is very suitable if called the investment that is most able to protect the value of one's wealth. So that when resold, gold investment holders tend to get higher returns. Another advantage of investing in gold is that you don't have to do it in large amounts.

2.3. Principal Component Regression Analysis

In forming the regression model there is a possibility of a relationship between one variable with another variables. Multiple regression in matrix notation:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p + \varepsilon_i \tag{2.1}$$

where Y_i is a dependent variable, $X_1, X_2, \ldots, X_p$ are independent variable, $\beta_1, \beta_2, \ldots, \beta_p$ are parameter estimator, and ε_i is the error term. In this model, the assumption that there is no relationship between variables X must be fulfilled $\left(E\left(X_i, X_j\right) = 0,\ \text{for all } i \neq j\right)$. The existence of relationships between independent variables in one regression is called multicollinearity. Multicollinearity causes the estimator to have a large variance as a result the estimation interval tends to be greater so as to make the independent variable statistically insignificant even though the coefficient of determination (R^2) is high so it is difficult to get an accurate estimate. Principal component regression is a method that combines linear regression with principal component analysis. The principal component regression forms the relationship between the dependent variable and the principal component selected from the independent variable (Tazliqoh et al., 2015).

In some sources it can be summarized that the stages carried out in the principal component regression analysis are:

1. Doing the independent variable X to Z score.
2. Find the eigen values and vectors from the matrix Z.
3. Determine the equation of the principal component of the eigen vectors, W.
4. Make a regression model between dependent variables and W.
5. Reverse transformation (Tazliqoh et al., 2015).

2.4. ARIMAX

The classical ARIMA approach becomes prohibitive, and in many cases, it is impossible to determine a model, when seasonal adjustment order is high or its diagnostics fail to indicate that time series is stationary after seasonal adjustment. In such cases, the static parameters of the classical ARIMA model are considered the principal constraint to forecasting high variable seasonal demand. ARIMA approach is a renowned and widely used linear method. It carries more flexibility by representing various components of time series including autoregressive (AR), moving average (MA), and combined AR and MA (Zhao et al., 2019).

In some sources, the general ARIMA (p, d, q) model based on backshift-operator is expressed concisely as:

$$\emptyset_p(B)(1-B)^d Y_t = \theta_q(B)e_t$$

$$\left(1-\emptyset_1 B-\emptyset_2 B^2-\cdots-\emptyset_p B^p\right)(1-B)^d Y_t = \left(1-\theta_1 B-\theta_2 B^2-\cdots-\theta_q B^q\right)e_t \quad (2.2)$$

where $\emptyset_p$is a autoregressive parameter with p-order,B is a backshift-operator,d is a difference order, Y_t is a dependent variable, θ_q is moving average parameter with q-order, and e_t is the error term.

Based on the ARIMA model, ARIMAX model can take the impact of covariates into account by adding the covariate to the right hand of the ARIMA model equation or ARIMAX extends ARIMA models by including exogenous variables X to transform ARIMA into a multiple regression model. The ARIMAX model has not been widely used in terms of forecasting in the economic field, even though forecasting results using several variables have proven to be better (Anggraeni et al., 2017). The results show that compared with a single series ARIMA model, the ARIMAX model has a higher prediction accuracy. The equation of ARIMAX model is presented as follows:

$$\emptyset_p(B)(1-B)^d Y_t = \beta_1 X_1+\beta_2 X_2+\cdots+\beta_p X_p+\theta_q(B)e_t \quad (2.3)$$

2.5. Distance-Based Spatial Weight Matrix

Spatial weight matrix is a matrix (W) that exists in spatial analysis that has applied neighboring structures to each location or provides weights that measure the intensity of relationships between pairs of spatial units. If based on distance then the weight may be also defined as a function of the distance between region i and j, d_{ij} where is usually computed as the distance between their centroids (or other important units). Let u_i and u_j be the longitude and v_i and v_j the latitude coordinates for region i and j, respectively: Let two point i and j, with respective coordinates (u_i, v_i) and $\left(u_j, v_j\right)$.

1. Minkowski metric.

$$d_{ij}^P = \left(\left|u_i-u_j\right|^p+\left|v_i-v_j\right|^p\right)^{1/p} \quad (2.4)$$

2. Euclidean metric.

Consider Minkowski metric and set $p=2$, then

$$d_{ij}^E = \sqrt{\left(u_i-u_j\right)^2+\left(v_i-v_j\right)^2} \quad (2.5)$$

3. Manhattan metric.

Consider Minkowski metric and set $p = 1$, then

$$d_{ij}^{M} = |u_i - u_j| + |v_i - v_j| \tag{2.6}$$

Based on Euclidean metric, a circle is all points on a field within the same certain distance, called the radius, from a certain point, called the center. Circles can be illustrated based on Figure 2.1.

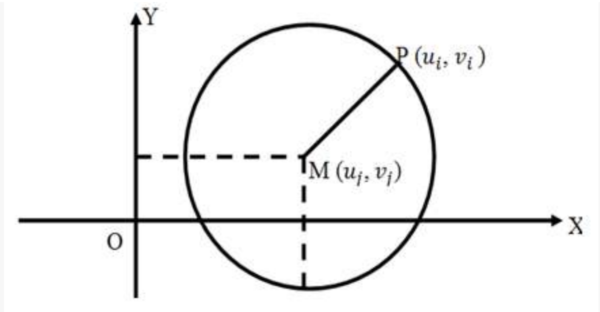

Figure 2.1. *Illustration of a radius*

where M-P is the radius of the circle (r). $M(u_j, v_j)$ point is the center of the circle which in the spatial concept is called the center of the area that is in focus and $P(u_j, v_j)$ is the center of another area. The concept of circles such as fingers can be an alternative in determining spatial order. For example, an area A has a distance with area B of 10 km and area C is 20 km. Area B to area C has a distance of 10 km. Set at a radius of 10 km from each region as spatial order-1 and at a radius of 20 km from each region as spatial order-2. Illustration of the case can be seen in Figure 2.2.

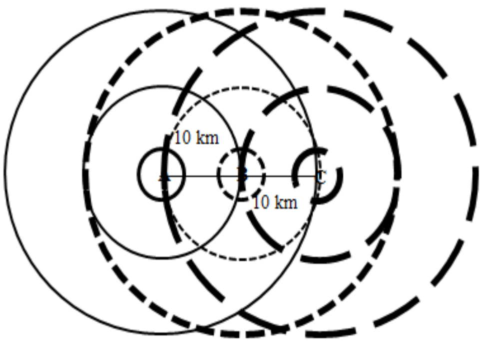

Figure 2.2. *Illustration of spatial order*

The proximity relationship between locations can be expressed in the form of a spatial weighting matrix. This aims to make statistical analysis easier. Spatial weighting inversion matrix is one of the weighting matrices of spatial data types (Bauman et al., 2018). Weighting by the inverse distance method is determined based on the actual distance between locations. The inverse distance weight gives a large weight value for closer distances and gives a small weight value for a longer distance (Mubarak et al., 2017). Calculation of distance between these locations can use latitude and longitude coordinates from the observed center point of location.

$$w_{ij} = \begin{cases} \dfrac{1}{d_{ij}} = \dfrac{1}{d_{ji}} \; (if\ include\ in\ radius) \\ 0 \quad (if\ not\ include\ in\ radius) \end{cases} \tag{2.7}$$

One development of the inverse distance matrix associated with the n-th spatial order that can be done is the rank of each distance inverse matrix element which is raised by its spatial order. Based on Figure 2.2, the first and second order spatial weighting matrices with their ideas raised can be:

$$w_{ij}^{1} = \begin{bmatrix} & A & B & C \\ A & 0 & \dfrac{1}{10^1} & 0 \\ B & \dfrac{1}{10^1} & 0 & \dfrac{1}{10^1} \\ C & 0 & \dfrac{1}{10^1} & 0 \end{bmatrix} \text{and} w_{ij}^{2} = \begin{bmatrix} & A & B & C \\ A & 0 & 0 & \dfrac{1}{20^2} \\ B & 0 & 0 & 0 \\ C & \dfrac{1}{20^2} & 0 & 0 \end{bmatrix}$$

2.6. GSTARIMA

The space time model is a model that combines time and location factors in multiple time series data variables. The GSTARIMA model is formulated as follows:

$$\nabla \boldsymbol{Y}_i(t) = \sum_{k=1}^{p} \sum_{l=0}^{\lambda_k} \boldsymbol{\phi}_{kl}^{(i)} \boldsymbol{W}^{(l)} \nabla \boldsymbol{Y}_i(t-k) + \boldsymbol{\varepsilon}_i(t) - \sum_{k=1}^{q} \sum_{l=0}^{m_k} \boldsymbol{\theta}_{kl}^{(i)} \boldsymbol{W}^{(l)} \boldsymbol{\varepsilon}_i(t-k) \tag{2.8}$$

where $\nabla \boldsymbol{Y}_i(t) = (1-B)^d Y_t$ is an N-dimensional vector, N is the number of locations, p is an autoregressive order, q is a moving average order, d is a differencing order, λ_k is the spatial order of the k-autoregressive condition, m_k is the spatial order of k-th moving average condition, $\boldsymbol{\phi}_{kl}^{(i)}$ is diagonal $\left(\emptyset_{kl}^{(1)}, \emptyset_{kl}^{(2)}, \ldots, \emptyset_{kl}^{(N)}\right) = \begin{bmatrix} \emptyset_{kl}^{(1)} & 0 & \cdots & 0 \\ 0 & \emptyset_{kl}^{(2)} & \cdots & 0 \\ \vdots & 0 & \ddots & \vdots \\ 0 & \cdots & 0 & \emptyset_{kl}^{(N)} \end{bmatrix}$, $\boldsymbol{W}^{(l)}$ is a spatial weighting matrix for the 1-st spatial order which is zero diagonal and the number for each row is equal to one, $\boldsymbol{W}^{(l)}$ is defined as the identity matrix $\boldsymbol{I}$, $\boldsymbol{\theta}_{kl}^{(i)}$ is diagonal$\left(\theta_{kl}^{(1)}, \theta_{kl}^{(2)}, \dots, \theta_{kl}^{(N)}\right) = \begin{bmatrix} \theta_{kl}^{(1)} & 0 & \cdots & 0 \\ 0 & \theta_{kl}^{(2)} & \cdots & 0 \\ \vdots & 0 & \ddots & \vdots \\ 0 & \cdots & 0 & \theta_{kl}^{(N)} \end{bmatrix}$ and $\boldsymbol{\varepsilon}_i(t)$ is the error term.

The GSTARIMA model in equation (2.8) can change to GSTAR if it has an autoregressive order but does not have a differentiation order and does not have a moving average order like equation (2.9).

$$\boldsymbol{Y}_i(t) = \sum_{k=1}^{p} \sum_{l=0}^{\lambda_k} \boldsymbol{\phi}_{kl}^{(i)} \boldsymbol{W}^{(l)} \boldsymbol{Y}_i(t-k) + \boldsymbol{\varepsilon}_i(t) \tag{2.9}$$

The GSTARIMA model in equation (2.8) can change to GSTARI if it has an autoregressive order and the differentiation order does not have a moving order averages such as equation (2.10).

$$\nabla \boldsymbol{Y}_i(t) = \sum_{k=1}^{p} \sum_{l=0}^{\lambda_k} \boldsymbol{\phi}_{kl}^{(i)} \boldsymbol{W}^{(l)} \nabla \boldsymbol{Y}_i(t-k) + \boldsymbol{\varepsilon}_i(t) \tag{2.10}$$

The GSTARIMA model in equation (2.8) can change to GSTMA if it has a moving averagen order but does not have an autoregressive order and does not have a differentiation order like equation (2.11).

$$\boldsymbol{Y}_i(t) = \boldsymbol{\varepsilon}_i(t) - \sum_{k=1}^{q} \sum_{l=0}^{m_k} \boldsymbol{\theta}_{kl}^{(i)} \boldsymbol{W}^{(l)} \boldsymbol{\varepsilon}_i(t-k) \tag{2.11}$$

The GSTARIMA model in equation (2.8) can change to GSTIMA if it has a moving average order and a differentiating order but does not have an autoregress order like equation (2.12).

$$\nabla \boldsymbol{Y}_i(t) = \boldsymbol{\varepsilon}_i(t) - \sum_{k=1}^{q} \sum_{l=0}^{m_k} \boldsymbol{\theta}_{kl}^{(i)} \boldsymbol{W}^{(l)} \boldsymbol{\varepsilon}_i(t-k) \tag{2.12}$$

The GSTARIMA model in equation (2.8) can change to GSTARMA if there is an autoregressive and order and the moving average order does not have a differentiation order like equation (2.13).

$$\boldsymbol{Y}_i(t) = \sum_{k=1}^{p} \sum_{l=0}^{\lambda_k} \boldsymbol{\phi}_{kl}^{(i)} \boldsymbol{W}^{(l)} \boldsymbol{Y}_i(t-k) + \boldsymbol{\varepsilon}_i(t) - \sum_{k=1}^{q} \sum_{l=0}^{m_k} \boldsymbol{\theta}_{kl}^{(i)} \boldsymbol{W}^{(l)} \boldsymbol{\varepsilon}_i(t-k) \tag{2.13}$$

Similar to ARIMAX which is the addition of free variables to the ARIMA model, GSTARIMAX is also the addition of a free variable to GSTARIMA. The addition of the free variable is expected to improve accuracy in the forecasting process. If you follow the ARIMAX model, then the GSTARIMAX model can be written as follows:

$$\nabla \boldsymbol{Y}_i(t) = \sum_{k=1}^{p} \sum_{l=0}^{\lambda_k} \boldsymbol{\phi}_{kl}^{(i)} \boldsymbol{W}^{(l)} \nabla \boldsymbol{Y}_i(t-k) + \beta_1^{(i)} \boldsymbol{X}_1^{(i)} + \beta_2^{(i)} \boldsymbol{X}_2^{(i)} + \cdots + \beta_p^{(i)} \boldsymbol{X}_p^{(i)} + \boldsymbol{\varepsilon}_i(t) - \sum_{k=1}^{q} \sum_{l=0}^{m_k} \boldsymbol{\theta}_{kl}^{(i)} \boldsymbol{W}^{(l)} \boldsymbol{\varepsilon}_i(t-k) \qquad (2.14)$$

Changes to GSTARIX, GSTARX, etc. are similar to equations (2.9) - (2.13).

3. METHODOLOGY

This section consists of an explanation of data and analysis procedures.

3.1. Data

In this study, the data used is the gold price in countries that are included in the G20 and also registered in the World Gold Council which are major gold consumer countries such as China, France, Indonesia, Japan, Russia, Saudi Arabia, South Korea, Switzerland, Türkiye and United States as shown in Table 3.1. Furthermore, from these 10 countries a search will be carried out related to the province which is the center of the search with the keywords "gold price" based on the main language used in each country as in Table 3.1 as well. These provinces will then become a reference for measuring the distance between each country and classifying spatial orders.

The data obtained from the World Gold Council and Google Trends data is in the form of daily data in the form of a percentage of the number of searches in a certain time. This study changes the form of the variables obtained from Google Trends data from the percentage to binary data (0: if there is no keyword search on a certain day and 1: if there is a keyword search on a certain day).

Table 3.1. *Keyword and currency in each country*

No	Country	Official Language	Keyword	Currency
1	China	Chinese	黄金价格	Chinese renmimbi (CNY)
2	France	French	prix de l'or	Euro (EUR)
3	Indonesia	Indonesian	harga emas	Indonesian rupiah (IDR)
4	Japan	Japanese	金価格	Japanese yen (JPY)
5	Russia	Russian	цена золота	Russian ruble (RUB)
6	Saudi Arabia	Arabic	سعر الذهب	Saudi riyal (SAR)
7	South Korea	Korean	황금가격	Korean won (KRW)
8	Switzerland	German	goldpreis	Swiss franc (CHF)
		French	prix de l'or	
		Italian	prezzo dell'oro	
		Romansh	pret de aur	
9	Türkiye	Turkish	altın fiyat	Turkish lira (TRY)
10	United States	English	gold price	US dollar (USD)

3.2. Procedure

The analytical steps used in this research are:

1. Splitting data.

The data divided into two parts, namely modeling or training (from January 1, 2016 to December 31, 2019) and the selection of the best model or testing (from January 1, 2020 to December 31, 2021).

2. Solving missing value.

Missing value in this study has been completed with 2 imputation techniques included last observation carried forward (LOCF) and moving average smoothing (MA). For MA imputation has been limited to k=2. The description and solutions for missing value data have also been displayed in the form of numbers and graphs.

3. Determining the order of an autoregressive moving average.

Determination of the autoregressive order and moving average can use multivariate timeseries (VARMAX) based on the lowest Multivariate AIC value.

4. Creating spatial weighting matrices.

The weighting matrix used is the inverse distance matrix which has been raised with 1, 2, and the spatial order obtained from the distance between countries.

a. Determining the center of country

   The center of the country has been determined based on the keyword "gold price". These keywords have been translated into the main languages of each country. If a country used more than 1 official language, then selected the language that appears most often appears in the Google Trends data.

b. Determining of distance between countries

   The distance between the centers of the countries has been determined in km.

c. Determining spatial order.

   The first order was chosen from the first closest distance between countries. The second order was the second closest distance plus the first order distance. The third order was the distance of the third closest plus the distance of the second order to the last order was the furthest distance plus the distance of the previous order. This process has stopped until the distance between the farthest countries entered the highest spatial order. Furthermore, all distances have been classified based on the radius that has been formed.

5. Creating model

From each imputed data, either LOCF or MA has been applied to the GSTARIMA model. In this model, a spatial weighting matrix that has been formed from the previous high order has been used. So, there are 16 models that will be carried out in this study to choose the best model including:

a. GSTARIMA

   This model is the first model to be tested in this study. This model will look at the lag effect in each country as well as the effect of neighboring relations with other countries.

b. GSTARIMA with differencing

   The model was the result of the development of the previous model which changed the form of the data into differencing. After the data has been differencing, the analysis will be carried out again using the GSTARIMA model. This model was an anticipation if the data was not stationary. The results of the differencing are then converted back to the initial data to match the gold price data in each country.

c. GSTARIMAX

   The GSTARIMA model also needs to be developed by adding exogenous variables. The GSTARIMA model has also been developed by adding exogenous variables derived from Google Trends data. The variables included are google shopping, image search, news search, web search, and youtube search.

d. GSTARIMAX with differencing

   The model was the result of the development of the GSTARIMAX model which changed the form of the data into differencing. After the data has been differencing, the analysis will be carried out again with the GSTARIMAX model.

e. GSTARIMA with principal component

   Reduction in the effect of neighborliness between countries also needs to be done by analyzing the principal components and then doing another GSTARIMA analysis. In this model, the correlation between parameters has been checked first. Furthermore, the principal component coefficients have been calculated and applied for each country in each of the existing models.

f. GSTARIMA with differencing and principal component

The model was the result of the development of the GSTARIMA with PCA model which changed the form of the data into differencing. In addition to reducing the effect of neighborliness, the data also needs to be differencing and then doing GSTARIMA analysis with the principal components again.

g. GSTARIMAX with principal component

This model is a combination of the GSTARIMAX model and the dummy variable from Google Trends data that has been added. The GSTARIMAX model also needs to adopt a principal component analysis. However, in this model dummy variables are not included in the PCA.

h. GSTARIMAX with differencing and principal component

The model was the result of the development of the GSTARIMAX with PCA model which changed the form of the data into differencing. The last model that will be used in this research is the GSTARIMAX model on the data that has been obtained differencing and principal component analysis.

6. Choosing the best model.

Evaluation of the model will be done by comparing the modeling data and the data for evaluation based on the errors obtained. The selection of the best model based on calculating the smallest mean absolute percentage error (MAPE).

$$MAPE = \frac{100}{T}\sum_{t=1}^{T}\frac{Y_t - \hat{Y}_t}{Y_t} \tag{3.1}$$

where T is the number of predictions, Y_t is the actual data at time t, and $\hat{Y}_t$ is the estimated data. The smaller the MAPE value, the better the model. The MAPE value has been determined based on the testing of each country and also the entire country that has been in this study.

7. Forecasting data

The best models that have been obtained are then forecasted for the future (from January 1, 2022 to December 31, 2023) for the gold price in each country. The existing forecasting forms, apart from numbers, have also been displayed in graphical form.

4. IMPUTATION AND MODEL

Based on the World Gold Council, the complete gold price chart for each country can be seen in Figure A.1.1. The price is the gold price in troy ounces. For example Türkiye, the graph of the gold price in units of Turkish Lira (TRY) can be seen in Figure 4.1. In the figure, there are several broken lines on the graph. This represented that there were missing values in the data. One solution that has been carried out in this research was the imputation method. The total series that has been used in this study was 2192 starting from January 1, 2016 to December 31, 2021.

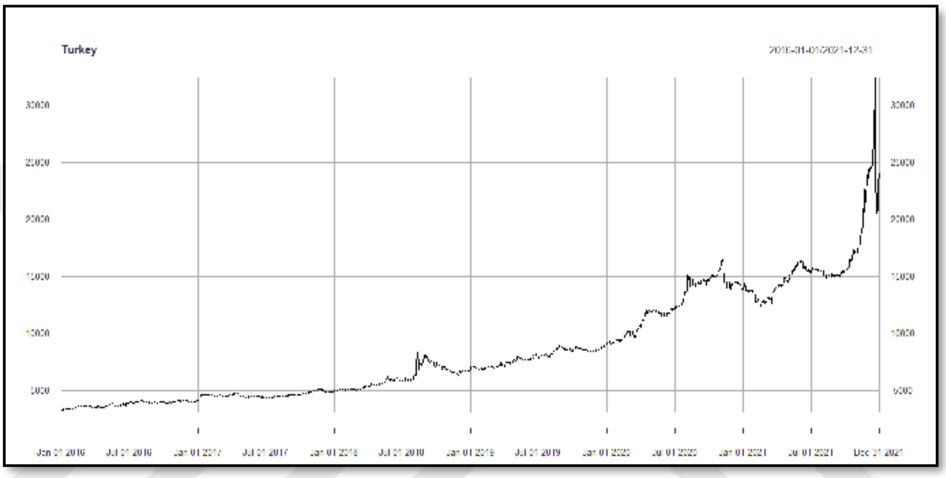

Figure 4.1. *Graph of gold price in Türkiye*

4.1. Imputation

This research used 2 imputation methods, namely last observation carried forward (LOCF) and moving average smoothing (MA) to impute gold price data that was found every Saturday and Sunday. Also, this imputation method has been applied to each country. If the first 5 data taken, the imputation results for gold prices in Türkiye shown in Table 4.1.

Table 4.1. *The result of imputed gold price in Türkiye*

Seri	Date	Original	LOCF	MA
1	January 1, 2016	3093.98	3093.98	3093.98
2	January 2, 2016	-	3093.98	3156.295
3	January 3, 2016	-	3093.98	3172.993
4	January 4, 2016	3218.61	3218.61	3218.61
5	January 5, 2016	3206.39	3206.39	3206.39

Based on Table 4.1, there had missing values of gold prices in Türkiye on January 2 and 3, 2016. The result of the LOCF imputation on that date was 3093.98 TRY/troy ounce for either January 2 or 3, 2016. While the result of the MA was 3156.295 TRY/troy ounce for January 2, 2016 and 3172.993 TRY/troy ounce for January 3, 2016. The gold price chart in Türkiye and its imputation results shown in Figure 4.2. In the graph, the black line represented the gold price which still had missing values (TRY in the graph), the red line represented the imputed results of the last observation carried forward (Last Value in the graph), and the yellow line represented the imputed results of moving average smoothing (Moving Average in graph). The complete graph of the gold price and the imputation results for each country has been presented in Figure A.2.1.

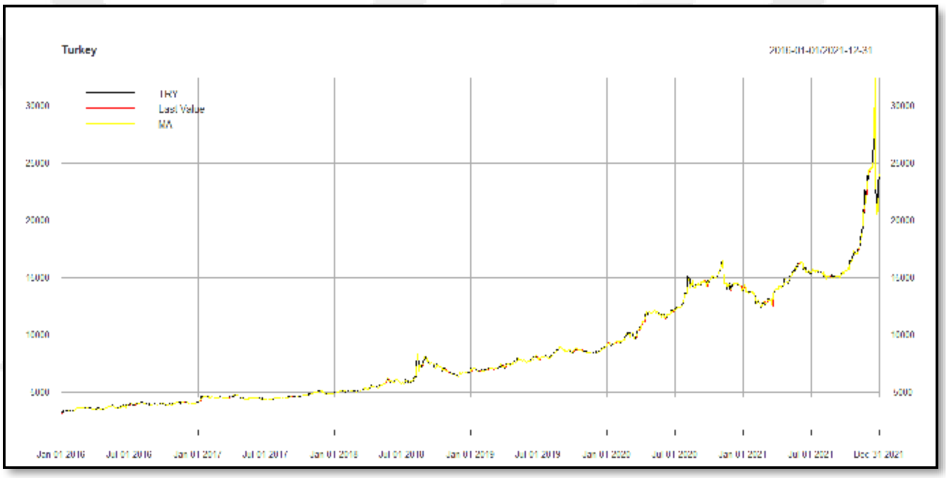

Figure 4.2. *Graph gold price in Türkiye*

4.2. Model

To build a GSTARIMA model, there are several things to consider including a spatial weighting matrix, autoregressive order, integrated order, and moving average order. The VARMAX minimum information criterion selected candidates for autoregressive and moving average order in the GSTARIMA model. The results can be seen in Table 4.2. Based on Table 4.2, it can be seen that the smallest value was 86.22838 which indicated autoregressive order 1 (AR 1). So that the GSTARIMA model that has been formed was GSTARIMA (1,0,0). But based on the graph, the data indicated that it was not stationary in the mean so that this study also used the GSTARIMA (1,1,0) model where there had one time differencing.

Table 4.2. *Minimum information criterion of VARMAX*

Lag	MA 0	MA 1	MA 2	MA 3	MA 4	MA 5
AR 0	86.32449	86.23086	86.25293	86.25433	86.26674	86.28444
AR 1	86.22838	86.24485	86.26075	86.26767	86.28179	86.29570
AR 2	86.25180	86.25842	86.26722	86.27599	86.27634	86.29260
AR 3	86.25096	86.26745	86.27427	86.28748	86.28966	86.30384
AR 4	86.25863	86.27806	86.27721	86.29112	86.30293	86.31234
AR 5	86.27529	86.29775	86.29204	86.29279	86.31489	86.33889

Furthermore, one of the advantages of this research was the spatial order which used Google Trends data. Based on Google Trends data by searching for the keyword "gold price" from each of the main languages of 10 countries, the provinces that were the center of a country have been obtained as shown in Table 4.3. In general, the capital in each country was different from the center of countries by google Trends data. For example, Türkiye, the keyword was "altın fiyat" so that based on Google Trends data, the category of google shopping was Kars. Meanwhile, based on other categories such as image search, news search, web search, youtube search were Gümüşhane, Sivas, Siirt, Bitlis respectively. These centers are different from the Turkish capital Ankara.

Table 4.3. *Country center based on Google Trends data*

No	Country	Keyword	Google Shooping	Image Search	News Search	Web Search	Youtube Search
1	China	黄金价格	*	*	Guangdong	Beijing	Beijing
2	France	prix de l'or	*	ÎledeFrance	Île de France	Rhone Alpes	Île de France
3	Indonesia	harga emas	North Kalimantan	Bengkulu	Aceh	Aceh	South East Sulawesi
4	Japan	金価格	Okayama	Fukuoka	Kagawa	Kagawa	Gunma
5	Russia	цена золота	Irkutsk Oblast	Omsk Oblast	Tatarstan	Krasnoyarsk Krai	Krasnoyarsk Krai
6	Saudi Arabia	سعر الذهب	Al Bahah	Al Bahah	Northern Borders	Najran	Jazan
7	South Korea	황금가격	Seoul	*	*	Seoul	*
8	Switzerland	goldpreis	Lucerne	Canton of Obwalden	Grisons	Canton of Uri	Canton of Schwyz
9	Türkiye	altın fiyat	Kars	Gümüşhane	Sivas	Siirt	Bitlis
10	United States	gold price	Hawaii	Mississippi	Delaware	Alaska	Mississippi

There were many alternative country centers that can be used, but in this study limited country centers have been selected based on Google Trends data in the web search category. This was because only in that category all countries display the center of the country based on Google Trends data. So that Beijing represented China, Rhone Alpes represented France, and so on until Alaska represented the United States.

Table 4.4. *Formation of spatial order*

Country-Country	Center-Center	KM	Radius	Order
France- Switzerland	Rhone Alpes-Canton of Uri	341.81	341.81	1
Japan-South Korea	Kagawa-Seoul	558.46	900.27	2
China-South Korea	Beijing-Seoul	956.30	1856.57	3
China-Japan	Beijing-Kagawa	1461.16	3317.73	4
Saudi Arabia-Türkiye	Najran-Siirt	2278.36	5596.09	5
Switzerland-Türkiye	Canton of Uri-Siirt	2865.96	8462.05	6
France-Türkiye	Rhone Alpes-Siirt	3178.35	11640.4	7
China-Russia	Beijing-Krasnoyarsk Krai	3243.39	14883.79	8

Note: max. distance is 14633.36

Furthermore, the distance from each of these countries has been determined in km as shown in Table A.3.1. So that after sorting the distance from the closest to the furthest, a classification radius has been formed as shown in Table 4.4. The results of the complete spatial order classification are in Table A.3.1. For example, Türkiye, the distance between Türkiye and France, Saudi Arabia, or Switzerland entered the 4th spatial order. The 5th spatial order was the distance between Türkiye and Russia. The distance between Türkiye and China, Indonesia, Japan, or South Korea entered the 6th spatial order. Meanwhile, the distance between Türkiye and the United States entered the 7th spatial order.

GSTARIMA (1,0,0) model

The AR 1 model obtained from VARMAX and spatial order classification has been applied to the GSTARIMA model so that written GSTARIMA model (1,0,0). Because the model has no order in differencing and moving averages and also the highest spatial order was 8, it can be written as equation (4.1).

$$\begin{aligned}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}) = {} & \mathbf{\Phi}_{1(0)}^{(\mathrm{i})}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(1)}^{(\mathrm{i})}\mathbf{W}^{(1)}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(2)}^{(\mathrm{i})}\mathbf{W}^{(2)}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(3)}^{(\mathrm{i})}\mathbf{W}^{(3)}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(4)}^{(\mathrm{i})}\mathbf{W}^{(4)} \\ & \mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(5)}^{(\mathrm{i})}\mathbf{W}^{(5)}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(6)}^{(\mathrm{i})}\mathbf{W}^{(6)}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(7)}^{(\mathrm{i})}\mathbf{W}^{(7)}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(8)}^{(\mathrm{i})}\mathbf{W}^{(8)} \\ & \mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t}) \end{aligned} \tag{4.1}$$

where $\mathbf{\Phi}_{10}^{(\mathrm{i})}$ is the i-th state 1 lag parameter, $\mathbf{\Phi}_{1l}^{(\mathrm{i})}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\mathbf{Y}_{\mathrm{i}}(\mathrm{t})$ is the gold price variable at time in i-th country, $\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)$ is lag 1 gold price variable at time in i-th country, and $\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t})$ is the error term. Suppose Türkiye, then equation (4.1) which can be formed into equation (4.2).

$$\textbf{Türkiye}_{\mathrm{i}}(\mathrm{t})=\emptyset_{1(0)}\textbf{Türkiye}_{\mathrm{i}}(\mathrm{t-1})+\emptyset_{1(4)}\left(\frac{1}{3178.35^{4}}\right)\textbf{France}_{\mathrm{i}}(\mathrm{t-1})+\emptyset_{1(4)}\left(\frac{1}{2278.36^{4}}\right)$$

$$\textbf{Saudi Arabia}_{\mathrm{i}}(\mathrm{t-1})+\emptyset_{1(4)}\left(\frac{1}{2865.96^{4}}\right)\textbf{Switzerland}_{\mathrm{i}}(\mathrm{t-1})+\emptyset_{1(5)}$$

$$\left(\frac{1}{4579.63^{5}}\right)\textbf{Russia}_{\mathrm{i}}(\mathrm{t-1})+\emptyset_{1(6)}\left(\frac{1}{4579.63^{6}}\right)\textbf{China}(\mathrm{t-1})+\emptyset_{1(6)}$$

$$\left(\frac{1}{6465.1^{6}}\right)\textbf{Indonesia}(\mathrm{t-1})+\emptyset_{1(6)}\left(\frac{1}{7707.28^{6}}\right)\textbf{Japan}(\mathrm{t-1})+\emptyset_{1(6)}$$

$$\left(\frac{1}{7185.6^{6}}\right)\textbf{South Korea}(\mathrm{t-1})+\emptyset_{1(7)}\left(\frac{1}{9583.69^{7}}\right)\textbf{United States}(\mathrm{t-1})$$

$$+\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t}) \tag{4.2}$$

Table 4.5. *Parameter estimation of GSTARIMA (1,0,0) from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	9.91E-01	<2e-16	$\emptyset^{3}_{1(6)}$	1.94E+22	0.777	$\emptyset^{6}_{1(0)}$	9.76E-01	<2e-16	$\emptyset^{8}_{1(4)}$	-2.36E+10	0.108
$\emptyset^{1}_{1(3)}$	9.56E+04	0.0221	$\emptyset^{3}_{1(7)}$	-7.36E+28	0.871	$\emptyset^{6}_{1(4)}$	-2.45E+10	0.454	$\emptyset^{8}_{1(5)}$	9.27E+13	0.6129
$\emptyset^{1}_{1(4)}$	-1.39E+10	0.7361	$\emptyset^{3}_{1(8)}$	-1.68E+35	0.507	$\emptyset^{6}_{1(5)}$	3.20E+16	0.331	$\emptyset^{8}_{1(6)}$	-1.55E+20	0.6443
$\emptyset^{1}_{1(5)}$	1.42E+13	0.0981	$\emptyset^{4}_{1(0)}$	9.97E-01	<2e-16	$\emptyset^{6}_{1(6)}$	8.75E+16	0.356	$\emptyset^{8}_{1(7)}$	8.30E+21	0.0599
$\emptyset^{1}_{1(6)}$	-1.49E+20	0.3198	$\emptyset^{4}_{1(2)}$	2.56E+02	0.0979	$\emptyset^{6}_{1(7)}$	1.02E+24	0.154	$\emptyset^{9}_{1(0)}$	9.99E-01	<2e-16
$\emptyset^{1}_{1(7)}$	-2.38E+27	0.043	$\emptyset^{4}_{1(3)}$	3.06E+08	0.4084	$\emptyset^{7}_{1(0)}$	1.00E+00	<2e-16	$\emptyset^{9}_{1(4)}$	4.44E+11	0.869
$\emptyset^{2}_{1(0)}$	1.01E+00	<2e-16	$\emptyset^{4}_{1(5)}$	2.36E+14	0.1562	$\emptyset^{7}_{1(2)}$	2.81E+04	0.197	$\emptyset^{9}_{1(5)}$	-6.06E+13	0.937
$\emptyset^{2}_{1(1)}$	-4.40E+00	0.221	$\emptyset^{4}_{1(6)}$	-8.42E+21	0.2305	$\emptyset^{7}_{1(3)}$	-2.26E+09	0.163	$\emptyset^{9}_{1(6)}$	2.01E+17	0.662
$\emptyset^{2}_{1(4)}$	-1.03E+10	0.628	$\emptyset^{4}_{1(7)}$	-1.70E+27	0.055	$\emptyset^{7}_{1(5)}$	-1.50E+15	0.385	$\emptyset^{9}_{1(7)}$	-7.55E+26	0.822
$\emptyset^{2}_{1(5)}$	2.18E+14	0.325	$\emptyset^{5}_{1(0)}$	9.93E-01	<2e-16	$\emptyset^{7}_{1(6)}$	7.67E+22	0.144	$\emptyset^{10}_{1(0)}$	9.87E-01	<2e-16
$\emptyset^{2}_{1(6)}$	-1.81E+20	0.622	$\emptyset^{5}_{1(4)}$	-1.51E+13	0.217	$\emptyset^{7}_{1(7)}$	1.97E+28	0.554	$\emptyset^{10}_{1(6)}$	5.75E+18	0.602
$\emptyset^{2}_{1(7)}$	5.29E+21	0.329	$\emptyset^{5}_{1(5)}$	4.06E+14	0.3857	$\emptyset^{8}_{1(0)}$	9.72E-01	<2e-16	$\emptyset^{10}_{1(7)}$	1.07E+23	0.114
$\emptyset^{3}_{1(0)}$	1.00E+00	<2e-16	$\emptyset^{5}_{1(6)}$	5.36E+18	0.0959	$\emptyset^{8}_{1(1)}$	4.30E+00	0.229	$\emptyset^{10}_{1(8)}$	3.10E+26	0.673
$\emptyset^{3}_{1(5)}$	1.68E+17	0.436									

The results of parameter estimation on the GSTARIMA model (1,0,0) which used LOCF and MA imputation shown in Table 4.5 and Table 4.6. More complete parameter estimation results shown in Table A.4.1 and Table A.5.1. In the GSTARIMA model (1,0,0) with LOCF imputation or MA imputation the parameters that had an effect on $\alpha = 5\%$ were $\emptyset^{1}_{1(0)}$, $\emptyset^{1}_{1(3)}$, $\emptyset^{1}_{1(7)}$, $\emptyset^{2}_{1(0)}$, $\emptyset^{3}_{1(0)}$, $\emptyset^{4}_{1(0)}$,$\emptyset^{6}_{1(0)}$, $\emptyset^{5}_{1(0)}$, $\emptyset^{7}_{1(0)}$, $\emptyset^{8}_{1(0)}$, $\emptyset^{9}_{1(0)}$, and $\emptyset^{10}_{1(0)}$.

Table 4.6. *Parameter estimation of GSTARIMA (1,0,0) from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	9.91E-01	<2e-16	$\emptyset^{3}_{1(6)}$	1.73E+22	0.795	$\emptyset^{6}_{1(0)}$	9.77E-01	<2e-16	$\emptyset^{8}_{1(4)}$	-2.31E+10	0.1103
$\emptyset^{1}_{1(3)}$	9.57E+04	0.0186	$\emptyset^{3}_{1(7)}$	-1.16E+29	0.794	$\emptyset^{6}_{1(4)}$	-2.30E+10	0.475	$\emptyset^{8}_{1(5)}$	1.09E+14	0.5442
$\emptyset^{1}_{1(4)}$	-1.37E+10	0.7323	$\emptyset^{3}_{1(8)}$	-1.67E+35	0.5	$\emptyset^{6}_{1(5)}$	3.07E+16	0.342	$\emptyset^{8}_{1(6)}$	-1.31E+20	0.6916
$\emptyset^{1}_{1(5)}$	1.42E+13	0.0888	$\emptyset^{4}_{1(0)}$	9.97E-01	<2e-16	$\emptyset^{6}_{1(6)}$	8.26E+16	0.376	$\emptyset^{8}_{1(7)}$	7.93E+21	0.0679
$\emptyset^{1}_{1(6)}$	-1.53E+20	0.2965	$\emptyset^{4}_{1(2)}$	2.61E+02	0.0827	$\emptyset^{6}_{1(7)}$	1.02E+24	0.146	$\emptyset^{9}_{1(0)}$	9.99E-01	<2e-16
$\emptyset^{1}_{1(7)}$	-2.42E+27	0.035	$\emptyset^{4}_{1(3)}$	2.96E+08	0.414	$\emptyset^{7}_{1(0)}$	1.00E+00	<2e-16	$\emptyset^{9}_{1(4)}$	3.04E+11	0.908
$\emptyset^{2}_{1(0)}$	1.01E+00	<2e-16	$\emptyset^{4}_{1(5)}$	2.30E+14	0.1564	$\emptyset^{7}_{1(2)}$	2.89E+04	0.177	$\emptyset^{9}_{1(5)}$	-4.76E+13	0.949
$\emptyset^{2}_{1(1)}$	-4.40E+00	0.213	$\emptyset^{4}_{1(6)}$	-8.25E+21	0.2307	$\emptyset^{7}_{1(3)}$	-2.16E+09	0.171	$\emptyset^{9}_{1(6)}$	1.96E+17	0.662
$\emptyset^{2}_{1(4)}$	-1.02E+10	0.628	$\emptyset^{4}_{1(7)}$	-1.69E+27	0.0516	$\emptyset^{7}_{1(5)}$	-1.47E+15	0.384	$\emptyset^{9}_{1(7)}$	-5.84E+26	0.859
$\emptyset^{2}_{1(5)}$	2.31E+14	0.288	$\emptyset^{5}_{1(0)}$	9.93E-01	<2e-16	$\emptyset^{7}_{1(6)}$	7.42E+22	0.148	$\emptyset^{10}_{1(0)}$	9.87E-01	<2e-16
$\emptyset^{2}_{1(6)}$	-1.61E+20	0.655	$\emptyset^{5}_{1(4)}$	-1.52E+13	0.206	$\emptyset^{7}_{1(7)}$	1.48E+28	0.65	$\emptyset^{10}_{1(6)}$	6.00E+18	0.578
$\emptyset^{2}_{1(7)}$	5.06E+21	0.341	$\emptyset^{5}_{1(5)}$	4.09E+14	0.374	$\emptyset^{8}_{1(0)}$	9.73E-01	<2e-16	$\emptyset^{10}_{1(7)}$	1.07E+23	0.106
$\emptyset^{3}_{1(0)}$	1.00E+00	<2e-16	$\emptyset^{5}_{1(6)}$	5.31E+18	0.092	$\emptyset^{8}_{1(1)}$	4.03E+00	0.2529	$\emptyset^{10}_{1(8)}$	2.81E+26	0.696
$\emptyset^{3}_{1(5)}$	1.90E+17	0.367									

GSTARIMA (1,1,0) model

The next model in this research was GSTARIMA (1,0,0) which has been differentiated or written GSTARIMA (1,1,0). So that the model has been written as equation (4.3).

$$\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t})=\mathbf{\Phi}^{(\mathrm{i})}_{1(0)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}^{(\mathrm{i})}_{1(\mathrm{l})}\mathbf{W}^{(\mathrm{l})}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}^{(\mathrm{i})}_{1(2)}\mathbf{W}^{(2)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}^{(\mathrm{i})}_{1(3)}\mathbf{W}^{(3)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+ \mathbf{\Phi}^{(\mathrm{i})}_{1(4)}\mathbf{W}^{(4)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}^{(\mathrm{i})}_{1(5)}\mathbf{W}^{(5)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}^{(\mathrm{i})}_{1(6)}\mathbf{W}^{(6)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}^{(\mathrm{i})}_{1(7)}\mathbf{W}^{(7)} \nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}^{(\mathrm{i})}_{1(8)}\mathbf{W}^{(8)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t}) \tag{4.3}$$

where $\mathbf{\Phi}^{(\mathrm{i})}_{10}$ is the i-th state 1 lag parameter, $\mathbf{\Phi}^{(\mathrm{i})}_{1l}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t})$ is differencing of the gold price variable at time in i-th country, $\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)$ is lag 1 differencing of gold price variable at time in i-th country, and $\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t})$ is the error term. Suppose Türkiye, then equation (4.1) which can be formed into equation (4.2).

$$\nabla\textbf{Türkiye}_i(t)=\emptyset_{1(0)}\nabla\textbf{Türkiye}_i(t\text{-}1)+\emptyset_{1(4)}\left(\frac{1}{3178.35^4}\right)\nabla\textbf{France}_i(t\text{-}1)+\emptyset_{1(4)}\left(\frac{1}{2278.36^4}\right)$$
$$\nabla\textbf{Saudi Arabia}_i(t\text{-}1)+\emptyset_{1(4)}\left(\frac{1}{2865.96^4}\right)\nabla\textbf{Switzerland}_i(t\text{-}1)+$$
$$\emptyset_{1(5)}\left(\frac{1}{4579.63^5}\right)\nabla\textbf{Russia}_i(t\text{-}1)+\emptyset_{1(6)}\left(\frac{1}{4579.63^6}\right)\nabla\textbf{China}(t\text{-}1)+$$
$$\emptyset_{1(6)}\left(\frac{1}{6465.1^6}\right)\nabla\textbf{Indonesia}(t\text{-}1)+\emptyset_{1(6)}\left(\frac{1}{7707.28^6}\right)\nabla\textbf{Japan}(t\text{-}1)+$$
$$\emptyset_{1(6)}\left(\frac{1}{7185.6^6}\right)\nabla\textbf{South Korea}(t\text{-}1)+\emptyset_{1(7)}\left(\frac{1}{9583.69^7}\right)$$
$$\nabla\textbf{United States}(t\text{-}1)+\boldsymbol{\varepsilon}_i(t) \tag{4.4}$$

The results of parameter estimation on the GSTARIMA model (1,0,0) which used LOCF and MA imputation shown in Table 4.7 and Table 4.8. More complete parameter estimation results shown in Table A.6.1 and Table A.7.1. In the GSTARIMA model (1,1,0) with LOCF imputation the parameters that had an effect on $\alpha = 5\%$ were $\emptyset^2_{1(1)}$, $\emptyset^3_{1(0)}$, $\emptyset^6_{1(7)}$, $\emptyset^7_{1(0)}$, $\emptyset^7_{1(2)}$, and $\emptyset^9_{1(0)}$. Meanwhile, in MA imputation, the parameters that affect on $\alpha = 5\%$ were $\emptyset^2_{1(6)}$, $\emptyset^4_{1(0)}$, $\emptyset^5_{1(0)}$, $\emptyset^6_{1(7)}$, $\emptyset^7_{1(0)}$, $\emptyset^7_{1(2)}$, $\emptyset^8_{1(0)}$, $\emptyset^9_{1(4)}$, $\emptyset^9_{1(6)}$, and $\emptyset^9_{1(7)}$.

Table 4.7. *Parameter estimation of GSTARIMA (1,1,0) from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^1_{1(0)}$	1.29E-01	0.1955	$\emptyset^3_{1(6)}$	5.60E+23	0.2675	$\emptyset^6_{1(0)}$	4.41E-02	0.5627	$\emptyset^8_{1(4)}$	4.40E+10	0.839
$\emptyset^1_{1(3)}$	-4.43E+05	0.0888	$\emptyset^3_{1(7)}$	-5.50E+29	0.8491	$\emptyset^6_{1(4)}$	1.62E+11	0.6572	$\emptyset^8_{1(5)}$	-7.44E+14	0.57
$\emptyset^1_{1(4)}$	5.78E+10	0.8436	$\emptyset^3_{1(8)}$	-3.86E+36	0.0752	$\emptyset^6_{1(5)}$	-1.95E+17	0.4711	$\emptyset^8_{1(6)}$	-1.38E+20	0.948
$\emptyset^1_{1(5)}$	4.39E+13	0.4722	$\emptyset^4_{1(0)}$	-3.63E-02	0.3456	$\emptyset^6_{1(6)}$	2.98E+17	0.6401	$\emptyset^8_{1(7)}$	1.64E+22	0.53
$\emptyset^1_{1(6)}$	7.33E+20	0.6163	$\emptyset^4_{1(2)}$	-9.83E+02	0.4153	$\emptyset^6_{1(7)}$	-1.29E+25	0.0285	$\emptyset^9_{1(0)}$	1.01E-01	0.00072
$\emptyset^1_{1(7)}$	-1.50E+28	0.096	$\emptyset^4_{1(3)}$	5.09E+09	0.2123	$\emptyset^7_{1(0)}$	-1.83E-01	0.00122	$\emptyset^9_{1(4)}$	-2.95E+13	0.13448
$\emptyset^2_{1(0)}$	4.79E-02	0.5135	$\emptyset^4_{1(5)}$	1.93E+15	0.136	$\emptyset^7_{1(2)}$	-5.67E+05	0.00136	$\emptyset^9_{1(5)}$	2.23E+15	0.72538
$\emptyset^2_{1(1)}$	-4.61E+01	0.0449	$\emptyset^4_{1(6)}$	2.66E+22	0.6925	$\emptyset^7_{1(3)}$	-2.71E+09	0.84221	$\emptyset^9_{1(6)}$	-5.65E+18	0.05026
$\emptyset^2_{1(4)}$	3.00E+11	0.3314	$\emptyset^4_{1(7)}$	-1.16E+28	0.0891	$\emptyset^7_{1(5)}$	2.67E+16	0.13188	$\emptyset^9_{1(7)}$	3.84E+28	0.08852
$\emptyset^2_{1(5)}$	-1.37E+15	0.3902	$\emptyset^5_{1(0)}$	-1.64E-03	0.9635	$\emptyset^7_{1(6)}$	5.99E+23	0.3558	$\emptyset^{10}_{1(0)}$	-2.64E-02	0.699
$\emptyset^2_{1(6)}$	3.02E+21	0.1821	$\emptyset^5_{1(4)}$	9.65E+13	0.3916	$\emptyset^7_{1(7)}$	2.70E+29	0.15868	$\emptyset^{10}_{1(6)}$	-5.86E+19	0.516
$\emptyset^2_{1(7)}$	-1.30E+22	0.6803	$\emptyset^5_{1(5)}$	-5.41E+15	0.0953	$\emptyset^8_{1(0)}$	-1.06E-01	0.137	$\emptyset^{10}_{1(7)}$	-6.67E+23	0.249
$\emptyset^3_{1(0)}$	1.56E-01	0.0434	$\emptyset^5_{1(6)}$	-2.24E+19	0.642	$\emptyset^8_{1(1)}$	1.60E+01	0.548	$\emptyset^{10}_{1(8)}$	1.35E+28	0.247
$\emptyset^3_{1(5)}$	-2.60E+18	0.0757									

Table 4.8. *Parameter estimation of GSTARIMA (1,1,0) from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	4.25E-02	0.677	$\emptyset^{3}_{1(6)}$	6.97E+23	0.153	$\emptyset^{6}_{1(0)}$	3.74E-02	0.62347	$\emptyset^{8}_{1(4)}$	-7.09E+10	0.73999
$\emptyset^{1}_{1(3)}$	-3.89E+05	0.135	$\emptyset^{3}_{1(7)}$	-2.41E+29	0.932	$\emptyset^{6}_{1(4)}$	4.20E+10	0.90769	$\emptyset^{8}_{1(5)}$	3.93E+14	0.75829
$\emptyset^{1}_{1(4)}$	2.36E+11	0.407	$\emptyset^{3}_{1(8)}$	-1.70E+36	0.426	$\emptyset^{6}_{1(5)}$	-8.83E+16	0.74075	$\emptyset^{8}_{1(6)}$	1.81E+21	0.39316
$\emptyset^{1}_{1(5)}$	-6.52E+13	0.285	$\emptyset^{4}_{1(0)}$	-2.49E-01	5.42E-11	$\emptyset^{6}_{1(6)}$	-1.01E+18	0.11894	$\emptyset^{8}_{1(7)}$	-2.83E+22	0.2776
$\emptyset^{1}_{1(6)}$	2.52E+20	0.861	$\emptyset^{4}_{1(2)}$	3.47E+02	0.772	$\emptyset^{6}_{1(7)}$	-1.62E+25	0.00567	$\emptyset^{9}_{1(0)}$	2.76E-02	0.3526
$\emptyset^{1}_{1(7)}$	-8.63E+27	0.35	$\emptyset^{4}_{1(3)}$	2.55E+09	0.542	$\emptyset^{7}_{1(0)}$	-2.69E-01	1.62E-06	$\emptyset^{9}_{1(4)}$	-4.16E+13	0.0327
$\emptyset^{2}_{1(0)}$	-1.04E-01	0.1463	$\emptyset^{4}_{1(5)}$	-1.03E+15	0.427	$\emptyset^{7}_{1(2)}$	-5.17E+05	0.00276	$\emptyset^{9}_{1(5)}$	-1.93E+15	0.7564
$\emptyset^{2}_{1(1)}$	-3.78E+01	0.0941	$\emptyset^{4}_{1(6)}$	-1.61E+21	0.98	$\emptyset^{7}_{1(3)}$	6.26E+09	0.64407	$\emptyset^{9}_{1(6)}$	-6.14E+18	0.0365
$\emptyset^{2}_{1(4)}$	1.07E+11	0.7268	$\emptyset^{4}_{1(7)}$	3.53E+27	0.613	$\emptyset^{7}_{1(5)}$	-4.94E+15	0.77764	$\emptyset^{9}_{1(7)}$	5.20E+28	0.0195
$\emptyset^{2}_{1(5)}$	-1.66E+14	0.9144	$\emptyset^{5}_{1(0)}$	-1.71E-01	9.49E-07	$\emptyset^{7}_{1(6)}$	7.17E+23	0.25755	$\emptyset^{10}_{1(0)}$	-4.23E-02	0.536
$\emptyset^{2}_{1(6)}$	5.11E+21	0.0239	$\emptyset^{5}_{1(4)}$	1.49E+14	0.186	$\emptyset^{7}_{1(7)}$	2.97E+29	0.11624	$\emptyset^{10}_{1(6)}$	-3.04E+19	0.732
$\emptyset^{2}_{1(7)}$	-5.83E+22	0.0645	$\emptyset^{5}_{1(5)}$	-4.34E+15	0.179	$\emptyset^{8}_{1(0)}$	-2.22E-01	0.00154	$\emptyset^{10}_{1(7)}$	-4.92E+23	0.4
$\emptyset^{3}_{1(0)}$	-1.07E-01	0.166	$\emptyset^{5}_{1(6)}$	-4.53E+19	0.348	$\emptyset^{8}_{1(1)}$	1.60E+01	0.53727	$\emptyset^{10}_{1(8)}$	-1.02E+28	0.389
$\emptyset^{3}_{1(5)}$	-1.96E+18	0.18									

GSTARIMAX (1,0,0) model

In this study, Google Trend data is not only used as an alternative to determine the center of the country, but as explanatory variable that predicts the gold price. The result of developing the GSTARIMA model (1,0,0) which has been combined with a dummy variable known as GSTARIMAX (1,0,0). The model has been shown in equation (4.5).

$$\begin{aligned}\mathbf{Y}_i(t) = {} & \mathbf{\Phi}^{(i)}_{1(0)}\mathbf{Y}_i(t\text{-}1) + \boldsymbol{\beta}^{(i)}_1\mathbf{X}^{(i)}_1 + \boldsymbol{\beta}^{(i)}_2\mathbf{X}^{(i)}_2 + \boldsymbol{\beta}^{(i)}_3\mathbf{X}^{(i)}_3 + \boldsymbol{\beta}^{(i)}_4\mathbf{X}^{(i)}_4 + \boldsymbol{\beta}^{(i)}_5\mathbf{X}^{(i)}_5 + \mathbf{\Phi}^{(i)}_{1(l)}\mathbf{W}^{(l)} \\ & \mathbf{Y}_i(t\text{-}1) + \mathbf{\Phi}^{(i)}_{1(2)}\mathbf{W}^{(2)}\mathbf{Y}_i(t\text{-}1) + \mathbf{\Phi}^{(i)}_{1(3)}\mathbf{W}^{(3)}\mathbf{Y}_i(t\text{-}1) + \mathbf{\Phi}^{(i)}_{1(4)}\mathbf{W}^{(4)}\mathbf{Y}_i(t\text{-}1) + \mathbf{\Phi}^{(i)}_{1(5)}\mathbf{W}^{(5)} \\ & \mathbf{Y}_i(t\text{-}1) + \mathbf{\Phi}^{(i)}_{1(6)}\mathbf{W}^{(6)}\mathbf{Y}_i(t\text{-}1) + \mathbf{\Phi}^{(i)}_{1(7)}\mathbf{W}^{(7)}\mathbf{Y}_i(t\text{-}1) + \mathbf{\Phi}^{(i)}_{1(8)}\mathbf{W}^{(8)}\mathbf{Y}_i(t\text{-}1) + \boldsymbol{\varepsilon}_i(t) \qquad (4.5)\end{aligned}$$

where $\mathbf{\Phi}^{(i)}_{10}$ is the i-th state 1 lag parameter, $\mathbf{\Phi}^{(i)}_{1l}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\mathbf{Y}_i(t)$ is the gold price variable at time in i-th country, $\mathbf{Y}_i(t\text{-}1)$ is lag 1 gold price variable at time in i-th country, $\beta^{(i)}_j X^{(i)}_j$ $(j = 1,2,\ldots,5)$ is dummy variable from Google Trends data for i-th country, and $\boldsymbol{\varepsilon}_i(t)$ is the error term. Suppose Türkiye, then equation (4.5) which can be formed into equation (4.6).

$$
\begin{aligned}
\mathbf{Türkiye}_{i}(t) = {} & \emptyset_{1(0)}\mathbf{Türkiye}_{i}(t\text{-}1) + \beta_1\mathbf{Google\ Shopping} + \beta_2\mathbf{Image\ Search} + \\
& \beta_3\mathbf{News\ Search} + \beta_4\mathbf{Web\ Search} + \beta_5\mathbf{YouTube\ Search} + \emptyset_{1(4)} \\
& \left(\frac{1}{3178.35^4}\right)\mathbf{France}_{i}(t\text{-}1) + \emptyset_{1(4)}\left(\frac{1}{2278.36^4}\right)\mathbf{Saudi\ Arabia}_{i}(t\text{-}1) + \emptyset_{1(4)} \\
& \left(\frac{1}{2865.96^4}\right)\mathbf{Switzerland}_{i}(t\text{-}1) + \emptyset_{1(5)}\left(\frac{1}{4579.63^5}\right)\mathbf{Russia}_{i}(t\text{-}1) + \emptyset_{1(6)} \\
& \left(\frac{1}{4579.63^6}\right)\mathbf{China}(t\text{-}1) + \emptyset_{1(6)}\left(\frac{1}{6465.1^6}\right)\mathbf{Indonesia}(t\text{-}1) + \emptyset_{1(6)} \\
& \left(\frac{1}{7707.28^6}\right)\mathbf{Japan}(t\text{-}1) + \emptyset_{1(6)}\left(\frac{1}{7185.6^6}\right)\mathbf{South\ Korea}(t\text{-}1) + \emptyset_{1(7)} \\
& \left(\frac{1}{9583.69^7}\right)\mathbf{United\ States}(t\text{-}1) + \boldsymbol{\varepsilon}_{i}(t) \qquad (4.6)
\end{aligned}
$$

Table 4.9. *Parameter estimation of GSTARIMAX (1,0,0) from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^1_{1(0)}$	9.91E-01	<2e-16	$\emptyset^3_{1(7)}$	-2.41E+29	6.21E-01	$\beta_1^{(6)}$	7.47E+00	0.68	$\emptyset^8_{1(1)}$	3.74E+00	0.302
$\beta_4^{(1)}$	7.32E+00	0.1149	$\emptyset^3_{1(8)}$	-3.66E+35	0.1802	$\beta_2^{(6)}$	-7.08E-01	0.718	$\emptyset^8_{1(4)}$	-1.64E+10	0.311
$\emptyset^1_{1(3)}$	9.25E+04	0.0269	$\emptyset^4_{1(0)}$	9.88E-01	<2e-16	$\beta_3^{(6)}$	-1.89E+00	0.598	$\emptyset^8_{1(5)}$	1.12E+14	0.544
$\emptyset^1_{1(4)}$	-1.05E+10	0.7996	$\beta_1^{(4)}$	6.84E+01	0.7308	$\beta_4^{(6)}$	1.54E+01	0.489	$\emptyset^8_{1(6)}$	-6.67E+19	0.847
$\emptyset^1_{1(5)}$	1.39E+13	0.1066	$\beta_2^{(4)}$	9.39E-01	0.9916	$\beta_5^{(6)}$	-4.15E-01	0.844	$\emptyset^8_{1(7)}$	6.78E+21	0.142
$\emptyset^1_{1(6)}$	-1.65E+20	0.271	$\beta_3^{(4)}$	-9.18E+01	0.3635	$\emptyset^6_{1(4)}$	-4.53E+09	0.923	$\emptyset^9_{1(0)}$	1.00E+00	<2e-16
$\emptyset^1_{1(7)}$	-2.31E+27	0.0498	$\beta_4^{(4)}$	1.12E+03	0.0256	$\emptyset^6_{1(5)}$	2.66E+16	0.47	$\beta_2^{(9)}$	-5.82E+00	0.143
$\emptyset^2_{1(0)}$	1.01E+00	<2e-16	$\beta_5^{(4)}$	2.03E+01	0.8769	$\emptyset^6_{1(6)}$	5.00E+16	0.663	$\beta_3^{(9)}$	6.43E+00	0.6
$\beta_2^{(2)}$	3.01E+00	0.531	$\emptyset^4_{1(2)}$	3.39E+02	0.0336	$\emptyset^6_{1(7)}$	6.55E+23	0.467	$\beta_4^{(9)}$	1.36E+01	0.724
$\beta_3^{(2)}$	-2.58E-01	0.97	$\emptyset^4_{1(3)}$	1.49E+08	0.6928	$\emptyset^7_{1(0)}$	1.00E+00	<2e-16	$\beta_5^{(9)}$	-3.84E-01	0.968
$\beta_4^{(2)}$	-7.08E-02	0.898	$\emptyset^4_{1(5)}$	3.39E+13	0.8574	$\beta_4^{(7)}$	-4.95E+02	0.489	$\emptyset^9_{1(4)}$	2.64E+11	0.929
$\emptyset^2_{1(1)}$	-4.44E+00	0.219	$\emptyset^4_{1(6)}$	3.24E+21	0.7142	$\beta_5^{(7)}$	-5.83E+02	0.705	$\emptyset^9_{1(5)}$	-4.34E+12	0.996
$\emptyset^2_{1(4)}$	-1.03E+10	0.629	$\emptyset^4_{1(7)}$	-9.54E+26	0.3135	$\emptyset^7_{1(2)}$	2.88E+04	0.187	$\emptyset^9_{1(6)}$	8.29E+16	0.888
$\emptyset^2_{1(5)}$	2.20E+14	0.323	$\emptyset^5_{1(0)}$	9.93E-01	<2e-16	$\emptyset^7_{1(3)}$	-2.30E+09	0.156	$\emptyset^9_{1(7)}$	-4.82E+26	0.898
$\emptyset^2_{1(6)}$	-1.82E+20	0.622	$\beta_1^{(5)}$	8.26E+00	0.981	$\emptyset^7_{1(5)}$	-1.49E+15	0.39	$\emptyset^{10}_{1(0)}$	9.79E-01	<2e-16
$\emptyset^2_{1(7)}$	5.32E+21	0.327	$\beta_2^{(5)}$	-7.28E+01	0.4	$\emptyset^7_{1(6)}$	7.94E+22	0.131	$\beta_1^{(10)}$	7.06E-01	0.3125
$\emptyset^3_{1(0)}$	9.97E-01	<2e-16	$\beta_3^{(5)}$	-6.64E+01	0.798	$\emptyset^7_{1(7)}$	2.04E+28	0.54	$\beta_2^{(10)}$	-8.08E-01	0.446
$\beta_1^{(3)}$	-8.07E+03	0.3752	$\beta_4^{(5)}$	3.48E+02	0.192	$\emptyset^8_{1(0)}$	9.72E-01	<2e-16	$\beta_3^{(10)}$	2.01E-01	0.661
$\beta_2^{(3)}$	-1.07E+04	0.3368	$\beta_5^{(5)}$	9.42E+00	0.902	$\beta_1^{(8)}$	-7.23E+00	0.314	$\beta_4^{(10)}$	7.44E+00	0.0388
$\beta_3^{(3)}$	6.59E+03	0.2841	$\emptyset^5_{1(4)}$	-1.38E+13	0.262	$\beta_2^{(8)}$	3.35E-01	0.811	$\beta_5^{(10)}$	3.43E-01	0.5099
$\beta_4^{(3)}$	1.28E+05	0.0122	$\emptyset^5_{1(5)}$	3.08E+14	0.524	$\beta_3^{(8)}$	-1.39E-01	0.902	$\emptyset^{10}_{1(6)}$	-3.92E+17	0.9729
$\beta_5^{(3)}$	1.42E+04	0.1312	$\emptyset^5_{1(6)}$	4.05E+18	0.229	$\beta_4^{(8)}$	2.36E+00	0.316	$\emptyset^{10}_{1(7)}$	1.51E+23	0.0377
$\emptyset^3_{1(5)}$	3.52E+17	0.1235	$\emptyset^6_{1(0)}$	9.81E-01	<2e-16	$\beta_5^{(8)}$	1.23E+00	0.498	$\emptyset^{10}_{1(8)}$	3.44E+26	0.6851
$\emptyset^3_{1(6)}$	1.12E+22	0.8717									

The results of parameter estimation on the GSTARIMAX model (1,0,0) which used LOCF and MA imputation shown in Table 4.9 and Table 4.10. More complete parameter estimation results shown in Table A.8.1 and Table A.9.1. In the GSTARIMAX model (1,1,0) with LOCF imputation the parameters that had an effect on $\alpha = 5\%$ were $\emptyset_{1(0)}^{1}$, $\emptyset_{1(3)}^{1}$, $\emptyset_{1(7)}^{1}$, $\emptyset_{1(0)}^{2}$, $\emptyset_{1(0)}^{3}$, $\beta_4^{(3)}$, $\emptyset_{1(0)}^{4}$, $\beta_4^{(4)}$, $\emptyset_{1(2)}^{4}$, $\emptyset_{1(0)}^{5}$, $\emptyset_{1(0)}^{7}$, $\emptyset_{1(0)}^{8}$, $\emptyset_{1(0)}^{9}$, $\emptyset_{1(0)}^{10}$, $\beta_4^{(10)}$, and $\emptyset_{1(7)}^{10}$. Meanwhile, in MA imputation, the parameters that affect on $\alpha = 5\%$ were $\emptyset_{1(0)}^{1}$, $\emptyset_{1(3)}^{1}$, $\emptyset_{1(7)}^{1}$, $\emptyset_{1(0)}^{2}$, $\emptyset_{1(0)}^{3}$, $\beta_4^{(3)}$, $\emptyset_{1(0)}^{4}$, $\beta_4^{(4)}$, $\emptyset_{1(2)}^{4}$, $\emptyset_{1(0)}^{5}$, $\emptyset_{1(0)}^{6}$, $\emptyset_{1(0)}^{7}$, $\emptyset_{1(0)}^{8}$, $\emptyset_{1(0)}^{9}$, $\emptyset_{1(0)}^{10}$, and $\beta_4^{(10)}$.

Table 4.10. *Parameter estimation of GSTARIMAX (1,0,0) from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	9.91E-01	<2e-16	$\emptyset_{1(7)}^{3}$	-3.23E+29	0.498	$\beta_2^{(6)}$	-1.56E+00	0.417	$\emptyset_{1(4)}^{8}$	-1.48E+10	0.353
$\beta_4^{(1)}$	4.54E+00	0.3157	$\emptyset_{1(8)}^{3}$	-3.34E+35	0.2105	$\beta_3^{(6)}$	1.26E+00	0.72	$\emptyset_{1(5)}^{8}$	1.32E+14	0.467
$\emptyset_{1(3)}^{1}$	9.39E+04	0.0212	$\emptyset_{1(0)}^{4}$	9.88E-01	<2e-16	$\beta_4^{(6)}$	1.21E+01	0.582	$\emptyset_{1(6)}^{8}$	-2.66E+19	0.938
$\emptyset_{1(4)}^{1}$	-1.16E+10	0.7723	$\beta_1^{(4)}$	1.40E+02	0.4699	$\beta_5^{(6)}$	6.58E-01	0.751	$\emptyset_{1(7)}^{8}$	6.31E+21	0.164
$\emptyset_{1(5)}^{1}$	1.40E+13	0.0942	$\beta_2^{(4)}$	9.93E+00	0.9094	$\emptyset_{1(4)}^{6}$	-7.70E+09	0.867	$\emptyset_{1(0)}^{9}$	1.00E+00	<2e-16
$\emptyset_{1(6)}^{1}$	-1.63E+20	0.2679	$\beta_3^{(4)}$	-1.38E+02	0.1605	$\emptyset_{1(5)}^{6}$	3.24E+16	0.371	$\beta_1^{(9)}$	2.93E+00	0.6528
$\emptyset_{1(7)}^{1}$	-2.37E+27	0.0389	$\beta_4^{(4)}$	1.09E+03	0.0252	$\emptyset_{1(6)}^{6}$	4.49E+16	0.691	$\beta_2^{(9)}$	-7.50E+00	0.0528
$\emptyset_{1(0)}^{2}$	1.01E+00	<2e-16	$\beta_5^{(4)}$	9.16E+01	0.4726	$\emptyset_{1(7)}^{6}$	6.63E+23	0.456	$\beta_3^{(9)}$	1.15E+01	0.3355
$\beta_2^{(2)}$	8.68E-01	0.854	$\emptyset_{1(2)}^{4}$	3.43E+02	0.0273	$\emptyset_{1(0)}^{7}$	1.00E+00	<2e-16	$\beta_4^{(9)}$	1.46E+01	0.6975
$\beta_3^{(2)}$	2.53E+00	0.703	$\emptyset_{1(3)}^{4}$	1.41E+08	0.702	$\beta_4^{(7)}$	-2.10E+02	0.763	$\beta_5^{(9)}$	2.91E+00	0.7544
$\beta_4^{(2)}$	1.34E-01	8.05E-01	$\emptyset_{1(5)}^{4}$	3.39E+13	0.8539	$\beta_5^{(7)}$	-8.88E+02	0.553	$\emptyset_{1(4)}^{9}$	2.94E+11	0.9194
$\emptyset_{1(1)}^{2}$	-4.52E+00	0.202	$\emptyset_{1(6)}^{4}$	2.70E+21	0.7552	$\emptyset_{1(2)}^{7}$	2.93E+04	0.172	$\emptyset_{1(5)}^{9}$	-2.94E+13	0.9691
$\emptyset_{1(4)}^{2}$	-1.06E+10	0.615	$\emptyset_{1(7)}^{4}$	-9.47E+26	0.3054	$\emptyset_{1(3)}^{7}$	-2.22E+09	0.16	$\emptyset_{1(6)}^{9}$	8.82E+16	0.8787
$\emptyset_{1(5)}^{2}$	2.28E+14	0.294	$\emptyset_{1(0)}^{5}$	9.93E-01	<2e-16	$\emptyset_{1(5)}^{7}$	-1.42E+15	0.404	$\emptyset_{1(7)}^{9}$	-5.16E+26	0.8884
$\emptyset_{1(6)}^{2}$	-1.62E+20	0.654	$\beta_1^{(5)}$	1.26E+02	0.711	$\emptyset_{1(6)}^{7}$	7.65E+22	0.138	$\emptyset_{1(0)}^{10}$	9.79E-01	<2e-16
$\emptyset_{1(7)}^{2}$	5.19E+21	0.33	$\beta_2^{(5)}$	-3.55E+01	0.676	$\emptyset_{1(7)}^{7}$	1.58E+28	0.628	$\beta_1^{(10)}$	1.38E-01	0.8409
$\emptyset_{1(0)}^{3}$	9.98E-01	<2e-16	$\beta_3^{(5)}$	-8.73E+01	0.732	$\emptyset_{1(0)}^{8}$	9.72E-01	<2e-16	$\beta_2^{(10)}$	-5.66E-01	0.5862
$\beta_1^{(3)}$	-2.18E+03	0.8067	$\beta_4^{(5)}$	3.16E+02	0.227	$\beta_1^{(8)}$	-7.27E+00	0.303	$\beta_3^{(10)}$	3.67E-01	0.4142
$\beta_2^{(3)}$	-7.90E+03	0.4657	$\beta_5^{(5)}$	-2.78E+01	0.712	$\beta_2^{(8)}$	-3.81E-01	0.782	$\beta_4^{(10)}$	7.34E+00	0.038
$\beta_3^{(3)}$	2.76E+03	0.6462	$\emptyset_{1(4)}^{5}$	-1.40E+13	0.246	$\beta_3^{(8)}$	-4.45E-01	0.687	$\beta_5^{(10)}$	-1.30E-01	0.7984
$\beta_4^{(3)}$	1.26E+05	0.0116	$\emptyset_{1(5)}^{5}$	2.87E+14	0.546	$\beta_4^{(8)}$	2.82E+00	0.225	$\emptyset_{1(6)}^{10}$	-1.13E+18	0.9205
$\beta_5^{(3)}$	1.03E+04	0.2648	$\emptyset_{1(6)}^{5}$	4.46E+18	0.177	$\beta_5^{(8)}$	-5.18E-01	0.771	$\emptyset_{1(7)}^{10}$	1.31E+23	0.0657
$\emptyset_{1(5)}^{3}$	3.74E+17	9.46E-02	$\emptyset_{1(0)}^{6}$	9.81E-01	<2e-16	$\emptyset_{1(1)}^{8}$	3.42E+00	0.337	$\emptyset_{1(8)}^{10}$	7.52E+26	0.3651
$\emptyset_{1(6)}^{3}$	2.77E+21	0.9674	$\beta_1^{(6)}$	6.69E+00	0.707						

GSTARIMAX (1,1,0) model

The next model in this study was GSTARIMAX (1,0,0) which has been differentiated or can be written as GSTARIMAX (1,1,0). So that the model has been written as equation (4.7).

$$\begin{aligned}\nabla\mathbf{Y}_i(t)=&\boldsymbol{\Phi}_{1(0)}^{(i)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\beta}_1^{(i)}\mathbf{X}_1^{(i)}+\boldsymbol{\beta}_2^{(i)}\mathbf{X}_2^{(i)}+\boldsymbol{\beta}_3^{(i)}\mathbf{X}_3^{(i)}+\boldsymbol{\beta}_4^{(i)}\mathbf{X}_4^{(i)}+\boldsymbol{\beta}_5^{(i)}\mathbf{X}_5^{(i)}+\boldsymbol{\Phi}_{1(l)}^{(i)}\mathbf{W}^{(l)}\\ &\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(2)}^{(i)}\mathbf{W}^{(2)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(3)}^{(i)}\mathbf{W}^{(3)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(4)}^{(i)}\mathbf{W}^{(4)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(5)}^{(i)}\\ &\mathbf{W}^{(5)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(6)}^{(i)}\mathbf{W}^{(6)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(7)}^{(i)}\mathbf{W}^{(7)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(8)}^{(i)}\mathbf{W}^{(8)}\nabla\mathbf{Y}_i(t\text{-}1)\\ &+\boldsymbol{\varepsilon}_i(t)\end{aligned} \tag{4.7}$$

where $\boldsymbol{\Phi}_{10}^{(i)}$ is the i-th state 1 lag parameter, $\boldsymbol{\Phi}_{1l}^{(i)}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\nabla\mathbf{Y}_i(t)$ is differencing of the gold price variable at time in i-th country, $\nabla\mathbf{Y}_i(t\text{-}1)$ is lag 1 differencing of gold price variable at time in i-th country, $\beta_j^{(i)}X_j^{(i)}$ $(j = 1,2,\dots,5)$ is dummy variable from Google Trends data for i-th country, and $\boldsymbol{\varepsilon}_i(t)$ is the error term. Suppose Türkiye, then equation (4.7) which can be formed into equation (4.8).

$$\begin{aligned}\nabla\textbf{Türkiye}_i(t)=&\emptyset_{1(0)}\nabla\textbf{Türkiye}_i(t\text{-}1)+\beta_1\textbf{Google Shopping}+\beta_2\textbf{Image Search}+\beta_3\\ &\textbf{News Search}+\beta_4\textbf{Web Search}+\beta_5\textbf{YouTube Search}+\emptyset_{1(4)}\\ &\left(\frac{1}{3178.35^4}\right)\nabla\textbf{France}_i(t\text{-}1)+\emptyset_{1(4)}\left(\frac{1}{2278.36^4}\right)\nabla\textbf{Saudi Arabia}_i(t\text{-}1)+\\ &\emptyset_{1(4)}\left(\frac{1}{2865.96^4}\right)\nabla\textbf{Switzerland}_i(t\text{-}1)+\emptyset_{1(5)}\left(\frac{1}{4579.63^5}\right)\nabla\textbf{Russia}_i(t\text{-}1)\\ &+\emptyset_{1(6)}\left(\frac{1}{4579.63^6}\right)\nabla\textbf{China}(t\text{-}1)+\emptyset_{1(6)}\left(\frac{1}{6465.1^6}\right)\nabla\textbf{Indonesia}(t\text{-}1)+\\ &\emptyset_{1(6)}\left(\frac{1}{7707.28^6}\right)\nabla\textbf{Japan}(t\text{-}1)+\emptyset_{1(6)}\left(\frac{1}{7185.6^6}\right)\nabla\textbf{South Korea}(t\text{-}1)\\ &+\emptyset_{1(7)}\left(\frac{1}{9583.69^7}\right)\nabla\textbf{United States}(t\text{-}1)+\boldsymbol{\varepsilon}_i(t)\end{aligned} \tag{4.8}$$

Table 4.11. *Parameter estimation of GSTARIMAX (1,1,0) from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	1.22E-01	0.2185	$\emptyset_{1(7)}^{3}$	-8.72E+29	0.7636	$\beta_2^{(6)}$	-8.75E-01	0.6547	$\emptyset_{1(4)}^{8}$	2.55E+10	0.906
$\beta_4^{(1)}$	9.01E+00	0.0342	$\emptyset_{1(8)}^{3}$	-3.71E+36	0.0879	$\beta_3^{(6)}$	·1.61E+00	0.6532	$\emptyset_{1(5)}^{8}$	-6.53E+14	0.619
$\emptyset_{1(3)}^{1}$	-4.26E+05	0.1011	$\emptyset_{1(0)}^{4}$	-3.64E-02	0.3457	$\beta_4^{(6)}$	1.52E+00	0.174	$\emptyset_{1(6)}^{8}$	-3.00E+20	0.888
$\emptyset_{1(4)}^{1}$	7.55E+10	0.7964	$\beta_1^{(4)}$	1.09E+02	0.5844	$\beta_5^{(6)}$	-1.58E-01	0.9295	$\emptyset_{1(7)}^{8}$	1.86E+22	0.478
$\emptyset_{1(5)}^{1}$	4.03E+13	0.5087	$\beta_2^{(4)}$	-2.94E+01	0.7409	$\emptyset_{1(4)}^{6}$	1.39E+11	0.7046	$\emptyset_{1(0)}^{9}$	9.69E-02	0.00121
$\emptyset_{1(6)}^{1}$	6.94E+20	0.6348	$\beta_3^{(4)}$	-8.42E+01	0.396	$\emptyset_{1(5)}^{6}$	·1.96E+17	0.4687	$\beta_1^{(9)}$	-5.47E+00	0.39391
$\emptyset_{1(7)}^{1}$	-1.44E+28	0.109	$\beta_4^{(4)}$	2.75E+01	0.1808	$\emptyset_{1(6)}^{6}$	2.89E+17	0.6505	$\beta_2^{(9)}$	-5.45E+00	0.16706
$\emptyset_{1(0)}^{2}$	4.68E-02	0.5241	$\beta_5^{(4)}$	3.25E+01	0.8008	$\emptyset_{1(7)}^{6}$	·1.32E+25	0.0257	$\beta_3^{(9)}$	5.64E+00	0.64327
$\beta_2^{(2)}$	2.83E+00	0.5553	$\emptyset_{1(2)}^{4}$	-9.94E+02	0.4115	$\emptyset_{1(0)}^{7}$	-1.83E-01	0.00124	$\beta_4^{(9)}$	5.86E+00	0.00683
$\beta_3^{(2)}$	2.34E-01	9.73E-01	$\emptyset_{1(3)}^{4}$	4.99E+09	0.2228	$\beta_4^{(7)}$	·5.19E+00	0.99353	$\beta_5^{(9)}$	-4.35E+00	0.64296
$\beta_4^{(2)}$	1.08E-01	0.8364	$\emptyset_{1(5)}^{4}$	2.01E+15	0.1228	$\beta_5^{(7)}$	9.20E+00	0.99503	$\emptyset_{1(4)}^{9}$	-2.89E+13	0.14251
$\emptyset_{1(1)}^{2}$	-4.60E+01	0.0461	$\emptyset_{1(6)}^{4}$	1.96E+22	0.7711	$\emptyset_{1(2)}^{7}$	·5.67E+05	0.00138	$\emptyset_{1(5)}^{9}$	2.66E+15	0.67514
$\emptyset_{1(4)}^{2}$	2.98E+11	0.3358	$\emptyset_{1(7)}^{4}$	-1.17E+28	0.0862	$\emptyset_{1(3)}^{7}$	·2.71E+09	0.84267	$\emptyset_{1(6)}^{9}$	-5.91E+18	0.04127
$\emptyset_{1(5)}^{2}$	-1.37E+15	0.3897	$\emptyset_{1(0)}^{5}$	-2.49E-03	0.945	$\emptyset_{1(5)}^{7}$	2.67E+16	0.13247	$\emptyset_{1(7)}^{9}$	3.79E+28	0.09261
$\emptyset_{1(6)}^{2}$	3.03E+21	0.1822	$\beta_1^{(5)}$	-5.91E-02	1	$\emptyset_{1(6)}^{7}$	6.00E+23	0.357	$\emptyset_{1(0)}^{10}$	-2.58E-02	0.705
$\emptyset_{1(7)}^{2}$	-1.28E+22	0.6842	$\beta_2^{(5)}$	-7.40E+01	0.388	$\emptyset_{1(7)}^{7}$	2.70E+29	0.15947	$\beta_1^{(10)}$	7.22E-01	0.303
$\emptyset_{1(0)}^{3}$	1.52E-01	0.0498	$\beta_3^{(5)}$	-3.50E+01	0.893	$\emptyset_{1(0)}^{8}$	-1.13E-01	0.115	$\beta_2^{(10)}$	-8.79E-01	0.407
$\beta_1^{(3)}$	-7.79E+03	0.3375	$\beta_4^{(5)}$	1.62E+01	0.461	$\beta_1^{(8)}$	·8.28E+00	0.25	$\beta_3^{(10)}$	3.27E-01	0.467
$\beta_2^{(3)}$	-7.52E+03	0.4879	$\beta_5^{(5)}$	1.50E+01	0.84	$\beta_2^{(8)}$	1.74E-01	0.901	$\beta_4^{(10)}$	2.59E-01	0.84
$\beta_3^{(3)}$	7.75E+03	0.2044	$\emptyset_{1(4)}^{5}$	9.57E+13	0.398	$\beta_3^{(8)}$	8.89E-02	0.937	$\beta_5^{(10)}$	9.17E-02	0.842
$\beta_4^{(3)}$	5.97E+03	6.09E-01	$\emptyset_{1(5)}^{5}$	-5.33E+15	0.101	$\beta_4^{(8)}$	2.68E-01	0.167	$\emptyset_{1(6)}^{10}$	-6.63E+19	0.465
$\beta_5^{(3)}$	5.15E+03	0.4339	$\emptyset_{1(6)}^{5}$	-2.28E+19	0.638	$\beta_5^{(8)}$	1.74E+00	0.336	$\emptyset_{1(7)}^{10}$	-6.48E+23	0.264
$\emptyset_{1(5)}^{3}$	-2.56E+18	0.0803	$\emptyset_{1(0)}^{6}$	4.57E-02	0.5495	$\emptyset_{1(1)}^{8}$	1.68E+01	0.529	$\emptyset_{1(8)}^{10}$	1.31E+28	0.263
$\emptyset_{1(6)}^{3}$	5.80E+23	0.251	$\beta_1^{(6)}$	5.32E+00	0.7674						

The results of parameter estimation on the GSTARIMAX model (1,1,0) which used LOCF and MA imputation shown in Table 4.11 and Table 4.12. More complete parameter estimation results shown in Table A.10.1 and Table A.11.1. In the GSTARIMAX model (1,1,0) with LOCF imputation the parameters that had an effect on $\alpha = 5\%$ were $\beta_4^{(1)}$, $\emptyset_{1(1)}^{2}$, $\emptyset_{1(0)}^{3}$, $\emptyset_{1(7)}^{6}$, $\emptyset_{1(0)}^{7}$, $\emptyset_{1(2)}^{7}$, $\emptyset_{1(0)}^{9}$, $\beta_4^{(9)}$, adn $\emptyset_{1(6)}^{9}$. Meanwhile, in MA imputation, the parameters that affect on $\alpha = 5\%$ were $\emptyset_{1(6)}^{2}$, $\emptyset_{1(0)}^{4}$, $\emptyset_{1(0)}^{5}$, $\emptyset_{1(7)}^{6}$, $\emptyset_{1(0)}^{7}$, $\emptyset_{1(0)}^{8}$, $\beta_4^{(9)}$, $\emptyset_{1(4)}^{9}$, $\emptyset_{1(6)}^{9}$, and $\emptyset_{1(7)}^{9}$.

Table 4.12. *Parameter estimation of GSTARIMAX (1,1,0) from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	3.27E-02	0.749	$\emptyset^{3}_{1(7)}$	-3.94E+29	0.889	$\beta^{(6)}_{2}$	-1.55E+00	0.41314	$\emptyset^{8}_{1(4)}$	-9.24E+10	0.66608
$\beta^{(1)}_{4}$	7.37E+00	0.071	$\emptyset^{3}_{1(8)}$	-1.65E+36	0.441	$\beta^{(6)}_{3}$	4.92E-01	0.88734	$\emptyset^{8}_{1(5)}$	4.70E+14	0.71309
$\emptyset^{1}_{1(3)}$	-3.76E+05	0.148	$\emptyset^{4}_{1(0)}$	-2.51E-01	3.64E-11	$\beta^{(6)}_{4}$	1.52E+00	0.16236	$\emptyset^{8}_{1(6)}$	1.67E+21	0.43187
$\emptyset^{1}_{1(4)}$	2.42E+11	0.395	$\beta^{(4)}_{1}$	1.41E+02	0.458	$\beta^{(6)}_{5}$	5.46E-01	0.75216	$\emptyset^{8}_{1(7)}$	-2.68E+22	0.3044
$\emptyset^{1}_{1(5)}$	-6.70E+13	0.272	$\beta^{(4)}_{2}$	-1.95E+01	0.818	$\emptyset^{6}_{1(4)}$	1.91E+10	0.95811	$\emptyset^{9}_{1(0)}$	2.09E-02	0.48388
$\emptyset^{1}_{1(6)}$	2.11E+20	0.883	$\beta^{(4)}_{3}$	-1.35E+02	0.153	$\emptyset^{6}_{1(5)}$	-8.56E+16	0.74878	$\beta^{(9)}_{1}$	1.39E+00	0.82371
$\emptyset^{1}_{1(7)}$	-7.77E+27	0.4	$\beta^{(4)}_{4}$	3.10E+01	0.114	$\emptyset^{6}_{1(6)}$	-1.01E+18	0.11817	$\beta^{(9)}_{2}$	-7.26E+00	0.05907
$\emptyset^{2}_{1(0)}$	-1.06E-01	0.1401	$\beta^{(4)}_{5}$	1.47E+02	0.229	$\emptyset^{6}_{1(7)}$	-1.64E+25	0.00511	$\beta^{(9)}_{3}$	1.02E+01	0.39047
$\beta^{(2)}_{2}$	1.51E+00	0.7449	$\emptyset^{4}_{1(2)}$	3.66E+02	0.76	$\emptyset^{7}_{1(0)}$	-2.68E-01	1.80E-06	$\beta^{(9)}_{4}$	5.78E+00	0.00614
$\beta^{(2)}_{3}$	2.51E+00	0.7025	$\emptyset^{4}_{1(3)}$	2.26E+09	0.59	$\beta^{(7)}_{4}$	3.11E+02	0.61036	$\beta^{(9)}_{5}$	2.57E+00	0.77865
$\beta^{(2)}_{4}$	2.83E-01	0.5736	$\emptyset^{4}_{1(5)}$	-9.65E+14	0.456	$\beta^{(7)}_{5}$	2.32E+02	0.86899	$\emptyset^{9}_{1(4)}$	-4.07E+13	0.03664
$\emptyset^{2}_{1(1)}$	-3.71E+01	0.1008	$\emptyset^{4}_{1(6)}$	-9.03E+21	0.891	$\emptyset^{7}_{1(2)}$	-5.19E+05	0.00269	$\emptyset^{9}_{1(5)}$	-1.97E+15	0.75179
$\emptyset^{2}_{1(4)}$	1.13E+11	0.7116	$\emptyset^{4}_{1(7)}$	3.69E+27	0.598	$\emptyset^{7}_{1(3)}$	6.27E+09	0.64382	$\emptyset^{9}_{1(6)}$	-6.05E+18	0.03976
$\emptyset^{2}_{1(5)}$	-2.18E+14	0.888	$\emptyset^{5}_{1(0)}$	-1.72E-01	9.55E-07	$\emptyset^{7}_{1(5)}$	-5.21E+15	0.76648	$\emptyset^{9}_{1(7)}$	5.08E+28	0.02228
$\emptyset^{2}_{1(6)}$	5.10E+21	0.0242	$\beta^{(5)}_{1}$	7.05E+01	0.832	$\emptyset^{7}_{1(6)}$	6.91E+23	0.27721	$\emptyset^{10}_{1(0)}$	-4.11E-02	0.549
$\emptyset^{2}_{1(7)}$	-5.81E+22	0.0654	$\beta^{(5)}_{2}$	-4.93E+01	0.549	$\emptyset^{7}_{1(7)}$	2.99E+29	0.11487	$\beta^{(10)}_{1}$	2.33E-01	0.731
$\emptyset^{3}_{1(0)}$	-1.10E-01	0.156	$\beta^{(5)}_{3}$	-8.91E-01	0.997	$\emptyset^{8}_{1(0)}$	-2.22E-01	0.00156	$\beta^{(10)}_{2}$	-7.73E-01	0.451
$\beta^{(3)}_{1}$	-3.44E+03	0.658	$\beta^{(5)}_{4}$	1.77E+01	0.401	$\beta^{(8)}_{1}$	-7.55E+00	0.27619	$\beta^{(10)}_{3}$	5.46E-01	0.21
$\beta^{(3)}_{2}$	-3.36E+03	0.746	$\beta^{(5)}_{5}$	-1.84E+01	0.797	$\beta^{(8)}_{2}$	-3.20E-01	0.81229	$\beta^{(10)}_{4}$	6.38E-01	0.608
$\beta^{(3)}_{3}$	3.79E+03	0.517	$\emptyset^{5}_{1(4)}$	1.47E+14	0.194	$\beta^{(8)}_{3}$	-3.13E-01	0.77326	$\beta^{(10)}_{5}$	-1.16E-01	0.795
$\beta^{(3)}_{4}$	5.15E+03	0.646	$\emptyset^{5}_{1(5)}$	-4.29E+15	0.186	$\beta^{(8)}_{4}$	3.44E-01	0.06616	$\emptyset^{10}_{1(6)}$	-3.41E+19	0.701
$\beta^{(3)}_{5}$	3.08E+03	0.625	$\emptyset^{5}_{1(6)}$	-4.49E+19	0.353	$\beta^{(8)}_{5}$	6.55E-01	0.7084	$\emptyset^{10}_{1(7)}$	-4.69E+23	0.423
$\emptyset^{3}_{1(5)}$	-1.94E+18	0.186	$\emptyset^{6}_{1(0)}$	3.77E-02	0.62012	$\emptyset^{8}_{1(1)}$	1.54E+01	0.55448	$\emptyset^{10}_{1(8)}$	-1.10E+28	0.355
$\emptyset^{3}_{1(6)}$	7.06E+23	0.148	$\beta^{(6)}_{1}$	4.56E+00	0.79345						

GSTARIMA (1,0,0) model with PCA

This study also used PCA which has been combined with the GSTARIMA model (1,0,0) because there was a correlation between the parameters as in Table A.12.1 and Table A.13.1. So the GSTARIMA model (1,0,0) which has been combined with the principal component analysis (PCA) has been written in equation (4.9).

$$\begin{aligned}\mathbf{Y}_i(t)=&\boldsymbol{\Phi}^{(i)}_{1(0)}\mathbf{A}^{1(0)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(l)}\mathbf{W}^{(l)}\mathbf{A}^{1(1)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(2)}\mathbf{W}^{(2)}\mathbf{A}^{1(2)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(3)}\mathbf{W}^{(3)}\\&\mathbf{A}^{1(3)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(4)}\mathbf{W}^{1(4)}\mathbf{A}^{(4)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(5)}\mathbf{W}^{1(5)}\mathbf{A}^{(5)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(6)}\mathbf{W}^{1(6)}\\&\mathbf{A}^{(6)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(7)}\mathbf{W}^{1(7)}\mathbf{A}^{(7)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}^{(i)}_{1(8)}\mathbf{W}^{1(8)}\mathbf{A}^{(8)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\varepsilon}_i(t)\end{aligned}\tag{4.9}$$

where $\mathbf{\Phi}_{10}^{(i)}$ is the i-th state 1 lag parameter, $\mathbf{\Phi}_{1l}^{(i)}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\mathbf{Y}_{\mathrm{i}}(\mathrm{t})$ is the gold price variable at time in i-th country, $\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)$ is lag 1 gold price variable at time in i-th country, $\mathbf{A}_{\mathrm{m}}^{(\mathrm{l})}$ is the principal component coefficient for the l-th spatial order the parameter, and $\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t})$ is the error term. Suppose Türkiye, then equation (4.9) which can be formed into equation (4.10). In addition, the main component coefficients shown in Table A.16.1 and Table A.17.1.

$$\textbf{Türkiye}_{\mathrm{i}}(\mathrm{t})=\emptyset_{1(0)}\textbf{Türkiye}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t}) \tag{4.10}$$

Table 4.13. *Parameter estimation of GSTARIMA (1,0,0) with PCA from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	1.000267	<2e-16	$\emptyset_{1(0)}^{4}$	1.00017	<2e-16	$\emptyset_{1(0)}^{7}$	1.000212	<2e-16	$\emptyset_{1(0)}^{9}$	1.000654	<2e-16
$\emptyset_{1(0)}^{2}$	1.00021	<2e-16	$\emptyset_{1(0)}^{5}$	1.000101	<2e-16	$\emptyset_{1(0)}^{8}$	1.0002	<2e-16	$\emptyset_{1(0)}^{10}$	1.000219	<2e-16
$\emptyset_{1(0)}^{3}$	1.000225	<2e-16	$\emptyset_{1(0)}^{6}$	1.000219	<2e-16						

The results of parameter estimation on the GSTARIMA model (1,0,0) with PCA which used LOCF and MA imputation shown in Table 4.13 and Table 4.14. More complete parameter estimation results shown in Table A.20.1 and Table A.21.1. At $\alpha = 5\%$ all parameters of the GSTARIMA model (1,0,0) which have been combined PCA with both LOCF and MA imputation have been significant.

Table 4.14. *Parameter estimation of GSTARIMA (1,0,0) with PCA from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	1.000268	<2e-16	$\emptyset_{1(0)}^{4}$	1.000171	<2e-16	$\emptyset_{1(0)}^{7}$	1.000214	<2e-16	$\emptyset_{1(0)}^{9}$	1.000657	<2e-16
$\emptyset_{1(0)}^{2}$	1.000211	<2e-16	$\emptyset_{1(0)}^{5}$	1.000103	<2e-16	$\emptyset_{1(0)}^{8}$	1.000201	<2e-16	$\emptyset_{1(0)}^{10}$	1.00022	<2e-16
$\emptyset_{1(0)}^{3}$	1.000226	<2e-16	$\emptyset_{1(0)}^{6}$	1.000219	<2e-16						

GSTARIMA (1,1,0) model with PCA

In addition to the GSTARIMA model (1,0,0), also PCA has been applied to the GSTARIMA (1,0,0) model. So that the model has been written according to equation (4.11).

$$\begin{aligned}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t})=&\mathbf{\Phi}_{1(0)}^{(\mathrm{i})}\mathbf{A}_{\mathrm{m}}^{1(0)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(\mathrm{l})}^{(\mathrm{i})}\mathbf{W}^{(\mathrm{l})}\mathbf{A}_{\mathrm{m}}^{1(1)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(2)}^{(\mathrm{i})}\mathbf{W}^{(2)}\mathbf{A}_{\mathrm{m}}^{1(2)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(3)}^{(\mathrm{i})}\\&\mathbf{W}^{(3)}\mathbf{A}_{\mathrm{m}}^{1(3)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(4)}^{(\mathrm{i})}\mathbf{W}^{1(4)}\mathbf{A}_{\mathrm{m}}^{(4)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(5)}^{(\mathrm{i})}\mathbf{W}^{1(5)}\mathbf{A}_{\mathrm{m}}^{(5)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(6)}^{(\mathrm{i})}\\&\mathbf{W}^{1(6)}\mathbf{A}_{\mathrm{m}}^{(6)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(7)}^{(\mathrm{i})}\mathbf{W}^{1(7)}\mathbf{A}_{\mathrm{m}}^{(7)}\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\mathbf{\Phi}_{1(8)}^{(\mathrm{i})}\mathbf{W}^{1(8)}\mathbf{A}_{\mathrm{m}}^{(8)}\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)+\\&\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t})\end{aligned} \tag{4.11}$$

where $\mathbf{\Phi}_{10}^{(i)}$ is the i-th state 1 lag parameter, $\mathbf{\Phi}_{1l}^{(i)}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t})$ is differencing of the gold price variable at time in i-th country, $\nabla\mathbf{Y}_{\mathrm{i}}(\mathrm{t}\text{-}1)$ is lag 1 differencing of gold price variable at time in i-th country, $\mathbf{A}_{\mathrm{m}}^{(\mathrm{l})}$ is the principal component coefficient for the l-th spatial order the parameter, and $\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t})$ is the error term. Suppose Türkiye, then equation (4.11) which can be formed into equation (4.12). In addition, the main component coefficients shown in Table A.18.1 and Table A.19.1.

$$\nabla\textbf{Türkiye}_{\mathrm{i}}(\mathrm{t})=\emptyset_{1(0)}\nabla\textbf{Türkiye}_{\mathrm{i}}(\mathrm{t}\text{-}1)\boldsymbol{\varepsilon}_{\mathrm{i}}(\mathrm{t}) \tag{4.12}$$

The results of parameter estimation on the GSTARIMA model (1,1,0) with PCA which used LOCF and MA imputation shown in Table 4.15 and Table 4.16. More complete parameter estimation results shown in Table A.22.1 and Table A.23.1. In the GSTARIMA model (1,1,0) with both PCA and LOCF imputation the parameters that had an effect on $\alpha = 5\%$ were $\emptyset_{1(0)}^{7}$ and $\emptyset_{1(0)}^{9}$. Meanwhile, in both PCA and MA imputation, the parameters that affect on $\alpha = 5\%$ were $\emptyset_{1(0)}^{1}$, $\emptyset_{1(0)}^{2}$, $\emptyset_{1(0)}^{3}$, $\emptyset_{1(0)}^{4}$, $\emptyset_{1(0)}^{5}$, $\emptyset_{1(0)}^{6}$, $\emptyset_{1(0)}^{7}$, $\emptyset_{1(0)}^{8}$, and $\emptyset_{1(0)}^{10}$.

Table 4.15. *Parameter estimation of GSTARIMA (1,1,0) with PCA from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	-0.03644	0.164	$\emptyset_{1(0)}^{4}$	-0.02326	0.375	$\emptyset_{1(0)}^{7}$	-0.0836	0.0013	$\emptyset_{1(0)}^{9}$	0.06735	0.0101
$\emptyset_{1(0)}^{2}$	-0.02715	0.3	$\emptyset_{1(0)}^{5}$	-0.04734	0.0706	$\emptyset_{1(0)}^{8}$	-0.04109	0.11	$\emptyset_{1(0)}^{10}$	-0.0151	0.564
$\emptyset_{1(0)}^{3}$	-0.03074	0.24	$\emptyset_{1(0)}^{6}$	-0.01477	0.573						

Table 4.16. *Parameter estimation of GSTARIMA (1,1,0) with PCA from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	-0.17466	1.76E-11	$\emptyset_{1(0)}^{4}$	-0.20067	9.78E-15	$\emptyset_{1(0)}^{7}$	-0.22311	<2e-16	$\emptyset_{1(0)}^{9}$	-0.02617	0.317
$\emptyset_{1(0)}^{2}$	-0.17325	2.50E-11	$\emptyset_{1(0)}^{5}$	-0.20579	1.95E-15	$\emptyset_{1(0)}^{8}$	-0.18872	3.35E-13	$\emptyset_{1(0)}^{10}$	-0.15245	4.68E-09
$\emptyset_{1(0)}^{3}$	-0.19268	1.05E-13	$\emptyset_{1(0)}^{6}$	-0.1522	4.97E-09						

GSTARIMAX (1,0,0) model with PCA

Also this study combined GSTARIMAX (1,0,0) and PCA. Mathematically this combination shown in equation (4.13).

$$\mathbf{Y}_i(t)=\mathbf{\Phi}^{(i)}_{1(0)}\mathbf{A}^{1(0)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\beta}^{(i)}_1\mathbf{X}^{(i)}_1+\boldsymbol{\beta}^{(i)}_2\mathbf{X}^{(i)}_2+\boldsymbol{\beta}^{(i)}_3\mathbf{X}^{(i)}_3+\boldsymbol{\beta}^{(i)}_4\mathbf{X}^{(i)}_4+\boldsymbol{\beta}^{(i)}_5\mathbf{X}^{(i)}_5+\mathbf{\Phi}^{(i)}_{1(l)}$$

$$\mathbf{W}^{(l)}\mathbf{A}^{1(1)}_{m}\mathbf{Y}_i(t\text{-}1)+\mathbf{\Phi}^{(i)}_{1(2)}\mathbf{W}^{(2)}\mathbf{A}^{1(2)}_{m}\mathbf{Y}_i(t\text{-}1)+\mathbf{\Phi}^{(i)}_{1(3)}\mathbf{W}^{(3)}\mathbf{A}^{1(3)}_{m}\mathbf{Y}_i(t\text{-}1)+\mathbf{\Phi}^{(i)}_{1(4)}\mathbf{W}^{1(4)}$$

$$\mathbf{A}^{(4)}_{m}\mathbf{Y}_i(t\text{-}1)+\mathbf{\Phi}^{(i)}_{1(5)}\mathbf{W}^{1(5)}\mathbf{A}^{(5)}_{m}\mathbf{Y}_i(t\text{-}1)+\mathbf{\Phi}^{(i)}_{1(6)}\mathbf{W}^{1(6)}\mathbf{A}^{(6)}_{m}\mathbf{Y}_i(t\text{-}1)+\mathbf{\Phi}^{(i)}_{1(7)}\mathbf{W}^{1(7)}$$

$$\mathbf{A}^{(7)}_{m}\mathbf{Y}_i(t\text{-}1)+\mathbf{\Phi}^{(i)}_{1(8)}\mathbf{W}^{1(8)}\mathbf{A}^{(8)}_{m}\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\varepsilon}_i(t) \quad (4.13)$$

where $\mathbf{\Phi}^{(i)}_{10}$ is the i-th state 1 lag parameter, $\mathbf{\Phi}^{(i)}_{1l}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\mathbf{Y}_i(t)$ is the gold price variable at time in i-th country, $\mathbf{Y}_i(t\text{-}1)$ is lag 1 gold price variable at time in i-th country, $\mathbf{A}^{(l)}_{m}$ is the principal component coefficient for the l-th spatial order the parameter, $\beta^{(i)}_j X^{(i)}_j$ is dummy variable from Google Trends data for i-th country, and $\boldsymbol{\varepsilon}_i(t)$ is the error term. Suppose Türkiye, then equation (4.13) which can be formed into equation (4.14). In addition, the main component coefficients shown in Table A.16.1 and Table A.17.1.

$$\textbf{Türkiye}_i(t)=\emptyset_{1(0)}\textbf{Türkiye}_i(t\text{-}1)+\beta_1\textbf{Google Shopping}+\beta_2\textbf{Image Search}+\beta_3\ \textbf{News Search}+\beta_4\textbf{Web Search}+\beta_5\textbf{YouTube Search}+\emptyset_{1(4)}+\boldsymbol{\varepsilon}_i(t) \quad (4.14)$$

The results of parameter estimation on the GSTARIMAX model (1,0,0) with PCA which used LOCF and MA imputation shown in Table 4.17 and Table 4.18. More complete parameter estimation results shown in Table A.24.1 and Table A.25.1. In the GSTARIMAX model (1,0,0) with both PCA and LOCF imputation the parameters that had an effect on $\alpha = 5\%$ were $\emptyset^1_{1(0)}$, $\emptyset^2_{1(0)}$, $\emptyset^3_{1(0)}$, $\beta^{(3)}_4$, $\emptyset^4_{1(0)}$, $\emptyset^5_{1(0)}$, $\emptyset^6_{1(0)}$, $\beta^{(6)}_4$, $\emptyset^7_{1(0)}$, $\emptyset^8_{1(0)}$, $\emptyset^9_{1(0)}$, and $\emptyset^{10}_{1(0)}$. Meanwhile, in both PCA and MA imputation, the parameters that affect on $\alpha = 5\%$ were $\emptyset^1_{1(0)}$, $\emptyset^2_{1(0)}$, $\emptyset^3_{1(0)}$, $\beta^{(3)}_4$, $\emptyset^4_{1(0)}$, $\emptyset^5_{1(0)}$, $\emptyset^6_{1(0)}$, $\emptyset^7_{1(0)}$, $\emptyset^8_{1(0)}$, $\emptyset^9_{1(0)}$, and $\emptyset^{10}_{1(0)}$.

Table 4.17. *Parameter estimation of GSTARIMAX (1,0,0) with PCA from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	1.000157	<2e-16	$\beta_3^{(4)}$	-8.34E+01	0.4	$\beta_3^{(6)}$	-1.78E+00	0.619	$\emptyset_{1(0)}^{9}$	1.00E+00	<2e-16
$\beta_4^{(1)}$	7.861952	0.0836	$\beta_4^{(4)}$	4.61E+02	0.19	$\beta_4^{(6)}$	2.42E+01	0.043	$\beta_1^{(9)}$	-5.84E+00	0.38
$\emptyset_{1(0)}^{2}$	1.000219	<2e-16	$\beta_5^{(4)}$	6.75E+01	0.603	$\beta_5^{(6)}$	-6.40E-02	0.971	$\beta_2^{(9)}$	-5.79E+00	0.144
$\emptyset_{1(0)}^{3}$	9.95E-01	<2e-16	$\emptyset_{1(0)}^{5}$	9.95E-01	<2e-16	$\emptyset_{1(0)}^{7}$	1.00E+00	<2e-16	$\beta_3^{(9)}$	6.36E+00	0.603
$\beta_1^{(3)}$	-4.46E+03	0.597	$\beta_1^{(5)}$	1.24E+00	0.9972	$\beta_4^{(7)}$	-4.20E+02	0.556	$\beta_4^{(9)}$	5.07E+00	0.421
$\beta_2^{(3)}$	-1.14E+04	0.3032	$\beta_2^{(5)}$	-8.00E+01	0.3503	$\beta_5^{(7)}$	-2.69E+02	0.858	$\beta_5^{(9)}$	-3.31E-02	0.997
$\beta_3^{(3)}$	7.52E+03	0.2177	$\beta_3^{(5)}$	-7.05E+01	0.7852	$\emptyset_{1(0)}^{8}$	9.98E-01	<2e-16	$\emptyset_{1(0)}^{10}$	9.95E-01	<2e-16
$\beta_4^{(3)}$	9.26E+04	0.0472	$\beta_4^{(5)}$	3.93E+02	0.0784	$\beta_1^{(8)}$	-7.17E+00	0.319	$\beta_1^{(10)}$	7.20E-01	0.3027
$\beta_5^{(3)}$	1.16E+04	0.1082	$\beta_5^{(5)}$	1.93E+01	0.7955	$\beta_2^{(8)}$	1.75E-01	0.9	$\beta_2^{(10)}$	-9.60E-01	0.3642
$\emptyset_{1(0)}^{4}$	9.97E-01	<2e-16	$\emptyset_{1(0)}^{6}$	9.95E-01	<2e-16	$\beta_3^{(8)}$	1.88E-02	0.987	$\beta_3^{(10)}$	2.72E-01	0.5444
$\beta_1^{(4)}$	9.22E+01	0.643	$\beta_1^{(6)}$	8.99E+00	0.618	$\beta_4^{(8)}$	2.88E+00	0.162	$\beta_4^{(10)}$	6.33E+00	0.0665
$\beta_2^{(4)}$	-3.37E+01	0.705	$\beta_2^{(6)}$	-7.86E-01	0.687	$\beta_5^{(8)}$	1.60E+00	0.376	$\beta_5^{(10)}$	1.47E-01	0.7488

Table 4.18. *Parameter estimation of GSTARIMAX (1,0,0) with PCA from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset_{1(0)}^{1}$	1.00E+00	<2e-16	$\beta_1^{(4)}$	1.64E+02	0.397	$\beta_2^{(6)}$	-1.59E+00	0.4061	$\emptyset_{1(0)}^{9}$	1.00E+00	<2e-16
$\beta_4^{(1)}$	5.22E+00	0.239	$\beta_2^{(4)}$	-2.40E+01	0.781	$\beta_3^{(6)}$	1.44E+00	0.6818	$\beta_1^{(9)}$	2.86E+00	0.6586
$\emptyset_{1(0)}^{2}$	1.00E+00	<2e-16	$\beta_3^{(4)}$	-1.26E+02	0.191	$\beta_4^{(6)}$	2.26E+01	0.0548	$\beta_2^{(9)}$	-7.47E+00	0.0531
$\beta_2^{(2)}$	4.49E-01	0.924	$\beta_4^{(4)}$	4.72E+02	0.168	$\beta_5^{(6)}$	7.05E-01	0.6871	$\beta_3^{(9)}$	1.15E+01	0.336
$\beta_3^{(2)}$	2.52E+00	0.704	$\beta_5^{(4)}$	1.37E+02	0.28	$\emptyset_{1(0)}^{7}$	1.00E+00	<2e-16	$\beta_4^{(9)}$	6.56E+00	0.2849
$\beta_4^{(2)}$	9.03E-02	0.867	$\emptyset_{1(0)}^{5}$	9.96E-01	<2e-16	$\beta_4^{(7)}$	-1.36E+02	0.845	$\beta_5^{(9)}$	3.24E+00	0.7229
$\emptyset_{1(0)}^{3}$	9.95E-01	<2e-16	$\beta_1^{(5)}$	1.20E+02	0.7233	$\beta_5^{(7)}$	-6.00E+02	0.682	$\emptyset_{1(0)}^{10}$	9.96E-01	<2e-16
$\beta_1^{(3)}$	9.90E+02	0.9043	$\beta_2^{(5)}$	-4.41E+01	0.5991	$\emptyset_{1(0)}^{8}$	9.98E-01	<2e-16	$\beta_1^{(10)}$	1.75E-01	0.799
$\beta_2^{(3)}$	-8.55E+03	0.4286	$\beta_3^{(5)}$	-9.38E+01	0.7113	$\beta_1^{(8)}$	-7.18E+00	0.309	$\beta_2^{(10)}$	-7.45E-01	0.4733
$\beta_3^{(3)}$	3.57E+03	0.5487	$\beta_4^{(5)}$	3.69E+02	0.0917	$\beta_2^{(8)}$	-5.47E-01	0.69	$\beta_3^{(10)}$	3.86E-01	0.3797
$\beta_4^{(3)}$	8.95E+04	0.0499	$\beta_5^{(5)}$	-1.54E+01	0.8329	$\beta_3^{(8)}$	-2.90E-01	0.793	$\beta_4^{(10)}$	6.18E+00	0.0684
$\beta_5^{(3)}$	8.01E+03	0.2552	$\emptyset_{1(0)}^{6}$	9.96E-01	<2e-16	$\beta_4^{(8)}$	3.17E+00	0.118	$\beta_5^{(10)}$	-1.93E-01	0.6679
$\emptyset_{1(0)}^{4}$	9.97E-01	<2e-16	$\beta_1^{(6)}$	8.07E+00	0.6488	$\beta_5^{(8)}$	-1.19E-01	0.947			

GSTARIMAX (1,1,0) model with PCA

The last model was GSTARIMAX (1,0,0) which has been combined with PCA. This model shown in equation (4.15).

$$\begin{aligned}\nabla\mathbf{Y}_i(t)=&\boldsymbol{\Phi}_{1(0)}^{(i)}\mathbf{A}_m^{1(0)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\beta}_1^{(i)}\mathbf{X}_1^{(i)}+\boldsymbol{\beta}_2^{(i)}\mathbf{X}_2^{(i)}+\boldsymbol{\beta}_3^{(i)}\mathbf{X}_3^{(i)}+\boldsymbol{\beta}_4^{(i)}\mathbf{X}_4^{(i)}+\boldsymbol{\beta}_5^{(i)}\mathbf{X}_5^{(i)}+\boldsymbol{\Phi}_{1(l)}^{(i)}\\&\mathbf{W}^{(l)}\mathbf{A}_m^{1(1)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(2)}^{(i)}\mathbf{W}^{(2)}\mathbf{A}_m^{1(2)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(3)}^{(i)}\mathbf{W}^{(3)}\mathbf{A}_m^{1(3)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(4)}^{(i)}\\&\mathbf{W}^{1(4)}\mathbf{A}_m^{(i)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(5)}^{(i)}\mathbf{W}^{1(5)}\mathbf{A}_m^{(5)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(6)}^{(i)}\mathbf{W}^{1(6)}\mathbf{A}_m^{(6)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(7)}^{(i)}\\&\mathbf{W}^{1(7)}\mathbf{A}_m^{(7)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\Phi}_{1(8)}^{(i)}\mathbf{W}^{1(8)}\mathbf{A}_m^{(8)}\nabla\mathbf{Y}_i(t\text{-}1)+\boldsymbol{\varepsilon}_i(t)\end{aligned}\tag{4.15}$$

where $\boldsymbol{\Phi}_{10}^{(i)}$ is the i-th state 1 lag parameter, $\boldsymbol{\Phi}_{1l}^{(i)}$ is the lag 1 weighting neighbors of the l-th spatial order the i-th country parameter, $\mathbf{W}^{(l)}$ is a spatial weighting matrix for the l-th spatial order, $\nabla\mathbf{Y}_i(t)$ is differencing of the gold price variable at time in i-th country, $\nabla\mathbf{Y}_i(t\text{-}1)$ is lag 1 differencing of gold price variable at time in i-th country, $\mathbf{A}_m^{(l)}$ is the principal component coefficient for the l-th spatial order the parameter, $\beta_j^{(i)}X_j^{(i)}$ is dummy variable from Google Trends data for i-th country, and $\boldsymbol{\varepsilon}_i(t)$ is the error term. Suppose Türkiye, then equation (4.15) which can be formed into equation (4.16). In addition, the main component coefficients shown in Table A.18.1 and Table A.19.1.

$$\begin{aligned}\textbf{Türkiye}_i(t)=&\emptyset_{1(0)}\textbf{Türkiye}_i(t\text{-}1)+\beta_1\textbf{Google Shopping}+\beta_2\textbf{Image Search}+\beta_3\\&\textbf{News Search}+\beta_4\textbf{Web Search}+\beta_5\textbf{YouTube Search}+\emptyset_{1(4)}\\&+\boldsymbol{\varepsilon}_i(t)\end{aligned}\tag{4.16}$$

The results of parameter estimation on the GSTARIMAX model (1,1,0) with PCA which used LOCF and MA imputation shown in Table 4.19 and Table 4.20. More complete parameter estimation results shown in Table A.26.1 and Table A.27.1. In the GSTARIMAX model (1,1,0) with both PCA and LOCF imputation the parameters that had an effect on $\alpha = 5\%$ were $\beta_4^{(1)}$, $\emptyset_{1(0)}^7$, $\emptyset_{1(0)}^9$, and $\beta_4^{(9)}$. Meanwhile, in both PCA and MA imputation, the parameters that affect on $\alpha = 5\%$ were $\emptyset_{1(0)}^1$, $\emptyset_{1(0)}^2$, $\emptyset_{1(0)}^3$, $\emptyset_{1(0)}^4$, $\emptyset_{1(0)}^5$, $\emptyset_{1(0)}^6$, $\emptyset_{1(0)}^7$, $\emptyset_{1(0)}^8$, $\beta_4^{(9)}$, and $\emptyset_{1(0)}^{10}$.

Table 4.19. *Parameter estimation of GSTARIMAX (1,1,0) with PCA from LOCF*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	-0.03752	0.1515	$\beta^{(4)}_{1}$	8.02E+01	0.687	$\beta^{(6)}_{2}$	-6.51E-01	0.739	$\beta^{(8)}_{5}$	1.67E+00	0.3548
$\beta^{(1)}_{4}$	9.38714	0.0272	$\beta^{(4)}_{2}$	-3.21E+01	0.718	$\beta^{(6)}_{3}$	-1.34E+00	0.709	$\beta^{(9)}_{1}$	-4.92E+00	0.4436
$\emptyset^{2}_{1(0)}$	-0.02754	0.294	$\beta^{(4)}_{3}$	-7.71E+01	0.437	$\beta^{(6)}_{4}$	1.41E+00	0.207	$\beta^{(9)}_{2}$	-5.66E+00	0.1519
$\beta^{(2)}_{2}$	2.83148	0.556	$\beta^{(4)}_{4}$	2.89E+01	0.16	$\beta^{(6)}_{5}$	-6.13E-02	0.973	$\beta^{(9)}_{3}$	5.78E+00	0.6354
$\beta^{(2)}_{3}$	-0.01625	0.998	$\beta^{(4)}_{5}$	4.82E+01	0.707	$\emptyset^{7}_{1(0)}$	-8.37E-02	0.00139	$\beta^{(9)}_{4}$	5.71E+00	0.0084
$\beta^{(2)}_{4}$	0.13435	0.796	$\emptyset^{5}_{1(0)}$	-4.80E-02	0.0678	$\beta^{(7)}_{4}$	1.99E+01	0.97521	$\beta^{(9)}_{5}$	-2.31E+00	0.8057
$\emptyset^{3}_{1(0)}$	-3.24E-02	0.216	$\beta^{(5)}_{1}$	-6.95E-01	0.9984	$\beta^{(7)}_{5}$	1.93E+02	0.89656	$\emptyset^{10}_{1(0)}$	-1.78E-02	0.499
$\beta^{(3)}_{1}$	-8.89E+03	0.274	$\beta^{(5)}_{2}$	-8.14E+01	0.3422	$\emptyset^{8}_{1(0)}$	-4.50E-02	0.0864	$\beta^{(10)}_{1}$	6.84E-01	0.329
$\beta^{(3)}_{2}$	-6.84E+03	0.529	$\beta^{(5)}_{3}$	-4.23E+01	0.8704	$\beta^{(8)}_{1}$	-7.94E+00	0.2691	$\beta^{(10)}_{2}$	-8.69E-01	0.411
$\beta^{(3)}_{3}$	7.56E+03	0.216	$\beta^{(5)}_{4}$	1.61E+01	0.4616	$\beta^{(8)}_{2}$	1.62E-01	0.9078	$\beta^{(10)}_{3}$	3.40E-01	0.448
$\beta^{(3)}_{4}$	5.21E+03	0.656	$\beta^{(5)}_{5}$	1.17E+01	0.8752	$\emptyset^{9}_{1(0)}$	6.29E-02	0.9701	$\beta^{(10)}_{4}$	2.77E-01	0.829
$\beta^{(3)}_{5}$	5.87E+03	0.373	$\emptyset^{6}_{1(0)}$	-1.63E-02	0.535	$\beta^{(8)}_{3}$	4.21E-02	0.1552	$\beta^{(10)}_{5}$	9.64E-02	0.834
$\emptyset^{4}_{1(0)}$	-2.51E-02	0.34	$\beta^{(6)}_{1}$	5.86E+00	0.745	$\beta^{(8)}_{4}$	2.75E-01	0.3548			

Table 4.20. *Parameter estimation of GSTARIMAX (1,1,0) with PCA from MA*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	-1.76E-01	1.24E-11	$\beta^{(4)}_{1}$	1.53E+02	0.42	$\beta^{(6)}_{2}$	-1.43E+00	0.451	$\emptyset^{9}_{1(0)}$	-3.28E-02	0.21291
$\beta^{(1)}_{4}$	7.69E+00	0.0592	$\beta^{(4)}_{2}$	-2.03E+01	0.811	$\beta^{(6)}_{3}$	8.87E-01	0.799	$\beta^{(9)}_{1}$	2.23E+00	0.7215
$\emptyset^{2}_{1(0)}$	-1.73E-01	2.50E-11	$\beta^{(4)}_{3}$	-1.36E+02	0.149	$\beta^{(6)}_{4}$	1.41E+00	0.194	$\beta^{(9)}_{2}$	-7.53E+00	0.05107
$\beta^{(2)}_{2}$	1.55E+00	0.738	$\beta^{(4)}_{4}$	3.17E+01	0.105	$\beta^{(6)}_{5}$	5.70E-01	0.742	$\beta^{(9)}_{3}$	1.18E+01	0.32211
$\beta^{(2)}_{3}$	2.65E+00	0.686	$\beta^{(4)}_{5}$	1.46E+02	0.233	$\emptyset^{7}_{1(0)}$	-2.24E-01	<2e-16	$\beta^{(9)}_{4}$	5.61E+00	0.00809
$\beta^{(2)}_{4}$	3.07E-01	0.54	$\emptyset^{5}_{1(0)}$	-2.06E-01	1.99E-15	$\beta^{(7)}_{4}$	3.44E+02	0.572	$\beta^{(9)}_{5}$	4.34E+00	0.63518
$\emptyset^{3}_{1(0)}$	-1.95E-01	6.27E-14	$\beta^{(5)}_{1}$	7.60E+01	0.819	$\beta^{(7)}_{5}$	2.01E+02	0.887	$\emptyset^{10}_{1(0)}$	-1.55E-01	2.84E-09
$\beta^{(3)}_{1}$	-3.75E+03	0.63	$\beta^{(5)}_{2}$	-5.40E+01	0.511	$\emptyset^{8}_{1(0)}$	-1.91E-01	1.96E-13	$\beta^{(10)}_{1}$	2.06E-01	0.761
$\beta^{(3)}_{2}$	-3.03E+03	0.77	$\beta^{(5)}_{3}$	-1.46E+01	0.953	$\beta^{(8)}_{1}$	-7.70E+00	0.2657	$\beta^{(10)}_{2}$	-7.48E-01	0.466
$\beta^{(3)}_{3}$	3.77E+03	0.519	$\beta^{(5)}_{4}$	1.80E+01	0.393	$\beta^{(8)}_{2}$	-3.60E-01	0.7891	$\beta^{(10)}_{3}$	5.35E-01	0.218
$\beta^{(3)}_{4}$	4.65E+03	0.678	$\beta^{(5)}_{5}$	-2.15E+01	0.764	$\beta^{(8)}_{3}$	-3.44E-01	0.7513	$\beta^{(10)}_{4}$	6.32E-01	0.611
$\beta^{(3)}_{5}$	3.49E+03	0.579	$\emptyset^{6}_{1(0)}$	-1.53E-01	4.17E-09	$\beta^{(8)}_{4}$	3.43E-01	0.0665	$\beta^{(10)}_{5}$	-1.01E-01	0.821
$\emptyset^{4}_{1(0)}$	-2.04E-01	3.73E-15	$\beta^{(6)}_{1}$	5.22E+00	0.765	$\beta^{(8)}_{5}$	6.96E-01	0.6901			

5. BEST MODEL AND FORECASTING

The mean absolute percentage error (MAPE) has been used to select the best model for modeling and forecasting gold prices in each country. The MAPE value has been chosen because in general it is easy to represent it because it has a positive value and is on a scale of 0 to 100. If it is associated with the data that has been used in this study, then MAPE was chosen because there is a very large difference between each country's currency. One of the advantages of this method is that it can compare the relative accuracy of the model. For example, the United States currency uses the US Dollar (USD) and the Indonesian currency uses the Indonesian Rupiah (IDR). If you use the classic error, automatically modeling and testing gold prices in Indonesia will produce a larger error than the United States, even though it is indicated that the relative difference in gold prices in Indonesia is smaller than the United States.

5.1. Best Model

MAPE values for all models are shown in Table 5.1-5.3. In testing data for 1 month and 2 years, the GSTARIMA model (1,0,0) with PCA is the recommended model because it has produced the smallest MAPE among other models. The difference between the two tests is for 1 month testing using LOCF imputation while for 2 years testing using MA imputation. Furthermore, the GSTARIMA model (1,0,0) with MA imputation becomes the recommended model for testing gold price forecasts in 1 year. Also based on MAPE, the more data used for testing, the lower the level of model accuracy. MAPE results on testing 1 month between 2.30-2.95%, on testing 1 year between 10.29-17.07%, and on testing 1 year between 10.29-17.94%.

In testing the gold price forecast in 1 month (January 1-31, 2020) when viewed from each country, the GSTARIMA model (1,0,0) with LOCF imputation has been recommended for forecasting gold prices in France, Indonesia, South Korea, Switzerland, and the United States. Although the model is used by the majority of countries in this study, overall the GSTARIMA model (1,0,0) with PCA and LOCF imputation is more recommended. For Russia and Saudi Arabia, the GSTARIMAX model (1,0,0) with LOCF imputation has been recommended. GSTARIMA (1,0,0) with PCA and LOCF imputation has been recommended for forecasting gold prices in China and Japan. Meanwhile, Türkiye is recommended to use GSTARIMAX (1,0,0) with PCA and LOCF imputation. In addition to these models for 1 month forecasting, it is still not recommended even though the resulting accuracy is not much different.

Table 5.1. *MAPE on 1 month testing*

Testing	GSTARIMA (1,0,0)		GSTARIMA (1,1,0)		GSTARIMAX (1,0,0)		GSTARIMAX (1,1,0)	
	Non-PCA		Non-PCA		Non-PCA		Non-PCA	
	LOCF	MA	LOCF	MA	LOCF	MA	LOCF	MA
China	2.0669	2.0936	2.1798	2.2007	2.3247	2.2554	2.1496	2.2350
France	3.2636	3.2865	3.6931	3.8336	3.3869	3.4150	3.7172	3.8573
Indonesia	0.9207	0.9249	1.6367	1.6778	2.5418	2.1821	1.9545	1.5964
Japan	2.8103	2.8539	3.2978	3.3392	3.4551	3.5190	3.1108	3.0985
Russia	2.5053	2.6223	2.3547	2.4927	3.4951	3.5041	2.0712	2.2721
Saudi Arabia	2.9026	2.9224	2.6716	2.8307	3.1481	3.1974	2.2647	2.4433
South Korea	3.0331	3.0375	3.4496	3.5664	3.2539	3.1085	3.4870	3.3456
Switzerland	2.3802	2.4038	2.8835	2.9194	2.7203	2.6563	2.6404	2.6285
Türkiye	2.1429	2.1441	2.2452	2.3839	1.6110	1.9878	1.5489	1.4703
United States	2.2354	2.2751	2.7497	2.8200	3.6489	3.2475	2.9779	2.5465
All	2.4261	2.4564	2.7162	2.8064	2.9586	2.9073	2.5922	2.5493
Testing	**GSTARIMA (1,0,0)**		**GSTARIMA (1,1,0)**		**GSTARIMAX (1,0,0)**		**GSTARIMAX (1,1,0)**	
	PCA		**PCA**		**PCA**		**PCA**	
	LOCF	**MA**	**LOCF**	**MA**	**LOCF**	**MA**	**LOCF**	**MA**
China	1.4451	1.4752	2.1558	2.2035	1.6173	1.5895	2.1558	2.2036
France	3.3395	3.3712	3.8293	3.8675	3.3255	3.3884	3.8292	3.8675
Indonesia	1.0078	1.0450	1.6290	1.6841	2.4380	2.0638	1.9669	1.5980
Japan	2.7742	2.8242	3.2868	3.3420	3.4200	3.4986	3.0237	3.0943
Russia	2.4380	2.5528	2.4049	2.5126	3.2554	3.3099	2.1513	2.2657
Saudi Arabia	2.4369	2.4771	2.7777	2.8246	3.4249	3.4634	2.3992	2.4890
South Korea	3.2147	3.2520	3.5245	3.5673	3.4854	3.3201	3.5084	3.3196
Switzerland	2.5331	2.5582	2.9003	2.9244	2.9855	3.0040	2.6212	2.6190
Türkiye	1.4756	1.5215	2.3579	2.4035	1.3800	1.7154	1.3325	1.4750
United States	2.4294	2.4703	2.7709	2.8190	3.9849	3.5216	2.9286	2.5351
All	2.3094	2.3548	2.7637	2.8148	2.9317	2.8875	2.5917	2.5467

In 1 year testing (January 1, 2020 – December 31, 2020) when viewed from each country, the GSTARIMA model (1,0,0) with MA imputation is the recommended model for forecasting gold prices in China, France, Indonesia, Japan, Russia, Saudi Arabia, South Korea, Switzerland, and the United States. In addition to being a model used for forecasting gold prices in the majority of countries, this model is also a recommended model for forecasting gold prices as a whole. Meanwhile, for forecasting gold prices in Türkiye the GSTARIMAX model (1,0,0) with PCA and LOCF imputation has been recommended. Relatively, the MAPE generated for forecasting gold prices in Türkiye and Russia is quite large when compared to other countries.

Table 5.2. *MAPE on 1 year testing*

Testing	GSTARIMA (1,0,0)		GSTARIMA (1,1,0)		GSTARIMAX (1,0,0)		GSTARIMAX (1,1,0)	
	Non-PCA		Non-PCA		Non-PCA		Non-PCA	
	LOCF	MA	LOCF	MA	LOCF	MA	LOCF	MA
China	8.2351	7.9621	13.1280	13.1324	9.3164	8.7427	12.8012	13.5023
France	7.1315	6.9180	12.5000	12.5989	12.5883	12.5473	12.7746	12.8634
Indonesia	11.3576	10.6417	17.5857	17.6110	17.8822	16.6519	20.5380	16.8845
Japan	5.4597	5.3945	12.4297	12.4435	7.7422	8.8359	10.6192	10.0562
Russia	19.8522	19.5544	25.3318	25.3690	28.7345	28.9806	22.9608	23.5873
Saudi Arabia	9.2178	8.8228	13.8345	13.9457	14.3325	14.0967	9.9527	10.2454
South Korea	7.8773	7.7105	15.4771	15.5599	7.7679	9.3395	15.8902	13.3991
Switzerland	5.3947	5.2824	11.2416	11.2611	11.2696	10.3456	8.8162	8.3488
Türkiye	25.3253	24.0771	25.7372	25.8374	20.5194	23.3293	20.5579	18.5581
United States	6.9243	6.5709	13.8882	13.9186	12.4760	12.2289	16.1121	11.2902
All	10.6775	10.2934	16.1154	16.1678	14.2629	14.5099	15.1023	13.8735
Testing	**GSTARIMA (1,0,0)**		**GSTARIMA (1,1,0)**		**GSTARIMAX (1,0,0)**		**GSTARIMAX (1,1,0)**	
	PCA		**PCA**		**PCA**		**PCA**	
	LOCF	**MA**	**LOCF**	**MA**	**LOCF**	**MA**	**LOCF**	**MA**
China	8.6263	8.6133	13.1059	13.1346	10.3933	9.7904	13.1060	13.1347
France	9.0847	9.0691	12.6284	12.6307	8.9340	9.2545	12.6284	12.6307
Indonesia	13.9685	13.9765	17.5788	17.6162	23.6660	21.3520	20.6812	16.8293
Japan	9.5126	9.5402	12.4188	12.4461	15.0297	15.2272	9.7897	9.9961
Russia	24.2137	24.2120	25.3716	25.3849	29.0359	28.8034	23.2881	23.3657
Saudi Arabia	10.5889	10.5768	13.9291	13.9402	17.9626	18.0567	10.2865	10.7269
South Korea	12.2735	12.2610	15.5465	15.5609	15.0070	12.9402	15.3883	13.1378
Switzerland	7.9880	7.9983	11.2580	11.2659	12.3836	12.3095	8.4408	8.1981
Türkiye	17.2270	17.2193	25.8247	25.8530	16.8267	19.4937	17.4883	18.4280
United States	10.5633	10.5510	13.9067	13.9176	21.5360	18.5294	15.4164	11.1986
All	12.4047	12.4018	16.1569	16.1750	17.0775	16.5757	14.6514	13.7646

In testing the gold price forecast in 2 years (January 1, 2020 – December 31, 2021) when viewed from each country, the GSTARIMA model (1,0,0) with LOCF imputation is recommended for forecasting gold prices in Indonesia. Meanwhile, GSTARIMA which is the same as MA imputation is recommended for forecasting gold prices in Russia. Furthermore, the GSTARIMAX model (1,0,0) with LOCF imputation is recommended for forecasting gold prices in China and Japan. For forecasting gold prices in Saudi Arabia, the GSTARIMAX model (1,0,0) is recommended. Forecasting gold prices in South Korea, Switzerland, Türkiye, and the United States is recommended using the GSTARIMA model (1,0,0) with PCA and MA imputation. Lastly, the GSTARIMAX model (1,0,0) has been recommended for gold price forecasting in France. In addition to being the most widely used model in the country category, the GSTARIMA model (1,0,0) with PCA is also the overall recommended model for forecasting gold prices.

Table 5.3. *MAPE on 2 years testing*

Testing	GSTARIMA (1,0,0)		GSTARIMA (1,1,0)		GSTARIMAX (1,0,0)		GSTARIMAX (1,1,0)	
	Non-PCA		Non-PCA		Non-PCA		Non-PCA	
	LOCF	MA	LOCF	MA	LOCF	MA	LOCF	MA
China	12.2943	14.6803	11.0839	11.0786	6.4388	7.3949	10.3838	11.8686
France	6.4189	7.2396	11.7848	11.8879	17.7297	17.7160	12.3505	12.4321
Indonesia	8.7458	10.3026	17.8776	17.8902	16.7549	16.6523	23.9284	16.4043
Japan	10.6883	12.8858	14.4947	14.4971	7.9417	11.1774	10.9206	9.7503
Russia	14.8169	13.9623	27.1243	27.1554	33.2804	33.4850	22.2976	23.5358
Saudi Arabia	9.0549	10.3809	14.7278	14.8378	14.7496	15.7614	6.8805	7.2718
South Korea	9.8411	11.2001	15.1066	15.1864	8.6500	12.0376	15.9547	10.7773
Switzerland	8.8834	10.3574	10.9736	10.9899	12.3712	11.9700	5.9901	5.1948
Türkiye	32.8125	29.7040	33.7882	33.8740	26.9074	30.4791	24.7119	21.0723
United States	8.3867	9.4533	14.7986	14.8272	12.9442	13.9546	19.3625	9.4397
All	12.1943	13.0166	17.1760	17.2224	15.7768	17.0628	15.2781	12.7747
Testing	GSTARIMA (1,0,0)		GSTARIMA (1,1,0)		GSTARIMAX (1,0,0)		GSTARIMAX (1,1,0)	
	PCA		PCA		PCA		PCA	
	LOCF	MA	LOCF	MA	LOCF	MA	LOCF	MA
China	7.4571	7.4826	11.0610	11.0808	6.5143	6.6095	11.0610	11.0809
France	5.5008	5.4946	11.9150	11.9201	5.4692	5.6024	11.9150	11.9201
Indonesia	10.5337	10.5108	17.8706	17.8955	26.3859	23.2172	24.2257	16.2840
Japan	8.8353	8.8326	14.4840	14.4997	18.5020	18.7550	9.2729	9.6284
Russia	24.6201	24.5877	27.1633	27.1709	32.1840	31.9175	22.9258	23.0660
Saudi Arabia	7.7740	7.7493	14.8235	14.8322	20.4396	20.6424	7.3545	8.2426
South Korea	8.3109	8.2674	15.1765	15.1873	14.0205	9.6580	14.8537	10.2433
Switzerland	4.9650	4.9608	10.9902	10.9948	12.8985	12.7405	5.3190	5.0467
Türkiye	17.3831	17.3258	33.8662	33.8879	17.6396	22.8489	19.1970	20.8270
United States	7.7611	7.7360	14.8174	14.8262	25.4321	21.4084	17.9133	9.2531
All	10.3141	10.2948	17.2168	17.2295	17.9486	17.3400	14.4038	12.5592

All parameter estimates $\emptyset^{1}_{1(0)}$, $\emptyset^{2}_{1(0)}$, $\emptyset^{3}_{1(0)}$, $\emptyset^{4}_{1(0)}$, $\emptyset^{5}_{1(0)}$, $\emptyset^{6}_{1(0)}$, $\emptyset^{7}_{1(0)}$, $\emptyset^{8}_{1(0)}$, $\emptyset^{9}_{1(0)}$, dan $\emptyset^{10}_{1(0)}$) of lag 1 gold prices in each country for 1 month, 1 year, and 2 year forecasts have been significant at $\alpha = 5\%$ (see Table 5.4 – 5.6). Even though they have parameter estimates that are both significant, they have different estimated values. In addition, there are several parameters that have a significant neighbor effect on the model for 1 year forecasting including $\emptyset^{1}_{1(3)}$, $\emptyset^{1}_{1(5)}$, $\emptyset^{1}_{1(6)}$, $\emptyset^{1}_{1(7)}$, $\emptyset^{2}_{1(6)}$, $\emptyset^{2}_{1(7)}$, $\emptyset^{3}_{1(8)}$, $\emptyset^{4}_{1(7)}$, $\emptyset^{6}_{1(6)}$, $\emptyset^{7}_{1(0)}$, $\emptyset^{8}_{1(1)}$, $\emptyset^{8}_{1(4)}$, $\emptyset^{8}_{1(6)}$, $\emptyset^{8}_{1(7)}$, and $\emptyset^{10}_{1(7)}$. The complete results of parameter estimation, correlation between parameters, and PCA of the best model are presented in Table A.28.1-A.34.1.

Table 5.4. *Parameter estimation of forecasting in 1 month*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	1.0001	<2e-16	$\emptyset^{4}_{1(0)}$	1.0002	<2e-16	$\emptyset^{7}_{1(0)}$	1.0002	<2e-16	$\emptyset^{9}_{1(0)}$	1.0009	<2e-16
$\emptyset^{2}_{1(0)}$	1.0001	<2e-16	$\emptyset^{5}_{1(0)}$	1.0002	<2e-16	$\emptyset^{8}_{1(0)}$	1.0001	<2e-16	$\emptyset^{10}_{1(0)}$	1.0002	<2e-16
$\emptyset^{3}_{1(0)}$	1.0002	<2e-16	$\emptyset^{6}_{1(0)}$	1.0002	<2e-16						

Table 5.5. *Parameter estimation of forecasting in 1 year*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	9.90E-01	<2e-16	$\emptyset^{3}_{1(6)}$	-2.73E+22	0.6014	$\emptyset^{6}_{1(0)}$	9.68E-01	<2e-16	$\emptyset^{8}_{1(4)}$	-1.94E+10	0.01174
$\emptyset^{1}_{1(3)}$	9.53E+04	0.00371	$\emptyset^{3}_{1(7)}$	2.39E+29	0.5726	$\emptyset^{6}_{1(4)}$	-1.30E+10	0.25527	$\emptyset^{8}_{1(5)}$	-2.37E+14	0.11126
$\emptyset^{1}_{1(4)}$	-3.87E+10	0.21225	$\emptyset^{3}_{1(8)}$	-5.63E+35	0.0118	$\emptyset^{6}_{1(5)}$	2.85E+16	0.31508	$\emptyset^{8}_{1(6)}$	-4.93E+20	0.04524
$\emptyset^{1}_{1(5)}$	1.26E+13	0.00992	$\emptyset^{4}_{1(0)}$	1.01E+00	<2e-16	$\emptyset^{6}_{1(6)}$	1.29E+17	0.00625	$\emptyset^{8}_{1(7)}$	8.50E+21	0.00324
$\emptyset^{1}_{1(6)}$	-9.44E+19	0.03713	$\emptyset^{4}_{1(2)}$	3.17E+02	0.06969	$\emptyset^{6}_{1(7)}$	1.50E+24	0.04367	$\emptyset^{9}_{1(0)}$	9.97E-01	<2e-16
$\emptyset^{1}_{1(7)}$	-1.98E+27	0.00048	$\emptyset^{4}_{1(3)}$	9.21E+07	0.78343	$\emptyset^{7}_{1(0)}$	1.00E+00	<2e-16	$\emptyset^{9}_{1(4)}$	6.68E+10	0.991
$\emptyset^{2}_{1(0)}$	1.01E+00	<2e-16	$\emptyset^{4}_{1(5)}$	1.27E+14	0.21048	$\emptyset^{7}_{1(2)}$	1.50E+04	0.518	$\emptyset^{9}_{1(5)}$	1.19E+15	0.546
$\emptyset^{2}_{1(1)}$	-2.62E+00	0.26547	$\emptyset^{4}_{1(6)}$	-2.92E+21	0.2136	$\emptyset^{7}_{1(3)}$	-1.33E+08	0.922	$\emptyset^{9}_{1(6)}$	6.54E+17	0.345
$\emptyset^{2}_{1(4)}$	-1.78E+10	0.09655	$\emptyset^{4}_{1(7)}$	-1.87E+27	0.00773	$\emptyset^{7}_{1(5)}$	-5.30E+12	0.996	$\emptyset^{9}_{1(7)}$	-1.19E+27	0.867
$\emptyset^{2}_{1(5)}$	-2.50E+14	0.1579	$\emptyset^{5}_{1(0)}$	9.92E-01	<2e-16	$\emptyset^{7}_{1(6)}$	-9.64E+21	0.654	$\emptyset^{10}_{1(0)}$	9.82E-01	<2e-16
$\emptyset^{2}_{1(6)}$	-6.23E+20	0.01996	$\emptyset^{5}_{1(4)}$	-1.23E+13	0.173	$\emptyset^{7}_{1(7)}$	-8.05E+27	0.774	$\emptyset^{10}_{1(6)}$	-1.22E+19	0.1331
$\emptyset^{2}_{1(7)}$	9.20E+21	0.00624	$\emptyset^{5}_{1(5)}$	4.09E+14	0.248	$\emptyset^{8}_{1(0)}$	9.84E-01	<2e-16	$\emptyset^{10}_{1(7)}$	1.48E+23	0.0112
$\emptyset^{3}_{1(0)}$	1.01E+00	<2e-16	$\emptyset^{5}_{1(6)}$	4.90E+18	0.138	$\emptyset^{8}_{1(1)}$	6.10E+00	0.02815	$\emptyset^{10}_{1(8)}$	1.24E+27	0.1239
$\emptyset^{3}_{1(5)}$	3.08E+17	0.1478									

Table 5.6. *Parameter estimation of forecasting in 2 years*

Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value	Par.	Estimate	p-value
$\emptyset^{1}_{1(0)}$	1.000169	<2e-16	$\emptyset^{4}_{1(0)}$	1.000213	<2e-16	$\emptyset^{7}_{1(0)}$	1.000207	<2e-16	$\emptyset^{9}_{1(0)}$	1.000999	<2e-16
$\emptyset^{2}_{1(0)}$	1.000191	<2e-16	$\emptyset^{5}_{1(0)}$	1.000229	<2e-16	$\emptyset^{8}_{1(0)}$	1.000157	<2e-16	$\emptyset^{10}_{1(0)}$	1.000194	<2e-16
$\emptyset^{3}_{1(0)}$	1.000204	<2e-16	$\emptyset^{6}_{1(0)}$	1.000194	<2e-16						

5.2. Forecasting

Based on the estimated parameters of the GSTARIMA model (1,0,0) with PCA and LOCF imputation in Table 5.4, the results of forecasting gold prices for each country in the next 1 month are shown in Figure 5.1. Forecasting gold prices based on the graph in each country has experienced a relative increase. This pattern is the same as forecasting gold prices for the next 2 years using MA imputation (Figure 5.3). However, this pattern is different from the gold price forecasting pattern using the GSTARIMA model (1,0,0) with an MA imputation for the next 1 year (Figure 5.2). Forecasting gold prices in France, Indonesia, Russia, Saudi Arabia, Switzerland, and Türkiye has increased relatively. Meanwhile, the forecast for gold prices in China, Japan, South Korea, and the United States is relatively declining. Even in Japan, South Korea, and the United States, gold price forecasting was initially relatively increasing and then decreasing.

The complete forecasting results for each country in the 1-year and 2-year forecasts are shown in Table A.35.1 and Table A.36.1. For example Türkiye, the gold price forecasting results with the GSTARIMA model (1,0,0) which use PCA and LOCF imputation for the next 1 month are shown in Table 5.7. Meanwhile, the results of forecasting gold prices for the next 1 year are shown in Table 5.8. Forecasting has used the GSTARIMA model (1,0,0) with MA imputation. Furthermore, the results of gold price forecasting with the GSTARIMA model (1,0,0) which uses PCA and MA imputation for the next 2 years are shown in Table 5.9. This model only differs in terms of imputation and forecasting for 1 month.

Table 5.7. *Forecasting gold prices in Türkiye for the next 1 month*

Date	TRY	Date	TRY	Date	TRY
1-Jan-22	23544.84	12-Jan-22	23801.43	22-Jan-22	24037.12
2-Jan-22	23568.05	13-Jan-22	23824.89	23-Jan-22	24060.82
3-Jan-22	23591.28	14-Jan-22	23848.38	24-Jan-22	24084.54
4-Jan-22	23614.54	15-Jan-22	23871.89	25-Jan-22	24108.28
5-Jan-22	23637.82	16-Jan-22	23895.43	26-Jan-22	24132.05
6-Jan-22	23661.13	17-Jan-22	23918.98	27-Jan-22	24155.84
7-Jan-22	23684.45	18-Jan-22	23942.56	28-Jan-22	24179.65
8-Jan-22	23707.80	19-Jan-22	23966.17	29-Jan-22	24203.49
9-Jan-22	23731.17	20-Jan-22	23989.8	30-Jan-22	24227.35
10-Jan-22	23754.57	21-Jan-22	24013.45	31-Jan-22	24251.23
11-Jan-22	23777.99				

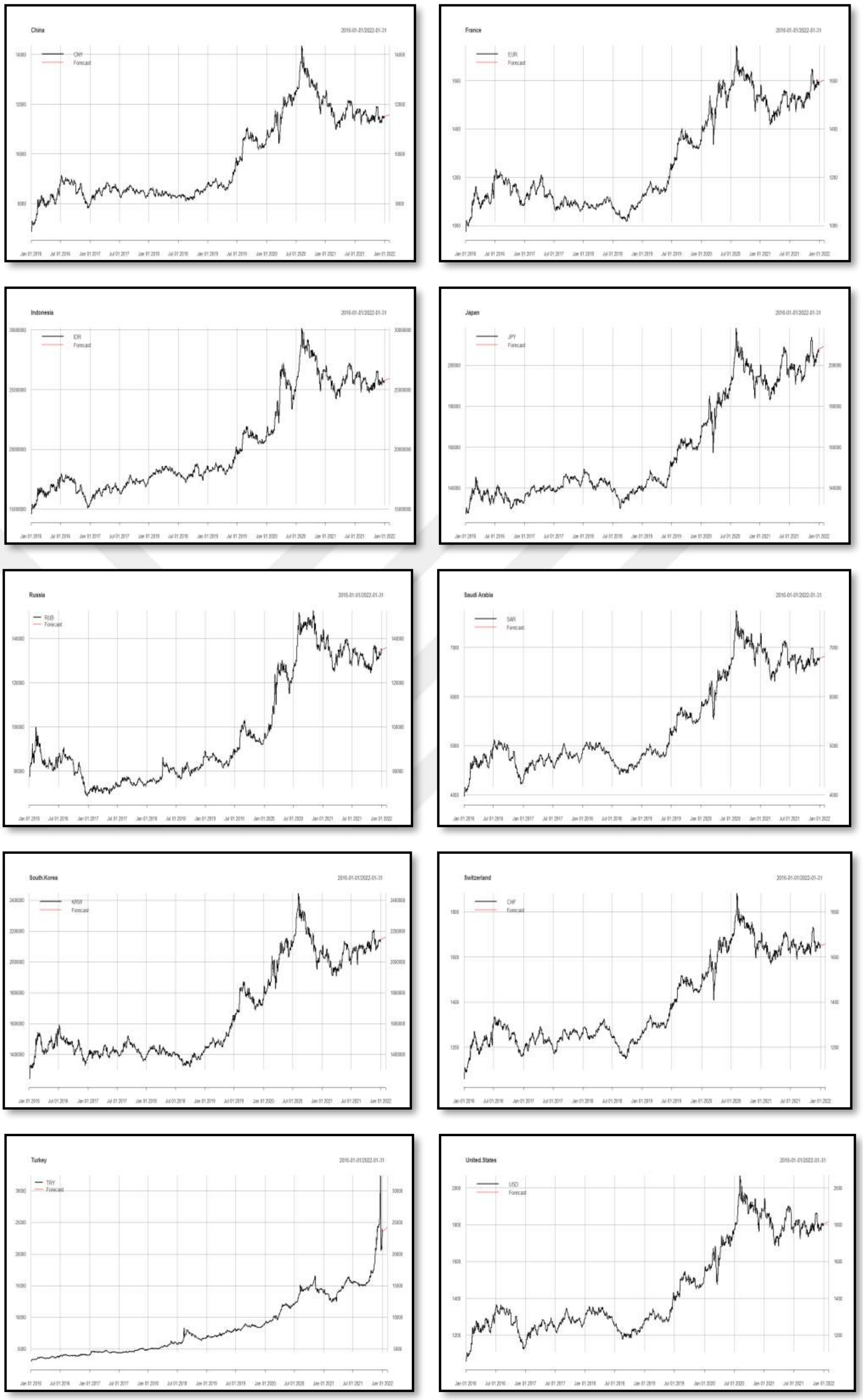

Figure 5.1. *Gold price forecast chart in the next 1 month*

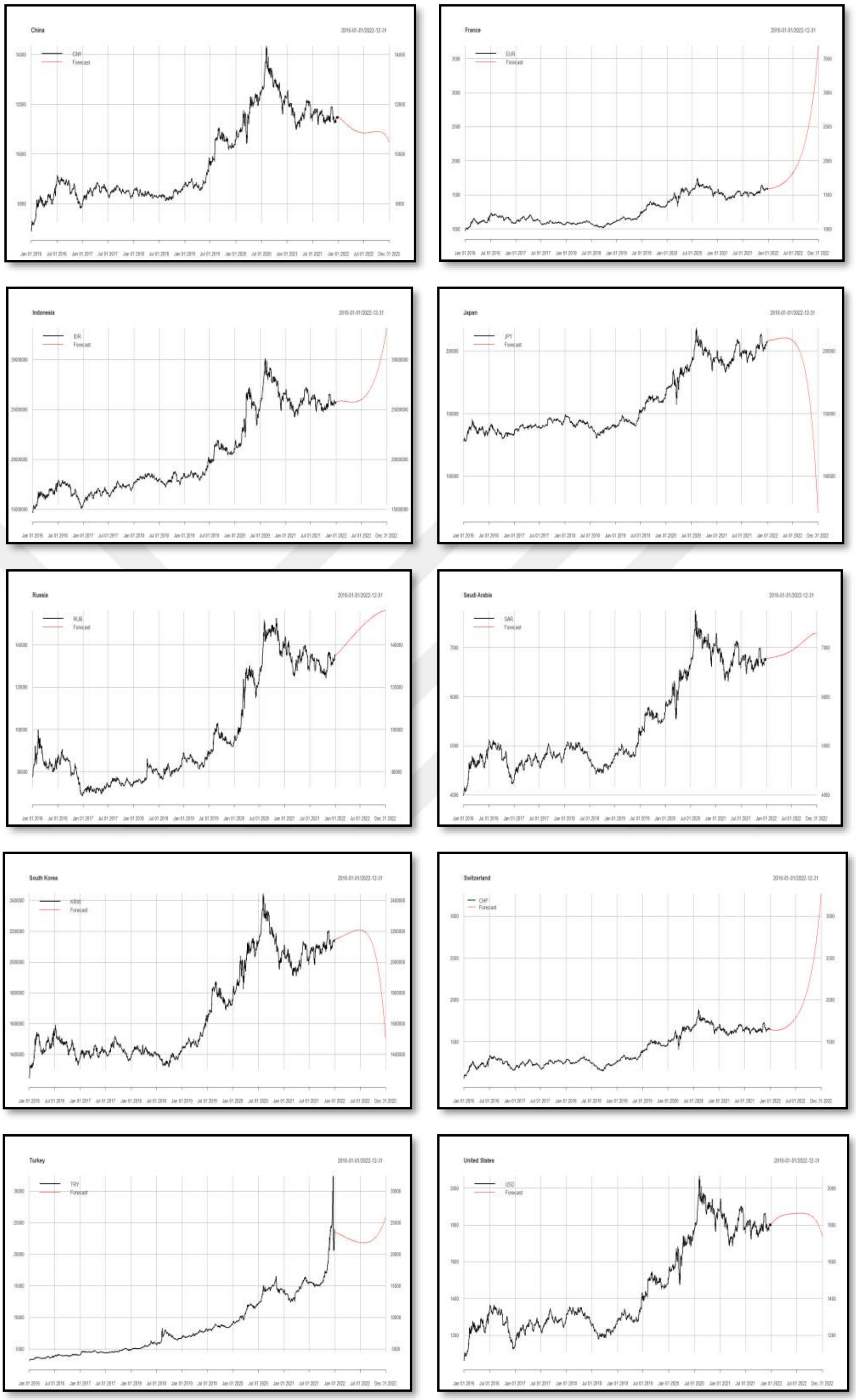

Figure 5.2. *Gold price forecast chart in the next 1 year*

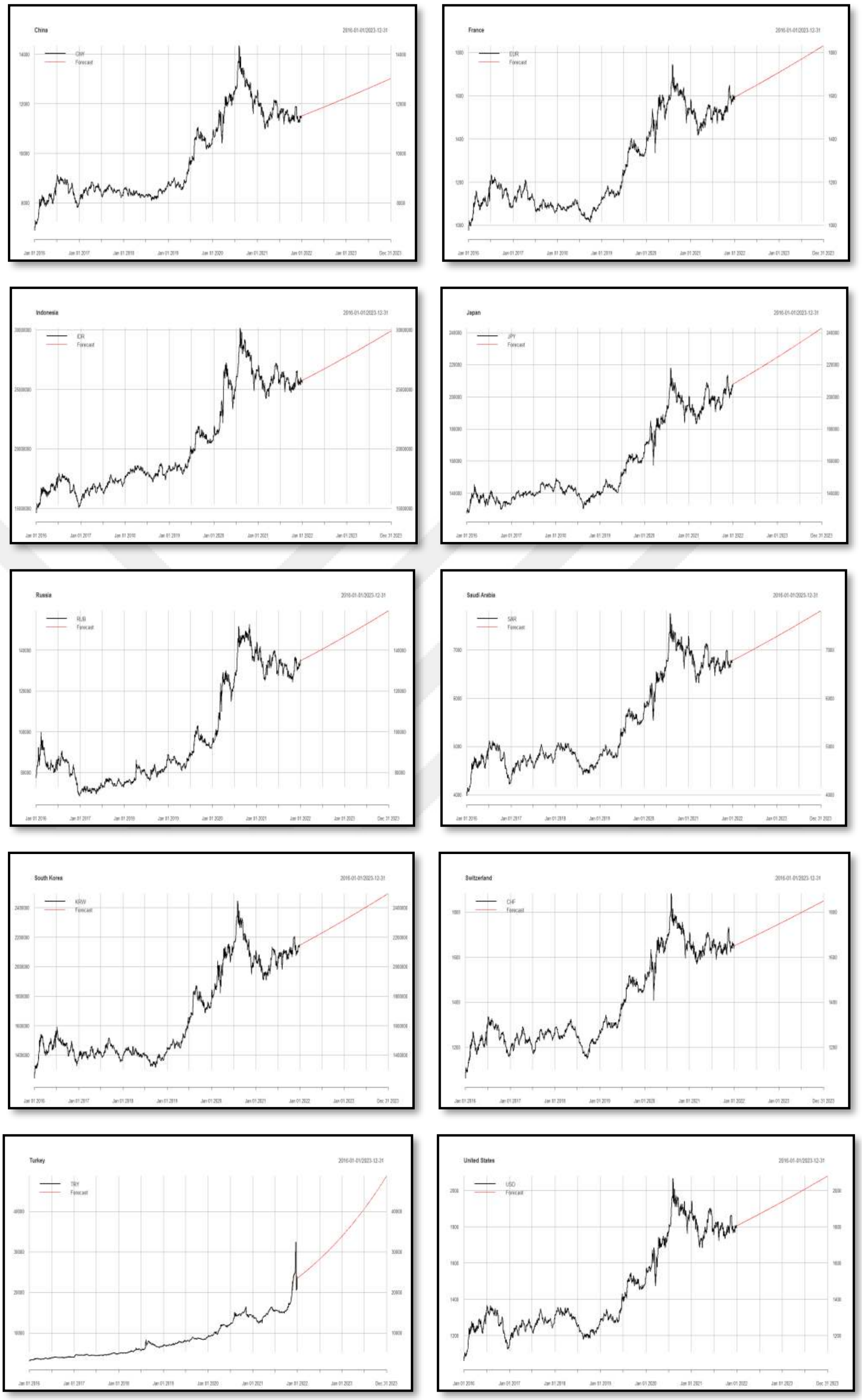

Figure 5.3. *Gold price forecast chart in the next 2 years*

Table 5.8. *Forecasting gold prices in Türkiye for the next 1 year*

Date	TRY	Date	TRY	Date	TRY	Date	TRY	Date	TRY	Date	TRY
1-Jan-22	23512.33	12-Jan-22	23407.67	22-Jan-22	23308.35	1-Dec-22	24144.35	12-Dec-22	24711.47	22-Dec-22	25312.00
2-Jan-22	23503.04	13-Jan-22	23397.91	23-Jan-22	23298.22	2-Dec-22	24192.18	13-Dec-22	24767.71	23-Dec-22	25376.91
3-Jan-22	23493.70	14-Jan-22	23388.10	24-Jan-22	23288.07	3-Dec-22	24240.72	14-Dec-22	24824.76	24-Dec-22	25442.76
4-Jan-22	23484.31	15-Jan-22	23378.26	25-Jan-22	23277.88	4-Dec-22	24290.00	15-Dec-22	24882.65	25-Dec-22	25509.54
5-Jan-22	23474.88	16-Jan-22	23368.38	26-Jan-22	23267.66	5-Dec-22	24340.01	16-Dec-22	24941.38	26-Dec-22	25577.27
6-Jan-22	23465.41	17-Jan-22	23358.46	27-Jan-22	23257.41	6-Dec-22	24390.77	17-Dec-22	25000.96	27-Dec-22	25645.97
7-Jan-22	23455.89	18-Jan-22	23348.51	28-Jan-22	23247.13	7-Dec-22	24442.28	18-Dec-22	25061.4	28-Dec-22	25715.64
8-Jan-22	23446.33	19-Jan-22	23338.52	29-Jan-22	23236.82	8-Dec-22	24494.55	19-Dec-22	25122.71	29-Dec-22	25786.29
9-Jan-22	23436.73	20-Jan-22	23328.50	30-Jan-22	23226.49	9-Dec-22	24547.60	20-Dec-22	25184.91	30-Dec-22	25857.95
10-Jan-22	23427.08	21-Jan-22	23318.44	31-Jan-22	23216.13	10-Dec-22	24601.43	21-Dec-22	25248.00	31-Dec-22	25930.62
11-Jan-22	23417.40					11-Dec-22	24656.05				

Forecasting gold prices in Türkiye has increased relative to either GSTARIMA (1,0,0) with PCA and LOCF imputation, GSTARIMA (1,0,0) with MA imputation, or GSTARIMA (1,0,0) with PCA and MA imputation . Even if you make a forecast for the next 2 years, especially until December 31, 2023, it is suspected that gold prices in Türkiye will be at 48737 TRY/troy ounce. Even the gold price forecast from December 16-31 2023 is in the range of 48000 TRY/troy ounce. The gold price is 2 times higher than the gold price in Türkiye on December 31, 2021. This is also very evident from the gold price chart in Türkiye from January 1, 2016 to the present. Relatively, the pattern of gold price movements in 9 countries other than Türkiye has the same shape. The pattern of gold prices in Türkiye seems to form an exponential movement.

Table 5.9. *Forecasting gold prices in Türkiye for the next 2 years*

Date	TRY	Date	TRY	Date	TRY	Date	TRY	Date	TRY	Date	TRY
1-Jan-22	23545.14	12-Jan-22	23805.04	22-Jan-22	24043.80	1-Dec-23	47300.20	12-Dec-23	47822.32	22-Dec-23	48301.97
2-Jan-22	23568.65	13-Jan-22	23828.81	23-Jan-22	24067.80	2-Dec-23	47347.43	13-Dec-23	47870.07	23-Dec-23	48350.20
3-Jan-22	23592.18	14-Jan-22	23852.60	24-Jan-22	24091.84	3-Dec-23	47394.70	14-Dec-23	47917.87	24-Dec-23	48398.48
4-Jan-22	23615.74	15-Jan-22	23876.41	25-Jan-22	24115.89	4-Dec-23	47442.03	15-Dec-23	47965.71	25-Dec-23	48446.80
5-Jan-22	23639.32	16-Jan-22	23900.25	26-Jan-22	24139.97	5-Dec-23	47489.40	16-Dec-23	48013.60	26-Dec-23	48495.17
6-Jan-22	23662.92	17-Jan-22	23924.12	27-Jan-22	24164.07	6-Dec-23	47536.82	17-Dec-23	48061.54	27-Dec-23	48543.60
7-Jan-22	23686.55	18-Jan-22	23948.01	28-Jan-22	24188.2	7-Dec-23	47584.28	18-Dec-23	48109.53	28-Dec-23	48592.07
8-Jan-22	23710.20	19-Jan-22	23971.92	29-Jan-22	24212.35	8-Dec-23	47631.79	19-Dec-23	48157.57	29-Dec-23	48640.58
9-Jan-22	23733.87	20-Jan-22	23995.85	30-Jan-22	24236.53	9-Dec-23	47679.35	20-Dec-23	48205.66	30-Dec-23	48689.15
10-Jan-22	23757.57	21-Jan-22	24019.81	31-Jan-22	24260.73	10-Dec-23	47726.96	21-Dec-23	48253.79	31-Dec-23	48737.77
11-Jan-22	23781.29					11-Dec-23	47774.61				

If still use the GSTARIMA(1,0,0) model with PCA with both LOCF and MA imputation, it is very likely that gold prices in Türkiye still have the potential to increase again. Even with the GSTARIMA(1,0,0) model with MA imputation, it still increases even though it is not as extreme as the two models. Of course this is quite profitable in terms of investment or even to save property. However, cases like this also need serious attention from all parties to stabilize gold prices. The government needs to make policies and people don't need to panic buying. Finally, this research can be a basic reference to describe the gold price in each country in the future.

6. CONCLUSION AND RECOMMENDATION

Missing value is one of the problems that occur in the field of statistics, especially time series. The assumption of sequential data, of course, can interfere with the predictions that have been made in the time series model. Likewise gold price data that has been obtained from the World Gold Council which has a missing value on every Saturday and Sunday. So in this research, LOCF and MA imputation techniques have been carried out to solve this problem. In this study, not all countries listed on the World Gold Council have been taken, but this has been limited to gold prices in a few countries including China, France, Indonesia, Japan, Russia, Saudi Arabia, South Korea, Switzerland, Türkiye, and the United States. These countries are not only listed on the World Gold Council but are also included in the G20. In addition, these countries have different primary languages.

Also this research has applied Google Trends data as an alternative to the center of the country apart from its capital. In addition, Google Trend has also been used as a dummy variable to predict gold prices in each country. The keyword that has been used in this research is "gold price". These keywords have been translated into the main languages of each country. Based on the center of the country, a high-order classification has been established for each distance between countries. The highest order that has been formed in this study is 8. In addition, the distance and spatial order have been applied to resemble the inverse distance matrix that will be used in the model.

Total of 16 models have been carried out in this study. The models include the GSTARIMA (1,0,0), GSTARIMA (1,1,0), GSTARIMAX (1,0,0), GSTARIMAX (1,1,0) models, GSTARIMA (1,0,0) with PCA, GSTARIMA (1,1,0) with PCA, GSTARIMAX (1,0,0) with PCA, GSTARIMAX (1,1,0) with PCA combined with imputation technique LOCF and MA. Furthermore, this study has selected the best model based on the smallest MAPE. Based on this, the GSTARIMA model (1,0,0) with PCA from LOCF imputation has been chosen to predict gold prices in the next 1 month. Meanwhile, to predict the gold price for the next 1 year, it is recommended to use the GSTARIMA model (1,0,0) with MA imputation. Furthermore, if forecasting for the next 2 years, the GSTARIMA model (1,0,0) with PCA and MA imputation is more recommended.

In general, the forecasting of gold prices from the end of 2022 to 2023 is relatively rising. Of course, a significant increase in gold prices, especially in Türkiye, can be an investment option or even a solution to save property. This is based on the 3 best models, namely GSTARIMA (1,0,0) with PCA and LOCF imputation, GSTARIMA (1,0,0) with MA imputation, and also GSTARIMA (1,0,0) with PCA and MA imputation. The parameters of these models for lag 1 gold prices in each country look significant at $\alpha = 5\%$. In addition, in the GSTARIMA (1,0,0) model with MA imputation, there are several neighboring parameters that affect the gold price in a country.

Based on the GSTARIMA (1,0,0) model with PCA and LOCF imputation, the forecast for gold prices in China from January 1, 2022 to January 31 is 11509-11578 CNY/troy ounce. This model is the best model for forecasting gold prices in 1 month. Furthermore, in France it is at 1588-1603 EUR/troy ounce, in Indonesia it is at 25737879-25933347 IDR/troy ounce, in Japan it is at 207953-209245 JPY/troy ounce, in Russia it is at 134865-135814 RUB/troy ounce, in Saudi Arabia was at 6780-6822 SAR/troy ounce, in South Korea it was at 2146704-2160554 KRW/troy ounce, in Switzerland it was at 1645-1658 CHF/troy ounce, in Türkiye it was at 23545-24251 TRY/troy ounce, and in the United States it was at 1806-1817 USD/troy ounce. In contrast to Türkiye, the range of changes in the gold price in the United States is quite small.

The best model to predict gold price in 1 year is GSTARIMA (1,0,0) with MA imputation. The gold price in China from January 1, 2022 to December 31, 2022 was at 10473-11510 CNY/troy ounce. Next up in France it is at 1588-3691 EUR/troy ounce, in Indonesia it is at 25737879-33162513 IDR/troy ounce, in Japan it is 70659-210353 JPY/troy ounce, in Russia it is at 134891-156167 RUB/troy ounce, in Saudi Arabia was at 6780-7292 SAR/troy ounce, in South Korea 1503080-2209551 KRW/troy ounce, in Switzerland 1636-3270 CHF/troy ounce, in Türkiye it was at 21814-25931 TRY/troy ounce, and the United States was at 1737- 1864 USD/troy ounce. Also the results of forecasting gold prices in the United States on the model have a small range like the previous model.

Furthermore, the best model used for forecasting gold prices in each country in 2 years is GSTARIMA (1,0,0) with PCA and MA imputation. Gold prices in China from January 1, 2022 to December 31, 2023 are at 11509-13024 CNY/troy ounce. Next in France it is at 1588-1832 EUR/troy ounce, in Indonesia it is at 25737879-29911290 IDR/troy ounce, in Japan 207953-242903 JPY/troy ounce, in Russia it is at 134865-159382 RUB/troy ounce, in Saudi Arabia was at 6780-7813 SAR/troy ounce, in South Korea 2146704-2497014 KRW/troy ounce, in Switzerland 1645-1850 CHF/troy ounce, in Türkiye it was at 23545-48738 TRY/troy ounce, and the United States was at 1806-2080 USD/troy ounce.

This research still has a lot of potential to be developed. The addition of the number of countries to be analyzed is also quite interesting, especially if you can predict gold prices in all countries in the world. In the application of big data, apart from the number of countries, the addition of the number of series also needs to be considered. Furthermore, the effect of changing keywords on changes in the center of the country also needs to be considered. This study only determines the center of the country based on a web search. Of course, further research still has the opportunity to use other categories such as google shopping, image search, news search, and youtube search. Even these categories are biased compared to the shape of the center of the country that will be produced.

In addition, the formation of spatial order classification also needs to be explored not only based on points but also national boundaries. The GSTARIMA model also needs to be developed to be more complex but must still consider the accuracy of the model. Finally, it is hoped that this research will contribute to the development of statistical research, especially spatial time series. The contribution can be related to alternative spatial weighting, high order spatial, simultaneous forecasting, etc.

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APPENDIX

Figure A.1.1. *Graph of gold price*

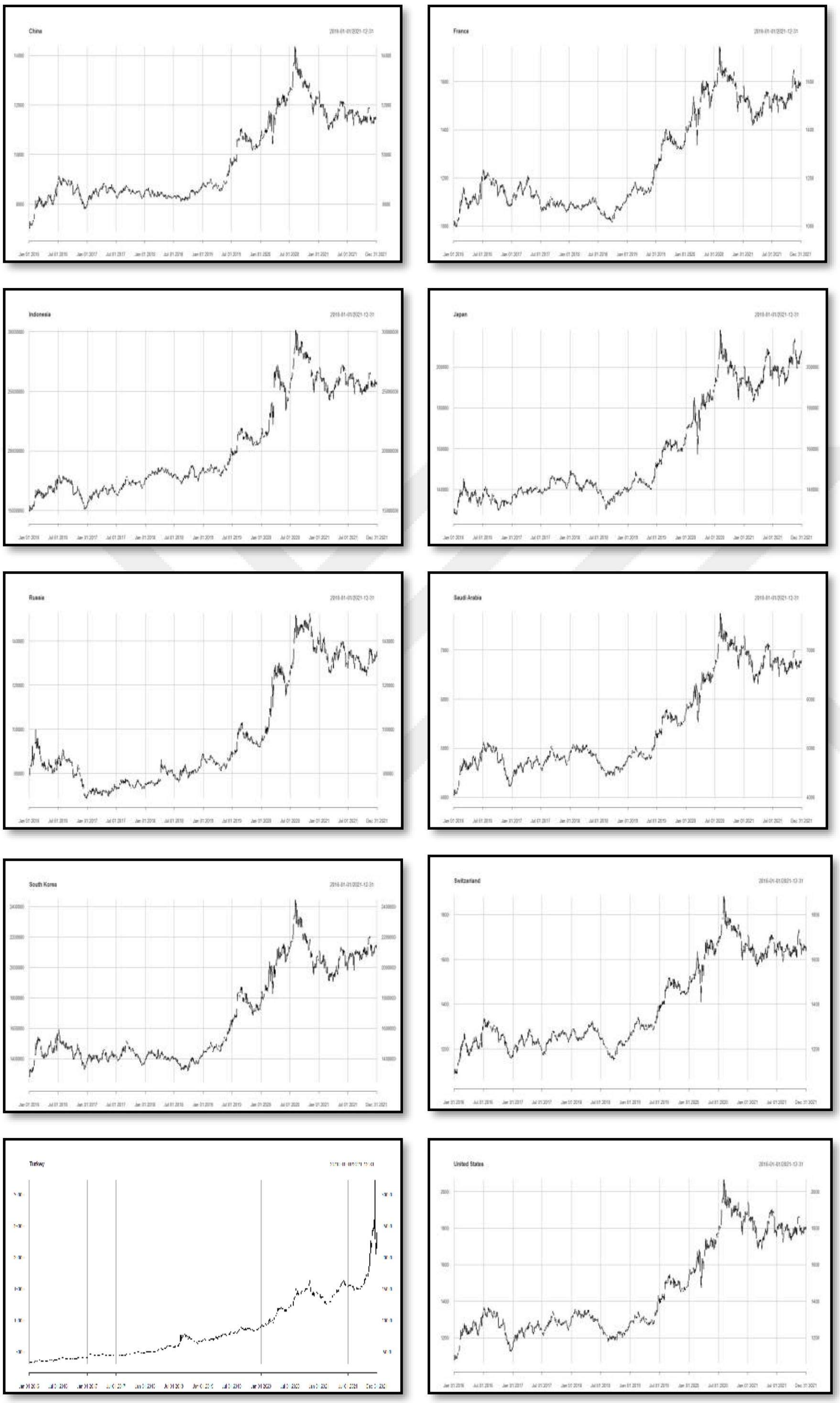

Figure A.2.1. *Graph of gold price and imputation results*

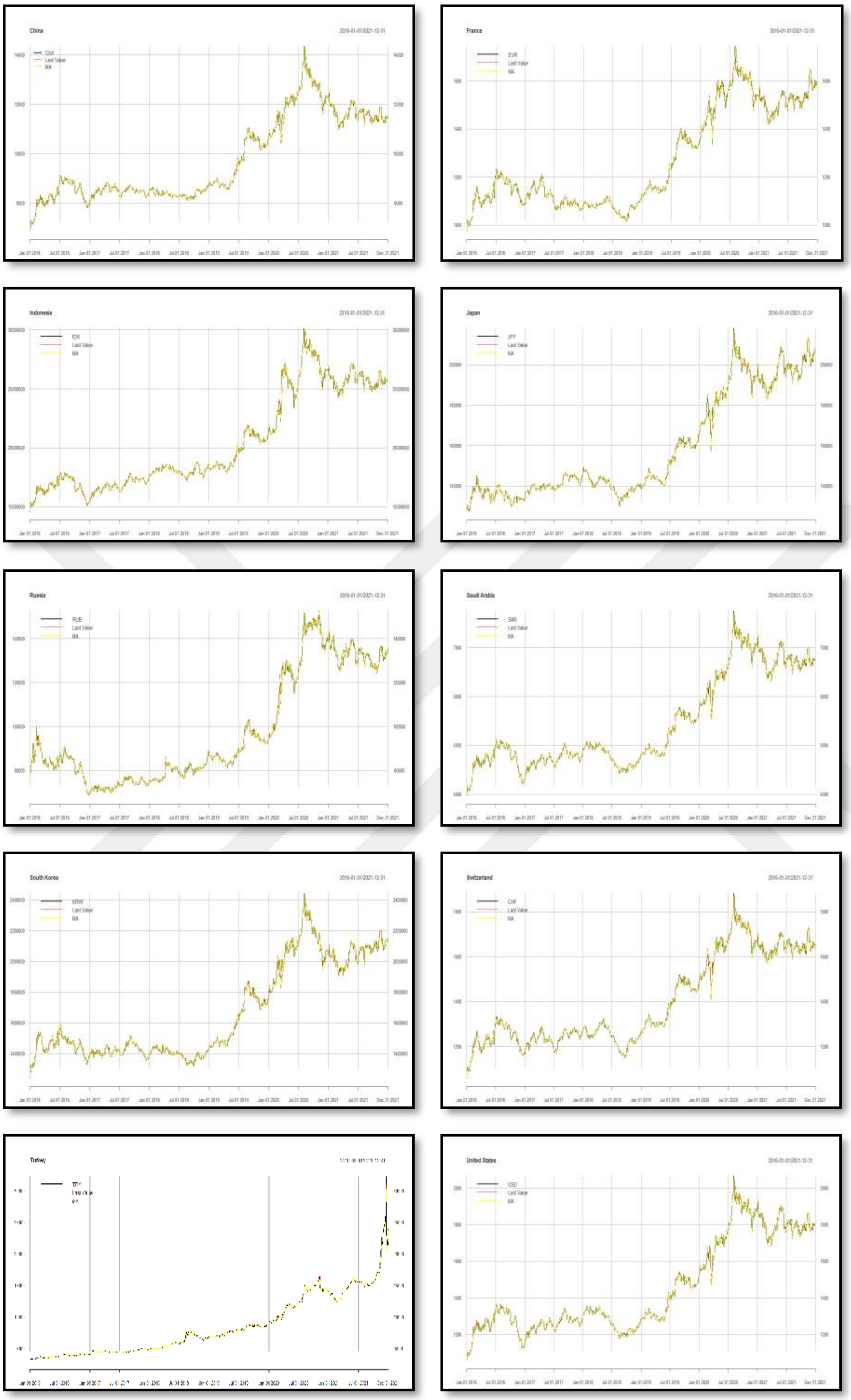

Table A.3.1. *Distance and spatial order classification*

	China	France	Indonesia	Japan	Russia	Saudi Arabia	South Korea	Switzerland	Türkiye	United States
China	*	8344.45	4365.17	1461.16	3243.39	7266.62	956.3	8027.15	6246.16	10552.22
France	8344.45	*	9621.68	9690.57	5483.53	4792.08	9132.6	341.81	3178.35	6790.76
Indonesia	4365.17	9621.68	*	4807.66	6779.54	5706.78	4790.66	9293.91	6465.1	14633.36
Japan	1461.16	9690.57	4807.66	*	4339.85	8634.49	558.46	9385.74	7707.28	10747.6
Russia	3243.39	5483.53	6779.54	4339.85	*	6550.55	3803.31	5215.31	4579.63	7854.39
Saudi Arabia	7266.62	4792.08	5706.78	8634.49	6550.55	*	8209.76	4569.36	2278.36	11562.27
South Korea	956.3	9132.6	4790.66	558.46	3803.31	8209.76	*	8827.37	7185.6	10490.51
Switzerland	8027.15	341.81	9293.91	9385.74	5215.31	4569.36	8827.37	*	2865.96	6995.18
Türkiye	6246.16	3178.35	6465.1	7707.28	4579.63	2278.36	7185.6	2865.96	*	9583.69
United States	10552.22	6790.76	14633.36	10747.6	7854.39	11562.27	10490.51	6995.18	9583.69	*

	China	France	Indonesia	Japan	Russia	Saudi Arabia	South Korea	Switzerland	Türkiye	United States
China	*	6	5	3	4	6	3	6	6	7
France	6	*	7	7	5	5	7	1	4	6
Indonesia	5	7	*	5	6	6	5	7	6	8
Japan	3	7	5	*	5	7	2	7	6	7
Russia	4	5	6	5	*	6	5	5	5	6
Saudi Arabia	6	5	6	7	6	*	6	5	4	7
South Korea	3	7	5	2	5	6	*	7	6	7
Switzerland	6	1	7	7	5	5	7	*	4	6
Türkiye	6	4	6	6	5	4	6	4	*	7
United States	7	6	8	7	6	7	7	6	7	*

Table A.4.1. *Parameter estimation of GSTARIMA (1,0,0) from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	9.91E-01	8.77E-03	112.919	<2e-16	$\emptyset^{6}_{1(0)}$	9.76E-01	1.15E-02	85.097	<2e-16
$\emptyset^{1}_{1(3)}$	9.56E+04	4.17E+04	2.291	0.0221	$\emptyset^{6}_{1(4)}$	-2.45E+10	3.26E+10	-0.75	0.454
$\emptyset^{1}_{1(4)}$	-1.39E+10	4.13E+10	-0.337	0.7361	$\emptyset^{6}_{1(5)}$	3.20E+16	3.29E+16	0.973	0.331
$\emptyset^{1}_{1(5)}$	1.42E+13	8.58E+12	1.655	0.0981	$\emptyset^{6}_{1(6)}$	8.75E+16	9.48E+16	0.923	0.356
$\emptyset^{1}_{1(6)}$	-1.49E+20	1.50E+20	-0.995	0.3198	$\emptyset^{6}_{1(7)}$	1.02E+24	7.11E+23	1.427	0.154
$\emptyset^{1}_{1(7)}$	-2.38E+27	1.18E+27	-2.026	0.043	$\emptyset^{7}_{1(0)}$	1.00E+00	7.64E-03	131.23	<2e-16
$\emptyset^{2}_{1(0)}$	1.01E+00	9.47E-03	106.168	<2e-16	$\emptyset^{7}_{1(2)}$	2.81E+04	2.18E+04	1.29	0.197
$\emptyset^{2}_{1(1)}$	-4.40E+00	3.59E+00	-1.225	0.221	$\emptyset^{7}_{1(3)}$	-2.26E+09	1.62E+09	-1.396	0.163
$\emptyset^{2}_{1(4)}$	-1.03E+10	2.13E+10	-0.485	0.628	$\emptyset^{7}_{1(5)}$	-1.50E+15	1.73E+15	-0.869	0.385
$\emptyset^{2}_{1(5)}$	2.18E+14	2.22E+14	0.984	0.325	$\emptyset^{7}_{1(6)}$	7.67E+22	5.24E+22	1.462	0.144
$\emptyset^{2}_{1(6)}$	-1.81E+20	3.68E+20	-0.493	0.622	$\emptyset^{7}_{1(7)}$	1.97E+28	3.33E+28	0.592	0.554
$\emptyset^{2}_{1(7)}$	5.29E+21	5.41E+21	0.977	0.329	$\emptyset^{8}_{1(0)}$	9.72E-01	1.12E-02	87.025	<2e-16
$\emptyset^{3}_{1(0)}$	1.00E+00	5.83E-03	171.686	<2e-16	$\emptyset^{8}_{1(1)}$	4.30E+00	3.57E+00	1.203	0.229
$\emptyset^{3}_{1(5)}$	1.68E+17	2.16E+17	0.779	0.436	$\emptyset^{8}_{1(4)}$	-2.36E+10	1.47E+10	-1.608	0.108
$\emptyset^{3}_{1(6)}$	1.94E+22	6.85E+22	0.283	0.777	$\emptyset^{8}_{1(5)}$	9.27E+13	1.83E+14	0.506	0.6129
$\emptyset^{3}_{1(7)}$	-7.36E+28	4.52E+29	-0.163	0.871	$\emptyset^{8}_{1(6)}$	-1.55E+20	3.35E+20	-0.462	0.6443
$\emptyset^{3}_{1(8)}$	-1.68E+35	2.53E+35	-0.663	0.507	$\emptyset^{8}_{1(7)}$	8.30E+21	4.41E+21	1.883	0.0599
$\emptyset^{4}_{1(0)}$	9.97E-01	4.57E-03	218.399	<2e-16	$\emptyset^{9}_{1(0)}$	9.99E-01	2.69E-03	371.514	<2e-16
$\emptyset^{4}_{1(2)}$	2.56E+02	1.54E+02	1.656	0.0979	$\emptyset^{9}_{1(4)}$	4.44E+11	2.69E+12	0.165	0.869
$\emptyset^{4}_{1(3)}$	3.06E+08	3.70E+08	0.827	0.4084	$\emptyset^{9}_{1(5)}$	-6.06E+13	7.64E+14	-0.079	0.937
$\emptyset^{4}_{1(5)}$	2.36E+14	1.66E+14	1.419	0.1562	$\emptyset^{9}_{1(6)}$	2.01E+17	4.60E+17	0.438	0.662
$\emptyset^{4}_{1(6)}$	-8.42E+21	7.02E+21	-1.2	0.2305	$\emptyset^{9}_{1(7)}$	-7.55E+26	3.35E+27	-0.225	0.822
$\emptyset^{4}_{1(7)}$	-1.70E+27	8.87E+26	-1.92	0.055	$\emptyset^{10}_{1(0)}$	9.87E-01	6.51E-03	151.733	<2e-16
$\emptyset^{5}_{1(0)}$	9.93E-01	4.88E-03	203.394	<2e-16	$\emptyset^{10}_{1(6)}$	5.75E+18	1.10E+19	0.522	0.602
$\emptyset^{5}_{1(4)}$	-1.51E+13	1.22E+13	-1.235	0.217	$\emptyset^{10}_{1(7)}$	1.07E+23	6.77E+22	1.582	0.114
$\emptyset^{5}_{1(5)}$	4.06E+14	4.68E+14	0.868	0.3857	$\emptyset^{10}_{1(8)}$	3.10E+26	7.35E+26	0.422	0.673
$\emptyset^{5}_{1(6)}$	5.36E+18	3.22E+18	1.666	0.0959					

Table A.5.1. *Parameter estimation of GSTARIMA (1,0,0) from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	9.91E-01	8.57E-03	115.667	<2e-16	$\emptyset^{6}_{1(0)}$	9.77E-01	1.13E-02	86.682	<2e-16
$\emptyset^{1}_{1(3)}$	9.57E+04	4.06E+04	2.356	0.0186	$\emptyset^{6}_{1(4)}$	-2.30E+10	3.22E+10	-0.715	0.475
$\emptyset^{1}_{1(4)}$	-1.37E+10	4.02E+10	-0.342	0.7323	$\emptyset^{6}_{1(5)}$	3.07E+16	3.24E+16	0.95	0.342
$\emptyset^{1}_{1(5)}$	1.42E+13	8.36E+12	1.703	0.0888	$\emptyset^{6}_{1(6)}$	8.26E+16	9.33E+16	0.885	0.376
$\emptyset^{1}_{1(6)}$	-1.53E+20	1.46E+20	-1.044	0.2965	$\emptyset^{6}_{1(7)}$	1.02E+24	7.05E+23	1.454	0.146
$\emptyset^{1}_{1(7)}$	-2.42E+27	1.15E+27	-2.11	0.035	$\emptyset^{7}_{1(0)}$	1.00E+00	7.44E-03	134.96	<2e-16
$\emptyset^{2}_{1(0)}$	1.01E+00	9.30E-03	108.109	<2e-16	$\emptyset^{7}_{1(2)}$	2.89E+04	2.14E+04	1.352	0.177
$\emptyset^{2}_{1(1)}$	-4.40E+00	3.53E+00	-1.246	0.213	$\emptyset^{7}_{1(3)}$	-2.16E+09	1.57E+09	-1.37	0.171
$\emptyset^{2}_{1(4)}$	-1.02E+10	2.10E+10	-0.484	0.628	$\emptyset^{7}_{1(5)}$	-1.47E+15	1.69E+15	-0.871	0.384
$\emptyset^{2}_{1(5)}$	2.31E+14	2.17E+14	1.063	0.288	$\emptyset^{7}_{1(6)}$	7.42E+22	5.13E+22	1.447	0.148
$\emptyset^{2}_{1(6)}$	-1.61E+20	3.61E+20	-0.447	0.655	$\emptyset^{7}_{1(7)}$	1.48E+28	3.25E+28	0.454	0.65
$\emptyset^{2}_{1(7)}$	5.06E+21	5.31E+21	0.953	0.341	$\emptyset^{8}_{1(0)}$	9.73E-01	1.10E-02	88.314	<2e-16
$\emptyset^{3}_{1(0)}$	1.00E+00	5.67E-03	176.58	<2e-16	$\emptyset^{8}_{1(1)}$	4.03E+00	3.52E+00	1.144	0.2529
$\emptyset^{3}_{1(5)}$	1.90E+17	2.11E+17	0.902	0.367	$\emptyset^{8}_{1(4)}$	-2.31E+10	1.45E+10	-1.598	0.1103
$\emptyset^{3}_{1(6)}$	1.73E+22	6.67E+22	0.26	0.795	$\emptyset^{8}_{1(5)}$	1.09E+14	1.80E+14	0.607	0.5442
$\emptyset^{3}_{1(7)}$	-1.16E+29	4.43E+29	-0.261	0.794	$\emptyset^{8}_{1(6)}$	-1.31E+20	3.30E+20	-0.397	0.6916
$\emptyset^{3}_{1(8)}$	-1.67E+35	2.47E+35	-0.674	0.5	$\emptyset^{8}_{1(7)}$	7.93E+21	4.34E+21	1.827	0.0679
$\emptyset^{4}_{1(0)}$	9.97E-01	4.49E-03	222.006	<2e-16	$\emptyset^{9}_{1(0)}$	9.99E-01	2.63E-03	379.868	<2e-16
$\emptyset^{4}_{1(2)}$	2.61E+02	1.50E+02	1.736	0.0827	$\emptyset^{9}_{1(4)}$	3.04E+11	2.63E+12	0.115	0.908
$\emptyset^{4}_{1(3)}$	2.96E+08	3.62E+08	0.817	0.414	$\emptyset^{9}_{1(5)}$	-4.76E+13	7.45E+14	-0.064	0.949
$\emptyset^{4}_{1(5)}$	2.30E+14	1.62E+14	1.418	0.1564	$\emptyset^{9}_{1(6)}$	1.96E+17	4.49E+17	0.437	0.662
$\emptyset^{4}_{1(6)}$	-8.25E+21	6.88E+21	-1.199	0.2307	$\emptyset^{9}_{1(7)}$	-5.84E+26	3.28E+27	-0.178	0.859
$\emptyset^{4}_{1(7)}$	-1.69E+27	8.66E+26	-1.948	0.0516	$\emptyset^{10}_{1(0)}$	9.87E-01	6.36E-03	155.15	<2e-16
$\emptyset^{5}_{1(0)}$	9.93E-01	4.79E-03	207.53	<2e-16	$\emptyset^{10}_{1(6)}$	6.00E+18	1.08E+19	0.556	0.578
$\emptyset^{5}_{1(4)}$	-1.52E+13	1.20E+13	-1.265	0.206	$\emptyset^{10}_{1(7)}$	1.07E+23	6.64E+22	1.617	0.106
$\emptyset^{5}_{1(5)}$	4.09E+14	4.60E+14	0.889	0.374	$\emptyset^{10}_{1(8)}$	2.81E+26	7.20E+26	0.391	0.696
$\emptyset^{5}_{1(6)}$	5.31E+18	3.15E+18	1.686	0.092					

Table A.6.1. *Parameter estimation of GSTARIMA (1,1,0) from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	1.29E-01	9.95E-02	1.295	0.1955	$\emptyset^{6}_{1(0)}$	4.41E-02	7.62E-02	0.579	0.5627
$\emptyset^{1}_{1(3)}$	-4.43E+05	2.60E+05	-1.703	0.0888	$\emptyset^{6}_{1(4)}$	1.62E+11	3.65E+11	0.444	0.6572
$\emptyset^{1}_{1(4)}$	5.78E+10	2.93E+11	0.197	0.8436	$\emptyset^{6}_{1(5)}$	-1.95E+17	2.70E+17	-0.721	0.4711
$\emptyset^{1}_{1(5)}$	4.39E+13	6.11E+13	0.719	0.4722	$\emptyset^{6}_{1(6)}$	2.98E+17	6.38E+17	0.468	0.6401
$\emptyset^{1}_{1(6)}$	7.33E+20	1.46E+21	0.501	0.6163	$\emptyset^{6}_{1(7)}$	-1.29E+25	5.90E+24	-2.193	0.0285
$\emptyset^{1}_{1(7)}$	-1.50E+28	9.01E+27	-1.666	0.096	$\emptyset^{7}_{1(0)}$	-1.83E-01	5.66E-02	-3.24	0.00122
$\emptyset^{2}_{1(0)}$	4.79E-02	7.33E-02	0.654	0.5135	$\emptyset^{7}_{1(2)}$	-5.67E+05	1.77E+05	-3.21	0.00136
$\emptyset^{2}_{1(1)}$	-4.61E+01	2.30E+01	-2.007	0.0449	$\emptyset^{7}_{1(3)}$	-2.71E+09	1.36E+10	-0.199	0.84221
$\emptyset^{2}_{1(4)}$	3.00E+11	3.08E+11	0.972	0.3314	$\emptyset^{7}_{1(5)}$	2.67E+16	1.77E+16	1.508	0.13188
$\emptyset^{2}_{1(5)}$	-1.37E+15	1.59E+15	-0.859	0.3902	$\emptyset^{7}_{1(6)}$	5.99E+23	6.49E+23	0.924	0.3558
$\emptyset^{2}_{1(6)}$	3.02E+21	2.27E+21	1.335	0.1821	$\emptyset^{7}_{1(7)}$	2.70E+29	1.92E+29	1.41	0.15868
$\emptyset^{2}_{1(7)}$	-1.30E+22	3.15E+22	-0.412	0.6803	$\emptyset^{8}_{1(0)}$	-1.06E-01	7.12E-02	-1.487	0.137
$\emptyset^{3}_{1(0)}$	1.56E-01	7.72E-02	2.021	0.0434	$\emptyset^{8}_{1(1)}$	1.60E+01	2.66E+01	0.601	0.548
$\emptyset^{3}_{1(5)}$	-2.60E+18	1.46E+18	-1.777	0.0757	$\emptyset^{8}_{1(4)}$	4.40E+10	2.16E+11	0.204	0.839
$\emptyset^{3}_{1(6)}$	5.60E+23	5.05E+23	1.109	0.2675	$\emptyset^{8}_{1(5)}$	-7.44E+14	1.31E+15	-0.568	0.57
$\emptyset^{3}_{1(7)}$	-5.50E+29	2.89E+30	-0.19	0.8491	$\emptyset^{8}_{1(6)}$	-1.38E+20	2.12E+21	-0.065	0.948
$\emptyset^{3}_{1(8)}$	-3.86E+36	2.17E+36	-1.781	0.0752	$\emptyset^{8}_{1(7)}$	1.64E+22	2.61E+22	0.628	0.53
$\emptyset^{4}_{1(0)}$	-3.63E-02	3.85E-02	-0.944	0.3456	$\emptyset^{9}_{1(0)}$	1.01E-01	2.96E-02	3.39	0.00072
$\emptyset^{4}_{1(2)}$	-9.83E+02	1.21E+03	-0.815	0.4153	$\emptyset^{9}_{1(4)}$	-2.95E+13	1.97E+13	-1.497	0.13448
$\emptyset^{4}_{1(3)}$	5.09E+09	4.08E+09	1.248	0.2123	$\emptyset^{9}_{1(5)}$	2.23E+15	6.35E+15	0.351	0.72538
$\emptyset^{4}_{1(5)}$	1.93E+15	1.30E+15	1.491	0.136	$\emptyset^{9}_{1(6)}$	-5.65E+18	2.88E+18	-1.959	0.05026
$\emptyset^{4}_{1(6)}$	2.66E+22	6.72E+22	0.396	0.6925	$\emptyset^{9}_{1(7)}$	3.84E+28	2.25E+28	1.704	0.08852
$\emptyset^{4}_{1(7)}$	-1.16E+28	6.80E+27	-1.701	0.0891	$\emptyset^{10}_{1(0)}$	-2.64E-02	6.82E-02	-0.387	0.699
$\emptyset^{5}_{1(0)}$	-1.64E-03	3.59E-02	-0.046	0.9635	$\emptyset^{10}_{1(6)}$	-5.86E+19	9.03E+19	-0.649	0.516
$\emptyset^{5}_{1(4)}$	9.65E+13	1.13E+14	0.857	0.3916	$\emptyset^{10}_{1(7)}$	-6.67E+23	5.79E+23	-1.152	0.249
$\emptyset^{5}_{1(5)}$	-5.41E+15	3.24E+15	-1.669	0.0953	$\emptyset^{10}_{1(8)}$	1.35E+28	1.17E+28	1.158	0.247
$\emptyset^{5}_{1(6)}$	-2.24E+19	4.83E+19	-0.465	0.642					

Table A.7.1. *Parameter estimation of GSTARIMA (1,1,0) from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset_{1(0)}^{1}$	4.25E-02	1.02E-01	0.416	0.677	$\emptyset_{1(0)}^{6}$	3.74E-02	7.61E-02	0.491	0.62347
$\emptyset_{1(3)}^{1}$	-3.89E+05	2.60E+05	-1.496	0.135	$\emptyset_{1(4)}^{6}$	4.20E+10	3.62E+11	0.116	0.90769
$\emptyset_{1(4)}^{1}$	2.36E+11	2.84E+11	0.829	0.407	$\emptyset_{1(5)}^{6}$	-8.83E+16	2.67E+17	-0.331	0.74075
$\emptyset_{1(5)}^{1}$	-6.52E+13	6.10E+13	-1.068	0.285	$\emptyset_{1(6)}^{6}$	-1.01E+18	6.47E+17	-1.56	0.11894
$\emptyset_{1(6)}^{1}$	2.52E+20	1.44E+21	0.175	0.861	$\emptyset_{1(7)}^{6}$	-1.62E+25	5.85E+24	-2.771	0.00567
$\emptyset_{1(7)}^{1}$	-8.63E+27	9.22E+27	-0.936	0.35	$\emptyset_{1(0)}^{7}$	-2.69E-01	5.59E-02	-4.816	1.62E-06
$\emptyset_{1(0)}^{2}$	-1.04E-01	7.14E-02	-1.453	0.1463	$\emptyset_{1(2)}^{7}$	-5.17E+05	1.72E+05	-2.998	0.00276
$\emptyset_{1(1)}^{2}$	-3.78E+01	2.26E+01	-1.675	0.0941	$\emptyset_{1(3)}^{7}$	6.26E+09	1.35E+10	0.462	0.64407
$\emptyset_{1(4)}^{2}$	1.07E+11	3.05E+11	0.349	0.7268	$\emptyset_{1(5)}^{7}$	-4.94E+15	1.75E+16	-0.282	0.77764
$\emptyset_{1(5)}^{2}$	-1.66E+14	1.55E+15	-0.108	0.9144	$\emptyset_{1(6)}^{7}$	7.17E+23	6.33E+23	1.133	0.25755
$\emptyset_{1(6)}^{2}$	5.11E+21	2.26E+21	2.261	0.0239	$\emptyset_{1(7)}^{7}$	2.97E+29	1.89E+29	1.572	0.11624
$\emptyset_{1(7)}^{2}$	-5.83E+22	3.15E+22	-1.85	0.0645	$\emptyset_{1(0)}^{8}$	-2.22E-01	7.00E-02	-3.173	0.00154
$\emptyset_{1(0)}^{3}$	-1.07E-01	7.74E-02	-1.385	0.166	$\emptyset_{1(1)}^{8}$	1.60E+01	2.59E+01	0.617	0.53727
$\emptyset_{1(5)}^{3}$	-1.96E+18	1.46E+18	-1.343	0.18	$\emptyset_{1(4)}^{8}$	-7.09E+10	2.14E+11	-0.332	0.73999
$\emptyset_{1(6)}^{3}$	6.97E+23	4.88E+23	1.429	0.153	$\emptyset_{1(5)}^{8}$	3.93E+14	1.28E+15	0.308	0.75829
$\emptyset_{1(7)}^{3}$	-2.41E+29	2.81E+30	-0.086	0.932	$\emptyset_{1(6)}^{8}$	1.81E+21	2.12E+21	0.854	0.39316
$\emptyset_{1(8)}^{3}$	-1.70E+36	2.14E+36	-0.796	0.426	$\emptyset_{1(7)}^{8}$	-2.83E+22	2.61E+22	-1.086	0.2776
$\emptyset_{1(0)}^{4}$	-2.49E-01	3.76E-02	-6.609	5.42E-11	$\emptyset_{1(0)}^{9}$	2.76E-02	2.96E-02	0.93	0.3526
$\emptyset_{1(2)}^{4}$	3.47E+02	1.20E+03	0.29	0.772	$\emptyset_{1(4)}^{9}$	-4.16E+13	1.95E+13	-2.138	0.0327
$\emptyset_{1(3)}^{4}$	2.55E+09	4.18E+09	0.609	0.542	$\emptyset_{1(5)}^{9}$	-1.93E+15	6.23E+15	-0.31	0.7564
$\emptyset_{1(5)}^{4}$	-1.03E+15	1.29E+15	-0.795	0.427	$\emptyset_{1(6)}^{9}$	-6.14E+18	2.94E+18	-2.093	0.0365
$\emptyset_{1(6)}^{4}$	-1.61E+21	6.57E+22	-0.025	0.98	$\emptyset_{1(7)}^{9}$	5.20E+28	2.22E+28	2.339	0.0195
$\emptyset_{1(7)}^{4}$	3.53E+27	6.99E+27	0.506	0.613	$\emptyset_{1(0)}^{10}$	-4.23E-02	6.85E-02	-0.618	0.536
$\emptyset_{1(0)}^{5}$	-1.71E-01	3.48E-02	-4.923	9.49E-07	$\emptyset_{1(6)}^{10}$	-3.04E+19	8.86E+19	-0.343	0.732
$\emptyset_{1(4)}^{5}$	1.49E+14	1.12E+14	1.323	0.186	$\emptyset_{1(7)}^{10}$	-4.92E+23	5.84E+23	-0.842	0.4
$\emptyset_{1(5)}^{5}$	-4.34E+15	3.23E+15	-1.343	0.179	$\emptyset_{1(8)}^{10}$	-1.02E+28	1.18E+28	-0.862	0.389
$\emptyset_{1(6)}^{5}$	-4.53E+19	4.82E+19	-0.939	0.348					

Table A.8.1. *Parameter estimation of GSTARIMAX (1,0,0) from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	9.91E-01	8.57E-03	115.671	<2e-16
$\beta^{(1)}_{1}$	NA	NA	NA	NA
$\beta^{(1)}_{2}$	NA	NA	NA	NA
$\beta^{(1)}_{3}$	NA	NA	NA	NA
$\beta^{(1)}_{4}$	4.54E+00	4.52E+00	1.004	0.3157
$\beta^{(1)}_{5}$	NA	NA	NA	NA
$\emptyset^{1}_{1(3)}$	9.39E+04	4.07E+04	2.307	0.0212
$\emptyset^{1}_{1(4)}$	-1.16E+10	4.02E+10	-0.289	0.7723
$\emptyset^{1}_{1(5)}$	1.40E+13	8.37E+12	1.675	0.0942
$\emptyset^{1}_{1(6)}$	-1.63E+20	1.47E+20	-1.108	0.2679
$\emptyset^{1}_{1(7)}$	-2.37E+27	1.15E+27	-2.067	0.0389
$\emptyset^{2}_{1(0)}$	1.01E+00	9.33E-03	107.782	<2e-16
$\beta^{(2)}_{1}$	NA	NA	NA	NA
$\beta^{(2)}_{2}$	8.68E-01	4.71E+00	0.184	0.854
$\beta^{(2)}_{3}$	2.53E+00	6.65E+00	0.381	0.703
$\beta^{(2)}_{4}$	1.34E-01	5.43E-01	0.247	8.05E-01
$\beta^{(2)}_{5}$	NA	NA	NA	NA
$\emptyset^{2}_{1(1)}$	-4.52E+00	3.54E+00	-1.276	0.202
$\emptyset^{2}_{1(4)}$	-1.06E+10	2.10E+10	-0.503	0.615
$\emptyset^{2}_{1(5)}$	2.28E+14	2.18E+14	1.049	0.294
$\emptyset^{2}_{1(6)}$	-1.62E+20	3.61E+20	-0.449	0.654
$\emptyset^{2}_{1(7)}$	5.19E+21	5.33E+21	0.974	0.33
$\emptyset^{3}_{1(0)}$	9.98E-01	7.87E-03	126.71	<2e-16
$\beta^{(3)}_{1}$	-2.18E+03	8.89E+03	-0.245	0.8067
$\beta^{(3)}_{2}$	-7.90E+03	1.08E+04	-0.73	0.4657
$\beta^{(3)}_{3}$	2.76E+03	6.00E+03	0.459	0.6462
$\beta^{(3)}_{4}$	1.26E+05	4.98E+04	2.527	0.0116
$\beta^{(3)}_{5}$	1.03E+04	9.19E+03	1.116	0.2648
$\emptyset^{3}_{1(5)}$	3.74E+17	2.24E+17	1.673	9.46E-02
$\emptyset^{3}_{1(6)}$	2.77E+21	6.77E+22	0.041	0.9674
$\emptyset^{3}_{1(7)}$	-3.23E+29	4.77E+29	-0.678	0.498
$\emptyset^{3}_{1(8)}$	-3.34E+35	2.66E+35	-1.253	0.2105
$\emptyset^{4}_{1(0)}$	9.88E-01	5.97E-03	165.451	<2e-16
$\beta^{(4)}_{1}$	1.40E+02	1.94E+02	0.723	0.4699
$\beta^{(4)}_{2}$	9.93E+00	8.72E+01	0.114	0.9094

Par.	Estimate	Std. Error	t value	p-value
$\beta^{(3)}_{3}$	-1.38E+02	9.84E+01	-1.404	0.1605
$\beta^{(3)}_{4}$	1.09E+03	4.88E+02	2.241	0.0252
$\beta^{(3)}_{5}$	9.16E+01	1.28E+02	0.718	0.4726
$\emptyset^{4}_{1(2)}$	3.43E+02	1.55E+02	2.209	0.0273
$\emptyset^{4}_{1(3)}$	1.41E+08	3.69E+08	0.383	0.702
$\emptyset^{4}_{1(5)}$	3.39E+13	1.84E+14	0.184	0.8539
$\emptyset^{4}_{1(6)}$	2.70E+21	8.64E+21	0.312	0.7552
$\emptyset^{4}_{1(7)}$	-9.47E+26	9.23E+26	-1.025	0.3054
$\emptyset^{5}_{1(0)}$	9.93E-01	4.83E-03	205.746	<2e-16
$\beta^{(5)}_{1}$	1.26E+02	3.40E+02	0.371	0.711
$\beta^{(5)}_{2}$	-3.55E+01	8.48E+01	-0.418	0.676
$\beta^{(5)}_{3}$	-8.73E+01	2.55E+02	-0.343	0.732
$\beta^{(5)}_{4}$	3.16E+02	2.61E+02	1.209	0.227
$\beta^{(5)}_{5}$	-2.78E+01	7.53E+01	-0.369	0.712
$\emptyset^{5}_{1(4)}$	-1.40E+13	1.21E+13	-1.16	0.246
$\emptyset^{5}_{1(5)}$	2.87E+14	4.75E+14	0.604	0.546
$\emptyset^{5}_{1(6)}$	4.46E+18	3.30E+18	1.352	0.177
$\emptyset^{6}_{1(0)}$	9.81E-01	1.35E-02	72.755	<2e-16
$\beta^{(6)}_{1}$	6.69E+00	1.78E+01	0.376	0.707
$\beta^{(6)}_{2}$	-1.56E+00	1.92E+00	-0.811	0.417
$\beta^{(6)}_{3}$	1.26E+00	3.52E+00	0.359	0.72
$\beta^{(6)}_{4}$	1.21E+01	2.20E+01	0.551	0.582
$\beta^{(6)}_{5}$	6.58E-01	2.07E+00	0.318	0.751
$\emptyset^{6}_{1(4)}$	-7.70E+09	4.61E+10	-0.167	0.867
$\emptyset^{6}_{1(5)}$	3.24E+16	3.62E+16	0.894	0.371
$\emptyset^{6}_{1(6)}$	4.49E+16	1.13E+17	0.397	0.691
$\emptyset^{6}_{1(7)}$	6.63E+23	8.90E+23	0.745	0.456
$\emptyset^{7}_{1(0)}$	1.00E+00	7.48E-03	134.172	<2e-16
$\beta^{(7)}_{1}$	NA	NA	NA	NA
$\beta^{(7)}_{2}$	NA	NA	NA	NA
$\beta^{(7)}_{3}$	NA	NA	NA	NA
$\beta^{(7)}_{4}$	-2.10E+02	6.96E+02	-0.301	0.763
$\beta^{(7)}_{5}$	-8.88E+02	1.50E+03	-0.593	0.553
$\emptyset^{7}_{1(2)}$	2.93E+04	2.14E+04	1.367	0.172
$\emptyset^{7}_{1(3)}$	-2.22E+09	1.58E+09	-1.405	0.16

Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{7}_{1(5)}$	-1.42E+15	1.70E+15	-0.835	0.404
$\emptyset^{7}_{1(6)}$	7.65E+22	5.15E+22	1.486	0.138
$\emptyset^{7}_{1(7)}$	1.58E+28	3.26E+28	0.484	0.628
$\emptyset^{8}_{1(0)}$	9.72E-01	1.11E-02	87.951	<2e-16
$\beta^{(8)}_{1}$	-7.27E+00	7.05E+00	-1.03	0.303
$\beta^{(8)}_{2}$	-3.81E-01	1.37E+00	-0.277	0.782
$\beta^{(8)}_{3}$	-4.45E-01	1.11E+00	-0.402	0.687
$\beta^{(8)}_{4}$	2.82E+00	2.32E+00	1.214	0.225
$\beta^{(8)}_{5}$	-5.18E-01	1.78E+00	-0.291	0.771
$\emptyset^{8}_{1(1)}$	3.42E+00	3.57E+00	0.96	0.337
$\emptyset^{8}_{1(4)}$	-1.48E+10	1.59E+10	-0.93	0.353
$\emptyset^{8}_{1(5)}$	1.32E+14	1.81E+14	0.727	0.467
$\emptyset^{8}_{1(6)}$	-2.66E+19	3.41E+20	-0.078	0.938
$\emptyset^{8}_{1(7)}$	6.31E+21	4.54E+21	1.391	0.164
$\emptyset^{9}_{1(0)}$	1.00E+00	3.81E-03	262.536	<2e-16
$\beta^{(9)}_{1}$	2.93E+00	6.50E+00	0.45	0.6528
$\beta^{(9)}_{2}$	-7.50E+00	3.87E+00	-1.938	0.0528
$\beta^{(9)}_{3}$	1.15E+01	1.20E+01	0.963	0.3355
$\beta^{(9)}_{4}$	1.46E+01	3.77E+01	0.389	0.6975
$\beta^{(9)}_{5}$	2.91E+00	9.31E+00	0.313	0.7544
$\emptyset^{9}_{1(4)}$	2.94E+11	2.90E+12	0.101	0.9194
$\emptyset^{9}_{1(5)}$	-2.94E+13	7.61E+14	-0.039	0.9691
$\emptyset^{9}_{1(6)}$	8.82E+16	5.77E+17	0.153	0.8787
$\emptyset^{9}_{1(7)}$	-5.16E+26	3.68E+27	-0.14	0.8884
$\emptyset^{10}_{1(0)}$	9.79E-01	7.50E-03	130.44	<2e-16
$\beta^{(10)}_{1}$	1.38E-01	6.86E-01	0.201	0.8409
$\beta^{(10)}_{2}$	-5.66E-01	1.04E+00	-0.544	0.5862
$\beta^{(10)}_{3}$	3.67E-01	4.49E-01	0.817	0.4142
$\beta^{(10)}_{4}$	7.34E+00	3.54E+00	2.077	0.038
$\beta^{(10)}_{5}$	-1.30E-01	5.10E-01	-0.255	0.7984
$\emptyset^{10}_{1(6)}$	-1.13E+18	1.13E+19	-0.1	0.9205
$\emptyset^{10}_{1(7)}$	1.31E+23	7.10E+22	1.842	0.0657
$\emptyset^{10}_{1(8)}$	7.52E+26	8.30E+26	0.906	0.3651

Table A.9.1. *Parameter estimation of GSTARIMAX (1,0,0) from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	9.91E-01	8.57E-03	115.671	<2e-16	$\beta_3^{(3)}$	-1.38E+02	9.84E+01	-1.404	0.1605	$\emptyset^{7}_{1(5)}$	-1.42E+15	1.70E+15	-0.835	0.404
$\beta_1^{(1)}$	NA	NA	NA	NA	$\beta_4^{(3)}$	1.09E+03	4.88E+02	2.241	0.0252	$\emptyset^{7}_{1(6)}$	7.65E+22	5.15E+22	1.486	0.138
$\beta_2^{(1)}$	NA	NA	NA	NA	$\beta_5^{(3)}$	9.16E+01	1.28E+02	0.718	0.4726	$\emptyset^{7}_{1(7)}$	1.58E+28	3.26E+28	0.484	0.628
$\beta_3^{(1)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(2)}$	3.43E+02	1.55E+02	2.209	0.0273	$\emptyset^{8}_{1(0)}$	9.72E-01	1.11E-02	87.951	<2e-16
$\beta_4^{(1)}$	4.54E+00	4.52E+00	1.004	0.3157	$\emptyset^{4}_{1(3)}$	1.41E+08	3.69E+08	0.383	0.702	$\beta_1^{(8)}$	-7.27E+00	7.05E+00	-1.03	0.303
$\beta_5^{(1)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(5)}$	3.39E+13	1.84E+14	0.184	0.8539	$\beta_2^{(8)}$	-3.81E-01	1.37E+00	-0.277	0.782
$\emptyset^{1}_{1(3)}$	9.39E+04	4.07E+04	2.307	0.0212	$\emptyset^{4}_{1(6)}$	2.70E+21	8.64E+21	0.312	0.7552	$\beta_3^{(8)}$	-4.45E-01	1.11E+00	-0.402	0.687
$\emptyset^{1}_{1(4)}$	-1.16E+10	4.02E+10	-0.289	0.7723	$\emptyset^{4}_{1(7)}$	-9.47E+26	9.23E+26	-1.025	0.3054	$\beta_4^{(8)}$	2.82E+00	2.32E+00	1.214	0.225
$\emptyset^{1}_{1(5)}$	1.40E+13	8.37E+12	1.675	0.0942	$\emptyset^{5}_{1(0)}$	9.93E-01	4.83E-03	205.746	<2e-16	$\beta_5^{(8)}$	-5.18E-01	1.78E+00	-0.291	0.771
$\emptyset^{1}_{1(6)}$	-1.63E+20	1.47E+20	-1.108	0.2679	$\beta_1^{(5)}$	1.26E+02	3.40E+02	0.371	0.711	$\emptyset^{8}_{1(1)}$	3.42E+00	3.57E+00	0.96	0.337
$\emptyset^{1}_{1(7)}$	-2.37E+27	1.15E+27	-2.067	0.0389	$\beta_2^{(5)}$	-3.55E+01	8.48E+01	-0.418	0.676	$\emptyset^{8}_{1(4)}$	-1.48E+10	1.59E+10	-0.93	0.353
$\emptyset^{2}_{1(0)}$	1.01E+00	9.33E-03	107.782	<2e-16	$\beta_3^{(5)}$	-8.73E+01	2.55E+02	-0.343	0.732	$\emptyset^{8}_{1(5)}$	1.32E+14	1.81E+14	0.727	0.467
$\beta_1^{(2)}$	NA	NA	NA	NA	$\beta_4^{(5)}$	3.16E+02	2.61E+02	1.209	0.227	$\emptyset^{8}_{1(6)}$	-2.66E+19	3.41E+20	-0.078	0.938
$\beta_2^{(2)}$	8.68E-01	4.71E+00	0.184	0.854	$\beta_5^{(5)}$	-2.78E+01	7.53E+01	-0.369	0.712	$\emptyset^{8}_{1(7)}$	6.31E+21	4.54E+21	1.391	0.164
$\beta_3^{(2)}$	2.53E+00	6.65E+00	0.381	0.703	$\emptyset^{5}_{1(4)}$	-1.40E+13	1.21E+13	-1.16	0.246	$\emptyset^{9}_{1(0)}$	1.00E+00	3.81E-03	262.536	<2e-16
$\beta_4^{(2)}$	1.34E-01	5.43E-01	0.247	8.05E-01	$\emptyset^{5}_{1(5)}$	2.87E+14	4.75E+14	0.604	0.546	$\beta_1^{(9)}$	2.93E+00	6.50E+00	0.45	0.6528
$\beta_5^{(2)}$	NA	NA	NA	NA	$\emptyset^{5}_{1(6)}$	4.46E+18	3.30E+18	1.352	0.177	$\beta_2^{(9)}$	-7.50E+00	3.87E+00	-1.938	0.0528
$\emptyset^{2}_{1(1)}$	-4.52E+00	3.54E+00	-1.276	0.202	$\emptyset^{6}_{1(0)}$	9.81E-01	1.35E-02	72.755	<2e-16	$\beta_3^{(9)}$	1.15E+01	1.20E+01	0.963	0.3355
$\emptyset^{2}_{1(4)}$	-1.06E+10	2.10E+10	-0.503	0.615	$\beta_1^{(6)}$	6.69E+00	1.78E+01	0.376	0.707	$\beta_4^{(9)}$	1.46E+01	3.77E+01	0.389	0.6975
$\emptyset^{2}_{1(5)}$	2.28E+14	2.18E+14	1.049	0.294	$\beta_2^{(6)}$	-1.56E+00	1.92E+00	-0.811	0.417	$\beta_5^{(9)}$	2.91E+00	9.31E+00	0.313	0.7544
$\emptyset^{2}_{1(6)}$	-1.62E+20	3.61E+20	-0.449	0.654	$\beta_3^{(6)}$	1.26E+00	3.52E+00	0.359	0.72	$\emptyset^{9}_{1(4)}$	2.94E+11	2.90E+12	0.101	0.9194
$\emptyset^{2}_{1(7)}$	5.19E+21	5.33E+21	0.974	0.33	$\beta_4^{(6)}$	1.21E+01	2.20E+01	0.551	0.582	$\emptyset^{9}_{1(5)}$	-2.94E+13	7.61E+14	-0.039	0.9691
$\emptyset^{3}_{1(0)}$	9.98E-01	7.87E-03	126.71	<2e-16	$\beta_5^{(6)}$	6.58E-01	2.07E+00	0.318	0.751	$\emptyset^{9}_{1(6)}$	8.82E+16	5.77E+17	0.153	0.8787
$\beta_1^{(3)}$	-2.18E+03	8.89E+03	-0.245	0.8067	$\emptyset^{6}_{1(4)}$	-7.70E+09	4.61E+10	-0.167	0.867	$\emptyset^{9}_{1(7)}$	-5.16E+26	3.68E+27	-0.14	0.8884
$\beta_2^{(3)}$	-7.90E+03	1.08E+04	-0.73	0.4657	$\emptyset^{6}_{1(5)}$	3.24E+16	3.62E+16	0.894	0.371	$\emptyset^{10}_{1(0)}$	9.79E-01	7.50E-03	130.44	<2e-16
$\beta_3^{(3)}$	2.76E+03	6.00E+03	0.459	0.6462	$\emptyset^{6}_{1(6)}$	4.49E+16	1.13E+17	0.397	0.691	$\beta_1^{(10)}$	1.38E-01	6.86E-01	0.201	0.8409
$\beta_4^{(3)}$	1.26E+05	4.98E+04	2.527	0.0116	$\emptyset^{6}_{1(7)}$	6.63E+23	8.90E+23	0.745	0.456	$\beta_2^{(10)}$	-5.66E-01	1.04E+00	-0.544	0.5862
$\beta_5^{(3)}$	1.03E+04	9.19E+03	1.116	0.2648	$\emptyset^{7}_{1(0)}$	1.00E+00	7.48E-03	134.172	<2e-16	$\beta_3^{(10)}$	3.67E-01	4.49E-01	0.817	0.4142
$\emptyset^{3}_{1(5)}$	3.74E+17	2.24E+17	1.673	9.46E-02	$\beta_1^{(7)}$	NA	NA	NA	NA	$\beta_4^{(10)}$	7.34E+00	3.54E+00	2.077	0.038
$\emptyset^{3}_{1(6)}$	2.77E+21	6.77E+22	0.041	0.9674	$\beta_2^{(7)}$	NA	NA	NA	NA	$\beta_5^{(10)}$	-1.30E-01	5.10E-01	-0.255	0.7984
$\emptyset^{3}_{1(7)}$	-3.23E+29	4.77E+29	-0.678	0.498	$\beta_3^{(7)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(6)}$	-1.13E+18	1.13E+19	-0.1	0.9205
$\emptyset^{3}_{1(8)}$	-3.34E+35	2.66E+35	-1.253	0.2105	$\beta_4^{(7)}$	-2.10E+02	6.96E+02	-0.301	0.763	$\emptyset^{10}_{1(7)}$	1.31E+23	7.10E+22	1.842	0.0657
$\emptyset^{4}_{1(0)}$	9.88E-01	5.97E-03	165.451	<2e-16	$\beta_5^{(7)}$	-8.88E+02	1.50E+03	-0.593	0.553	$\emptyset^{10}_{1(8)}$	7.52E+26	8.30E+26	0.906	0.3651
$\beta_1^{(4)}$	1.40E+02	1.94E+02	0.723	0.4699	$\emptyset^{7}_{1(2)}$	2.93E+04	2.14E+04	1.367	0.172					
$\beta_2^{(4)}$	9.93E+00	8.72E+01	0.114	0.9094	$\emptyset^{7}_{1(3)}$	-2.22E+09	1.58E+09	-1.405	0.16					

Table A.10.1. *Parameter estimation of GSTARIMAX (1,1,0) from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	1.22E-01	9.94E-02	1.231	0.2185	$\beta^{(3)}_{3}$	-8.42E+01	9.92E+01	-0.849	0.396	$\emptyset^{7}_{1(5)}$	2.67E+16	1.77E+16	1.505	0.13247
$\beta^{(1)}_{1}$	NA	NA	NA	NA	$\beta^{(3)}_{4}$	2.75E+01	2.05E+01	1.339	0.1808	$\emptyset^{7}_{1(6)}$	6.00E+23	6.51E+23	0.921	0.357
$\beta^{(1)}_{2}$	NA	NA	NA	NA	$\beta^{(3)}_{5}$	3.25E+01	1.29E+02	0.252	0.8008	$\emptyset^{7}_{1(7)}$	2.70E+29	1.92E+29	1.408	0.15947
$\beta^{(1)}_{3}$	NA	NA	NA	NA	$\emptyset^{4}_{1(2)}$	-9.94E+02	1.21E+03	-0.821	0.4115	$\emptyset^{8}_{1(0)}$	-1.13E-01	7.14E-02	-1.579	0.115
$\beta^{(1)}_{4}$	9.01E+00	4.25E+00	2.12	0.0342	$\emptyset^{4}_{1(3)}$	4.99E+09	4.09E+09	1.22	0.2228	$\beta^{(8)}_{1}$	-8.28E+00	7.20E+00	-1.15	0.25
$\beta^{(1)}_{5}$	NA	NA	NA	NA	$\emptyset^{4}_{1(5)}$	2.01E+15	1.30E+15	1.544	0.1228	$\beta^{(8)}_{2}$	1.74E-01	1.40E+00	0.124	0.901
$\emptyset^{1}_{1(3)}$	-4.26E+05	2.60E+05	-1.641	0.1011	$\emptyset^{4}_{1(6)}$	1.96E+22	6.74E+22	0.291	0.7711	$\beta^{(8)}_{3}$	8.89E-02	1.13E+00	0.079	0.937
$\emptyset^{1}_{1(4)}$	7.55E+10	2.93E+11	0.258	0.7964	$\emptyset^{4}_{1(7)}$	-1.17E+28	6.83E+27	-1.717	0.0862	$\beta^{(8)}_{4}$	2.68E-01	1.94E-01	1.381	0.167
$\emptyset^{1}_{1(5)}$	4.03E+13	6.10E+13	0.661	0.5087	$\emptyset^{5}_{1(0)}$	-2.49E-03	3.60E-02	-0.069	0.945	$\beta^{(8)}_{5}$	1.74E+00	1.81E+00	0.962	0.336
$\emptyset^{1}_{1(6)}$	6.94E+20	1.46E+21	0.475	0.6348	$\beta^{(5)}_{1}$	-5.91E-02	3.46E+02	0	1	$\emptyset^{8}_{1(1)}$	1.68E+01	2.66E+01	0.63	0.529
$\emptyset^{1}_{1(7)}$	-1.44E+28	9.00E+27	-1.604	0.109	$\beta^{(5)}_{2}$	-7.40E+01	8.57E+01	-0.863	0.388	$\emptyset^{8}_{1(4)}$	2.55E+10	2.16E+11	0.118	0.906
$\emptyset^{2}_{1(0)}$	4.68E-02	7.34E-02	0.637	0.5241	$\beta^{(5)}_{3}$	-3.50E+01	2.60E+02	-0.135	0.893	$\emptyset^{8}_{1(5)}$	-6.53E+14	1.31E+15	-0.497	0.619
$\beta^{(2)}_{1}$	NA	NA	NA	NA	$\beta^{(5)}_{4}$	1.62E+01	2.19E+01	0.737	0.461	$\emptyset^{8}_{1(6)}$	-3.00E+20	2.12E+21	-0.141	0.888
$\beta^{(2)}_{2}$	2.83E+00	4.80E+00	0.59	0.5553	$\beta^{(5)}_{5}$	1.50E+01	7.44E+01	0.201	0.84	$\emptyset^{8}_{1(7)}$	1.86E+22	2.62E+22	0.709	0.478
$\beta^{(2)}_{3}$	2.34E-01	6.81E+00	0.034	9.73E-01	$\emptyset^{5}_{1(4)}$	9.57E+13	1.13E+14	0.846	0.398	$\emptyset^{9}_{1(0)}$	9.69E-02	2.99E-02	3.242	0.00121
$\beta^{(2)}_{4}$	1.08E-01	5.20E-01	0.207	0.8364	$\emptyset^{5}_{1(5)}$	-5.33E+15	3.25E+15	-1.641	0.101	$\beta^{(9)}_{1}$	-5.47E+00	6.41E+00	-0.853	0.39391
$\beta^{(2)}_{5}$	NA	NA	NA	NA	$\emptyset^{5}_{1(6)}$	-2.28E+19	4.84E+19	-0.471	0.638	$\beta^{(9)}_{2}$	-5.45E+00	3.94E+00	-1.382	0.16706
$\emptyset^{2}_{1(1)}$	-4.60E+01	2.30E+01	-1.996	0.0461	$\emptyset^{6}_{1(0)}$	4.57E-02	7.64E-02	0.599	0.5495	$\beta^{(9)}_{3}$	5.64E+00	1.22E+01	0.463	0.64327
$\emptyset^{2}_{1(4)}$	2.98E+11	3.10E+11	0.963	0.3358	$\beta^{(6)}_{1}$	5.32E+00	1.80E+01	0.296	0.7674	$\beta^{(9)}_{4}$	5.86E+00	2.16E+00	2.709	0.00683
$\emptyset^{2}_{1(5)}$	-1.37E+15	1.59E+15	-0.86	0.3897	$\beta^{(6)}_{2}$	-8.75E-01	1.96E+00	-0.447	0.6547	$\beta^{(9)}_{5}$	-4.35E+00	9.39E+00	-0.464	0.64296
$\emptyset^{2}_{1(6)}$	3.03E+21	2.27E+21	1.335	0.1822	$\beta^{(6)}_{3}$	-1.61E+00	3.59E+00	-0.449	0.6532	$\emptyset^{9}_{1(4)}$	-2.89E+13	1.97E+13	-1.467	0.14251
$\emptyset^{2}_{1(7)}$	-1.28E+22	3.16E+22	-0.407	0.6842	$\beta^{(6)}_{4}$	1.52E+00	1.12E+00	1.36	0.174	$\emptyset^{9}_{1(5)}$	2.66E+15	6.35E+15	0.419	0.67514
$\emptyset^{3}_{1(0)}$	1.52E-01	7.73E-02	1.963	0.0498	$\beta^{(6)}_{5}$	-1.58E-01	1.79E+00	-0.088	0.9295	$\emptyset^{9}_{1(6)}$	-5.91E+18	2.89E+18	-2.043	0.04127
$\beta^{(3)}_{1}$	-7.79E+03	8.12E+03	-0.96	0.3375	$\emptyset^{6}_{1(4)}$	1.39E+11	3.66E+11	0.379	0.7046	$\emptyset^{9}_{1(7)}$	3.79E+28	2.25E+28	1.683	0.09261
$\beta^{(3)}_{2}$	-7.52E+03	1.08E+04	-0.694	0.4879	$\emptyset^{6}_{1(5)}$	-1.96E+17	2.70E+17	-0.725	0.4687	$\emptyset^{10}_{1(0)}$	-2.58E-02	6.82E-02	-0.379	0.705
$\beta^{(3)}_{3}$	7.75E+03	6.10E+03	1.27	0.2044	$\emptyset^{6}_{1(6)}$	2.89E+17	6.39E+17	0.453	0.6505	$\beta^{(10)}_{1}$	7.22E-01	7.00E-01	1.031	0.303
$\beta^{(3)}_{4}$	5.97E+03	1.17E+04	0.511	6.09E-01	$\emptyset^{6}_{1(7)}$	-1.32E+25	5.92E+24	-2.234	0.0257	$\beta^{(10)}_{2}$	-8.79E-01	1.06E+00	-0.83	0.407
$\beta^{(3)}_{5}$	5.15E+03	6.58E+03	0.783	0.4339	$\emptyset^{7}_{1(0)}$	-1.83E-01	5.66E-02	-3.236	0.00124	$\beta^{(10)}_{3}$	3.27E-01	4.49E-01	0.728	0.467
$\emptyset^{3}_{1(5)}$	-2.56E+18	1.46E+18	-1.75	0.0803	$\beta^{(7)}_{1}$	NA	NA	NA	NA	$\beta^{(10)}_{4}$	2.59E-01	1.28E+00	0.202	0.84
$\emptyset^{3}_{1(6)}$	5.80E+23	5.05E+23	1.148	0.251	$\beta^{(7)}_{2}$	NA	NA	NA	NA	$\beta^{(10)}_{5}$	9.17E-02	4.59E-01	0.2	0.842
$\emptyset^{3}_{1(7)}$	-8.72E+29	2.90E+30	-0.301	0.7636	$\beta^{(7)}_{3}$	NA	NA	NA	NA	$\emptyset^{10}_{1(6)}$	-6.63E+19	9.06E+19	-0.732	0.465
$\emptyset^{3}_{1(8)}$	-3.71E+36	2.17E+36	-1.708	0.0879	$\beta^{(7)}_{4}$	-5.19E+00	6.41E+02	-0.008	0.99353	$\emptyset^{10}_{1(7)}$	-6.48E+23	5.80E+23	-1.118	0.264
$\emptyset^{4}_{1(0)}$	-3.64E-02	3.85E-02	-0.943	0.3457	$\beta^{(7)}_{5}$	9.20E+00	1.48E+03	0.006	0.99503	$\emptyset^{10}_{1(8)}$	1.31E+28	1.17E+28	1.119	0.263
$\beta^{(4)}_{1}$	1.09E+02	1.99E+02	0.547	0.5844	$\emptyset^{7}_{1(2)}$	-5.67E+05	1.77E+05	-3.205	0.00138					
$\beta^{(4)}_{2}$	-2.94E+01	8.89E+01	-0.331	0.7409	$\emptyset^{7}_{1(3)}$	-2.71E+09	1.36E+10	-0.199	0.84267					

Table A.11.1. *Parameter estimation of GSTARIMAX (1,1,0) from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	3.27E-02	1.02E-01	0.32	0.749	$\beta^{(3)}_{3}$	-1.35E+02	9.46E+01	-1.431	0.153	$\emptyset^{7}_{1(5)}$	-5.21E+15	1.75E+16	-0.297	0.76648
$\beta^{(1)}_{1}$	NA	NA	NA	NA	$\beta^{(3)}_{4}$	3.10E+01	1.96E+01	1.579	0.114	$\emptyset^{7}_{1(6)}$	6.91E+23	6.36E+23	1.087	0.27721
$\beta^{(1)}_{2}$	NA	NA	NA	NA	$\beta^{(3)}_{5}$	1.47E+02	1.23E+02	1.203	0.229	$\emptyset^{7}_{1(7)}$	2.99E+29	1.89E+29	1.578	0.11487
$\beta^{(1)}_{3}$	NA	NA	NA	NA	$\emptyset^{4}_{1(2)}$	3.66E+02	1.20E+03	0.306	0.76	$\emptyset^{8}_{1(0)}$	-2.22E-01	7.02E-02	-3.169	0.00156
$\beta^{(1)}_{4}$	7.37E+00	4.08E+00	1.807	0.071	$\emptyset^{4}_{1(3)}$	2.26E+09	4.19E+09	0.54	0.59	$\beta^{(8)}_{1}$	-7.55E+00	6.93E+00	-1.089	0.27619
$\beta^{(1)}_{5}$	NA	NA	NA	NA	$\emptyset^{4}_{1(5)}$	-9.65E+14	1.29E+15	-0.746	0.456	$\beta^{(8)}_{2}$	-3.20E-01	1.35E+00	-0.238	0.81229
$\emptyset^{1}_{1(3)}$	-3.76E+05	2.60E+05	-1.447	0.148	$\emptyset^{4}_{1(6)}$	-9.03E+21	6.58E+22	-0.137	0.891	$\beta^{(8)}_{3}$	-3.13E-01	1.09E+00	-0.288	0.77326
$\emptyset^{1}_{1(4)}$	2.42E+11	2.84E+11	0.85	0.395	$\emptyset^{4}_{1(7)}$	3.69E+27	7.00E+27	0.527	0.598	$\beta^{(8)}_{4}$	3.44E-01	1.87E-01	1.839	0.06616
$\emptyset^{1}_{1(5)}$	-6.70E+13	6.10E+13	-1.099	0.272	$\emptyset^{5}_{1(0)}$	-1.72E-01	3.50E-02	-4.922	9.55E-07	$\beta^{(8)}_{5}$	6.55E-01	1.75E+00	0.374	0.7084
$\emptyset^{1}_{1(6)}$	2.11E+20	1.44E+21	0.147	0.883	$\beta^{(5)}_{1}$	7.05E+01	3.33E+02	0.212	0.832	$\emptyset^{8}_{1(1)}$	1.54E+01	2.60E+01	0.591	0.55448
$\emptyset^{1}_{1(7)}$	-7.77E+27	9.23E+27	-0.842	0.4	$\beta^{(5)}_{2}$	-4.93E+01	8.23E+01	-0.599	0.549	$\emptyset^{8}_{1(4)}$	-9.24E+10	2.14E+11	-0.432	0.66608
$\emptyset^{2}_{1(0)}$	-1.06E-01	7.16E-02	-1.476	0.1401	$\beta^{(5)}_{3}$	-8.91E-01	2.49E+02	-0.004	0.997	$\emptyset^{8}_{1(5)}$	4.70E+14	1.28E+15	0.368	0.71309
$\beta^{(2)}_{1}$	NA	NA	NA	NA	$\beta^{(5)}_{4}$	1.77E+01	2.10E+01	0.839	0.401	$\emptyset^{8}_{1(6)}$	1.67E+21	2.12E+21	0.786	0.43187
$\beta^{(2)}_{2}$	1.51E+00	4.63E+00	0.325	0.7449	$\beta^{(5)}_{5}$	-1.84E+01	7.14E+01	-0.258	0.797	$\emptyset^{8}_{1(7)}$	-2.68E+22	2.61E+22	-1.027	0.3044
$\beta^{(2)}_{3}$	2.51E+00	6.56E+00	0.382	0.7025	$\emptyset^{5}_{1(4)}$	1.47E+14	1.13E+14	1.299	0.194	$\emptyset^{9}_{1(0)}$	2.09E-02	2.98E-02	0.7	0.48388
$\beta^{(2)}_{4}$	2.83E-01	5.02E-01	0.563	0.5736	$\emptyset^{5}_{1(5)}$	-4.29E+15	3.24E+15	-1.323	0.186	$\beta^{(9)}_{1}$	1.39E+00	6.25E+00	0.223	0.82371
$\beta^{(2)}_{5}$	NA	NA	NA	NA	$\emptyset^{5}_{1(6)}$	-4.49E+19	4.84E+19	-0.93	0.353	$\beta^{(9)}_{2}$	-7.26E+00	3.84E+00	-1.889	0.05907
$\emptyset^{2}_{1(1)}$	-3.71E+01	2.26E+01	-1.642	0.1008	$\emptyset^{6}_{1(0)}$	3.77E-02	7.61E-02	0.496	0.62012	$\beta^{(9)}_{3}$	1.02E+01	1.19E+01	0.859	0.39047
$\emptyset^{2}_{1(4)}$	1.13E+11	3.06E+11	0.37	0.7116	$\beta^{(6)}_{1}$	4.56E+00	1.74E+01	0.262	0.79345	$\beta^{(9)}_{4}$	5.78E+00	2.11E+00	2.744	0.00614
$\emptyset^{2}_{1(5)}$	-2.18E+14	1.55E+15	-0.141	0.888	$\beta^{(6)}_{2}$	-1.55E+00	1.89E+00	-0.819	0.41314	$\beta^{(9)}_{5}$	2.57E+00	9.13E+00	0.281	0.77865
$\emptyset^{2}_{1(6)}$	5.10E+21	2.26E+21	2.257	0.0242	$\beta^{(6)}_{3}$	4.92E-01	3.47E+00	0.142	0.88734	$\emptyset^{9}_{1(4)}$	-4.07E+13	1.94E+13	-2.092	0.03664
$\emptyset^{2}_{1(7)}$	-5.81E+22	3.15E+22	-1.844	0.0654	$\beta^{(6)}_{4}$	1.52E+00	1.08E+00	1.398	0.16236	$\emptyset^{9}_{1(5)}$	-1.97E+15	6.23E+15	-0.316	0.75179
$\emptyset^{3}_{1(0)}$	-1.10E-01	7.75E-02	-1.419	0.156	$\beta^{(6)}_{5}$	5.46E-01	1.73E+00	0.316	0.75216	$\emptyset^{9}_{1(6)}$	-6.05E+18	2.94E+18	-2.058	0.03976
$\beta^{(3)}_{1}$	-3.44E+03	7.78E+03	-0.442	0.658	$\emptyset^{6}_{1(4)}$	1.91E+10	3.64E+11	0.053	0.95811	$\emptyset^{9}_{1(7)}$	5.08E+28	2.22E+28	2.288	0.02228
$\beta^{(3)}_{2}$	-3.36E+03	1.04E+04	-0.323	0.746	$\emptyset^{6}_{1(5)}$	-8.56E+16	2.67E+17	-0.32	0.74878	$\emptyset^{10}_{1(0)}$	-4.11E-02	6.85E-02	-0.6	0.549
$\beta^{(3)}_{3}$	3.79E+03	5.85E+03	0.648	0.517	$\emptyset^{6}_{1(6)}$	-1.01E+18	6.47E+17	-1.563	0.11817	$\beta^{(10)}_{1}$	2.33E-01	6.79E-01	0.343	0.731
$\beta^{(3)}_{4}$	5.15E+03	1.12E+04	0.46	0.646	$\emptyset^{6}_{1(7)}$	-1.64E+25	5.86E+24	-2.804	0.00511	$\beta^{(10)}_{2}$	-7.73E-01	1.03E+00	-0.754	0.451
$\beta^{(3)}_{5}$	3.08E+03	6.30E+03	0.489	0.625	$\emptyset^{7}_{1(0)}$	-2.68E-01	5.59E-02	-4.795	1.80E-06	$\beta^{(10)}_{3}$	5.46E-01	4.35E-01	1.255	0.21
$\emptyset^{3}_{1(5)}$	-1.94E+18	1.46E+18	-1.323	0.186	$\beta^{(7)}_{1}$	NA	NA	NA	NA	$\beta^{(10)}_{4}$	6.38E-01	1.24E+00	0.513	0.608
$\emptyset^{3}_{1(6)}$	7.06E+23	4.88E+23	1.446	0.148	$\beta^{(7)}_{2}$	NA	NA	NA	NA	$\beta^{(10)}_{5}$	-1.16E-01	4.45E-01	-0.26	0.795
$\emptyset^{3}_{1(7)}$	-3.94E+29	2.82E+30	-0.14	0.889	$\beta^{(7)}_{3}$	NA	NA	NA	NA	$\emptyset^{10}_{1(6)}$	-3.41E+19	8.87E+19	-0.384	0.701
$\emptyset^{3}_{1(8)}$	-1.65E+36	2.14E+36	-0.77	0.441	$\beta^{(7)}_{4}$	3.11E+02	6.10E+02	0.51	0.61036	$\emptyset^{10}_{1(7)}$	-4.69E+23	5.85E+23	-0.802	0.423
$\emptyset^{4}_{1(0)}$	-2.51E-01	3.76E-02	-6.67	3.64E-11	$\beta^{(7)}_{5}$	2.32E+02	1.41E+03	0.165	0.86899	$\emptyset^{10}_{1(8)}$	-1.10E+28	1.18E+28	-0.926	0.355
$\beta^{(4)}_{1}$	1.41E+02	1.90E+02	0.743	0.458	$\emptyset^{7}_{1(2)}$	-5.19E+05	1.73E+05	-3.006	0.00269					
$\beta^{(4)}_{2}$	-1.95E+01	8.48E+01	-0.23	0.818	$\emptyset^{7}_{1(3)}$	6.27E+09	1.36E+10	0.462	0.64382					

Table A.12.1. *Correlation of GSTARIMA model parameters (1,0,0) from LOCF imputation*

	$\varnothing^{1}_{1(0)}$	$\varnothing^{1}_{1(3)}$	$\varnothing^{1}_{1(4)}$	$\varnothing^{1}_{1(5)}$	$\varnothing^{1}_{1(6)}$
$\varnothing^{1}_{1(3)}$	0.937				
$\varnothing^{1}_{1(4)}$	0.66	0.767			
$\varnothing^{1}_{1(5)}$	0.891	0.829	0.708		
$\varnothing^{1}_{1(6)}$	0.757	0.649	0.583	0.899	
$\varnothing^{1}_{1(7)}$	0.93	0.908	0.654	0.893	0.661

	$\varnothing^{2}_{1(0)}$	$\varnothing^{2}_{1(1)}$	$\varnothing^{2}_{1(4)}$	$\varnothing^{2}_{1(5)}$	$\varnothing^{2}_{1(6)}$
$\varnothing^{2}_{1(1)}$	0.92				
$\varnothing^{2}_{1(4)}$	0.535	0.678			
$\varnothing^{2}_{1(5)}$	0.71	0.729	0.573		
$\varnothing^{2}_{1(6)}$	0.929	0.97	0.69	0.711	
$\varnothing^{2}_{1(7)}$	0.778	0.919	0.853	0.761	0.924

	$\varnothing^{3}_{1(0)}$	$\varnothing^{3}_{1(5)}$	$\varnothing^{3}_{1(6)}$	$\varnothing^{3}_{1(7)}$
$\varnothing^{3}_{1(5)}$	0.836			
$\varnothing^{3}_{1(6)}$	0.842	0.825		
$\varnothing^{3}_{1(7)}$	0.848	0.952	0.781	
$\varnothing^{3}_{1(8)}$	0.893	0.913	0.749	0.938

	$\varnothing^{4}_{1(0)}$	$\varnothing^{4}_{1(2)}$	$\varnothing^{4}_{1(3)}$	$\varnothing^{4}_{1(5)}$	$\varnothing^{4}_{1(6)}$
$\varnothing^{4}_{1(2)}$	0.856				
$\varnothing^{4}_{1(3)}$	0.878	0.936			
$\varnothing^{4}_{1(5)}$	0.864	0.827	0.891		
$\varnothing^{4}_{1(6)}$	0.696	0.595	0.712	0.868	
$\varnothing^{4}_{1(7)}$	0.893	0.923	0.946	0.894	0.615

	$\varnothing^{5}_{1(0)}$	$\varnothing^{5}_{1(4)}$	$\varnothing^{5}_{1(5)}$
$\varnothing^{5}_{1(4)}$	0.66		
$\varnothing^{5}_{1(5)}$	0.766	0.939	
$\varnothing^{5}_{1(6)}$	0.708	0.891	0.833

	$\varnothing^{6}_{1(0)}$	$\varnothing^{6}_{1(4)}$	$\varnothing^{6}_{1(5)}$	$\varnothing^{6}_{1(6)}$
$\varnothing^{6}_{1(4)}$	0.605			
$\varnothing^{6}_{1(5)}$	0.938	0.627		
$\varnothing^{6}_{1(6)}$	0.895	0.867	0.851	
$\varnothing^{6}_{1(7)}$	0.888	0.696	0.87	0.866

	$\varnothing^{7}_{1(0)}$	$\varnothing^{7}_{1(2)}$	$\varnothing^{7}_{1(3)}$	$\varnothing^{7}_{1(5)}$	$\varnothing^{7}_{1(6)}$
$\varnothing^{7}_{1(2)}$	0.856				
$\varnothing^{7}_{1(3)}$	0.936	0.878			
$\varnothing^{7}_{1(5)}$	0.829	0.863	0.891		
$\varnothing^{7}_{1(6)}$	0.64	0.734	0.752	0.897	
$\varnothing^{7}_{1(7)}$	0.95	0.879	0.968	0.863	0.676

	$\varnothing^{8}_{1(0)}$	$\varnothing^{8}_{1(1)}$	$\varnothing^{8}_{1(4)}$	$\varnothing^{8}_{1(5)}$	$\varnothing^{8}_{1(6)}$
$\varnothing^{8}_{1(1)}$	0.92				
$\varnothing^{8}_{1(4)}$	0.678	0.535			
$\varnothing^{8}_{1(5)}$	0.728	0.709	0.573		
$\varnothing^{8}_{1(6)}$	0.967	0.932	0.697	0.708	
$\varnothing^{8}_{1(7)}$	0.919	0.778	0.853	0.761	0.922

	$\varnothing^{9}_{1(0)}$	$\varnothing^{9}_{1(4)}$	$\varnothing^{9}_{1(5)}$	$\varnothing^{9}_{1(6)}$
$\varnothing^{9}_{1(4)}$	0.613			
$\varnothing^{9}_{1(5)}$	0.554	0.665		
$\varnothing^{9}_{1(6)}$	0.863	0.902	0.716	
$\varnothing^{9}_{1(7)}$	0.605	0.999	0.654	0.901

	$\varnothing^{10}_{1(0)}$	$\varnothing^{10}_{1(6)}$	$\varnothing^{10}_{1(7)}$
$\varnothing^{10}_{1(6)}$	0.676		
$\varnothing^{10}_{1(7)}$	0.913	0.785	
$\varnothing^{10}_{1(8)}$	0.893	0.724	0.843

Table A.13.1. *Correlation of GSTARIMA model parameters (1,0,0) from MA imputation*

	$\emptyset^{1}_{1(0)}$	$\emptyset^{1}_{1(3)}$	$\emptyset^{1}_{1(4)}$	$\emptyset^{1}_{1(5)}$	$\emptyset^{1}_{1(6)}$
$\emptyset^{1}_{1(3)}$	0.937				
$\emptyset^{1}_{1(4)}$	0.659	0.766			
$\emptyset^{1}_{1(5)}$	0.89	0.828	0.707		
$\emptyset^{1}_{1(6)}$	0.758	0.65	0.582	0.9	
$\emptyset^{1}_{1(7)}$	0.93	0.907	0.652	0.893	0.662

	$\emptyset^{2}_{1(0)}$	$\emptyset^{2}_{1(1)}$	$\emptyset^{2}_{1(4)}$	$\emptyset^{2}_{1(5)}$	$\emptyset^{2}_{1(6)}$
$\emptyset^{2}_{1(1)}$	0.92				
$\emptyset^{2}_{1(4)}$	0.535	0.679			
$\emptyset^{2}_{1(5)}$	0.708	0.728	0.573		
$\emptyset^{2}_{1(6)}$	0.929	0.97	0.691	0.709	
$\emptyset^{2}_{1(7)}$	0.777	0.919	0.854	0.76	0.924

	$\emptyset^{3}_{1(0)}$	$\emptyset^{3}_{1(5)}$	$\emptyset^{3}_{1(6)}$	$\emptyset^{3}_{1(7)}$
$\emptyset^{3}_{1(5)}$	0.836			
$\emptyset^{3}_{1(6)}$	0.842	0.825		
$\emptyset^{3}_{1(7)}$	0.848	0.953	0.78	
$\emptyset^{3}_{1(8)}$	0.893	0.912	0.748	0.938

	$\emptyset^{4}_{1(0)}$	$\emptyset^{4}_{1(2)}$	$\emptyset^{4}_{1(3)}$	$\emptyset^{4}_{1(5)}$	$\emptyset^{4}_{1(6)}$
$\emptyset^{4}_{1(2)}$	0.857				
$\emptyset^{4}_{1(3)}$	0.879	0.936			
$\emptyset^{4}_{1(5)}$	0.865	0.827	0.89		
$\emptyset^{4}_{1(6)}$	0.697	0.596	0.712	0.869	
$\emptyset^{4}_{1(7)}$	0.894	0.923	0.946	0.893	0.616

	$\emptyset^{5}_{1(0)}$	$\emptyset^{5}_{1(4)}$	$\emptyset^{5}_{1(5)}$
$\emptyset^{5}_{1(4)}$	0.659		
$\emptyset^{5}_{1(5)}$	0.765	0.939	
$\emptyset^{5}_{1(6)}$	0.707	0.89	0.833

	$\emptyset^{6}_{1(0)}$	$\emptyset^{6}_{1(4)}$	$\emptyset^{6}_{1(5)}$	$\emptyset^{6}_{1(6)}$
$\emptyset^{6}_{1(4)}$	0.605			
$\emptyset^{6}_{1(5)}$	0.938	0.628		
$\emptyset^{6}_{1(6)}$	0.895	0.868	0.85	
$\emptyset^{6}_{1(7)}$	0.889	0.697	0.871	0.867

	$\emptyset^{7}_{1(0)}$	$\emptyset^{7}_{1(2)}$	$\emptyset^{7}_{1(3)}$	$\emptyset^{7}_{1(5)}$	$\emptyset^{7}_{1(6)}$
$\emptyset^{7}_{1(2)}$	0.857				
$\emptyset^{7}_{1(3)}$	0.936	0.879			
$\emptyset^{7}_{1(5)}$	0.828	0.865	0.891		
$\emptyset^{7}_{1(6)}$	0.641	0.735	0.753	0.897	
$\emptyset^{7}_{1(7)}$	0.95	0.88	0.968	0.863	0.676

	$\emptyset^{8}_{1(0)}$	$\emptyset^{8}_{1(1)}$	$\emptyset^{8}_{1(4)}$	$\emptyset^{8}_{1(5)}$	$\emptyset^{8}_{1(6)}$
$\emptyset^{8}_{1(1)}$	0.92				
$\emptyset^{8}_{1(4)}$	0.679	0.535			
$\emptyset^{8}_{1(5)}$	0.728	0.708	0.572		
$\emptyset^{8}_{1(6)}$	0.967	0.932	0.697	0.707	
$\emptyset^{8}_{1(7)}$	0.919	0.777	0.854	0.76	0.921

	$\emptyset^{9}_{1(0)}$	$\emptyset^{9}_{1(4)}$	$\emptyset^{9}_{1(5)}$	$\emptyset^{9}_{1(6)}$
$\emptyset^{9}_{1(4)}$	0.614			
$\emptyset^{9}_{1(5)}$	0.553	0.664		
$\emptyset^{9}_{1(6)}$	0.864	0.902	0.715	
$\emptyset^{9}_{1(7)}$	0.605	0.999	0.652	0.9

	$\emptyset^{10}_{1(0)}$	$\emptyset^{10}_{1(6)}$	$\emptyset^{10}_{1(7)}$
$\emptyset^{10}_{1(6)}$	0.675		
$\emptyset^{10}_{1(7)}$	0.913	0.784	
$\emptyset^{10}_{1(8)}$	0.893	0.723	0.843

Table A.14.1. *Correlation of GSTARIMA model parameters (1,1,0) from LOCF imputation*

	$\emptyset^{1}_{1(0)}$	$\emptyset^{1}_{1(3)}$	$\emptyset^{1}_{1(4)}$	$\emptyset^{1}_{1(5)}$	$\emptyset^{1}_{1(6)}$
$\emptyset^{1}_{1(3)}$	0.872				
$\emptyset^{1}_{1(4)}$	0.65	0.653			
$\emptyset^{1}_{1(5)}$	0.924	0.871	0.668		
$\emptyset^{1}_{1(6)}$	0.561	0.543	0.507	0.578	
$\emptyset^{1}_{1(7)}$	0.952	0.832	0.646	0.92	0.558

	$\emptyset^{2}_{1(0)}$	$\emptyset^{2}_{1(1)}$	$\emptyset^{2}_{1(4)}$	$\emptyset^{2}_{1(5)}$	$\emptyset^{2}_{1(6)}$
$\emptyset^{2}_{1(1)}$	0.922				
$\emptyset^{2}_{1(4)}$	0.431	0.378			
$\emptyset^{2}_{1(5)}$	0.656	0.618	0.426		
$\emptyset^{2}_{1(6)}$	0.836	0.835	0.411	0.697	
$\emptyset^{2}_{1(7)}$	0.817	0.805	0.44	0.711	0.938

	$\emptyset^{3}_{1(0)}$	$\emptyset^{3}_{1(5)}$	$\emptyset^{3}_{1(6)}$	$\emptyset^{3}_{1(7)}$
$\emptyset^{3}_{1(5)}$	0.878			
$\emptyset^{3}_{1(6)}$	0.727	0.705		
$\emptyset^{3}_{1(7)}$	0.82	0.779	0.669	
$\emptyset^{3}_{1(8)}$	0.92	0.844	0.712	0.849

	$\emptyset^{4}_{1(0)}$	$\emptyset^{4}_{1(2)}$	$\emptyset^{4}_{1(3)}$	$\emptyset^{4}_{1(5)}$	$\emptyset^{4}_{1(6)}$
$\emptyset^{4}_{1(2)}$	0.56				
$\emptyset^{4}_{1(3)}$	0.674	0.868			
$\emptyset^{4}_{1(5)}$	0.643	0.869	0.925		
$\emptyset^{4}_{1(6)}$	0.283	0.415	0.411	0.438	
$\emptyset^{4}_{1(7)}$	0.726	0.834	0.953	0.923	0.409

	$\emptyset^{5}_{1(0)}$	$\emptyset^{5}_{1(4)}$	$\emptyset^{5}_{1(5)}$
$\emptyset^{5}_{1(4)}$	0.65		
$\emptyset^{5}_{1(5)}$	0.654	0.875	
$\emptyset^{5}_{1(6)}$	0.668	0.924	0.873

	$\emptyset^{6}_{1(0)}$	$\emptyset^{6}_{1(4)}$	$\emptyset^{6}_{1(5)}$	$\emptyset^{6}_{1(6)}$
$\emptyset^{6}_{1(4)}$	0.398			
$\emptyset^{6}_{1(5)}$	0.85	0.408		
$\emptyset^{6}_{1(6)}$	0.92	0.437	0.821	
$\emptyset^{6}_{1(7)}$	0.711	0.283	0.714	0.644

	$\emptyset^{7}_{1(0)}$	$\emptyset^{7}_{1(2)}$	$\emptyset^{7}_{1(3)}$	$\emptyset^{7}_{1(5)}$	$\emptyset^{7}_{1(6)}$
$\emptyset^{7}_{1(2)}$	0.56				
$\emptyset^{7}_{1(3)}$	0.868	0.674			
$\emptyset^{7}_{1(5)}$	0.869	0.643	0.925		
$\emptyset^{7}_{1(6)}$	0.534	0.391	0.554	0.573	
$\emptyset^{7}_{1(7)}$	0.788	0.729	0.877	0.856	0.547

	$\emptyset^{8}_{1(0)}$	$\emptyset^{8}_{1(1)}$	$\emptyset^{8}_{1(4)}$	$\emptyset^{8}_{1(5)}$	$\emptyset^{8}_{1(6)}$
$\emptyset^{8}_{1(1)}$	0.922				
$\emptyset^{8}_{1(4)}$	0.378	0.431			
$\emptyset^{8}_{1(5)}$	0.618	0.656	0.426		
$\emptyset^{8}_{1(6)}$	0.832	0.834	0.411	0.695	
$\emptyset^{8}_{1(7)}$	0.804	0.817	0.44	0.71	0.937

	$\emptyset^{9}_{1(0)}$	$\emptyset^{9}_{1(4)}$	$\emptyset^{9}_{1(5)}$	$\emptyset^{9}_{1(6)}$
$\emptyset^{9}_{1(4)}$	0.406			
$\emptyset^{9}_{1(5)}$	0.417	0.653		
$\emptyset^{9}_{1(6)}$	0.438	0.924	0.672	
$\emptyset^{9}_{1(7)}$	0.398	0.998	0.646	0.921

	$\emptyset^{10}_{1(0)}$	$\emptyset^{10}_{1(6)}$	$\emptyset^{10}_{1(7)}$
$\emptyset^{10}_{1(6)}$	0.663		
$\emptyset^{10}_{1(7)}$	0.843	0.669	
$\emptyset^{10}_{1(8)}$	0.92	0.683	0.877

Table A.15.1. *Correlation of GSTARIMA model parameters (1,1,0) from MA imputation*

	$\emptyset^1_{1(0)}$	$\emptyset^1_{1(3)}$	$\emptyset^1_{1(4)}$	$\emptyset^1_{1(5)}$	$\emptyset^1_{1(6)}$
$\emptyset^1_{1(3)}$	0.874				
$\emptyset^1_{1(4)}$	0.641	0.652			
$\emptyset^1_{1(5)}$	0.927	0.874	0.659		
$\emptyset^1_{1(6)}$	0.563	0.543	0.506	0.576	
$\emptyset^1_{1(7)}$	0.956	0.835	0.636	0.923	0.557

	$\emptyset^2_{1(0)}$	$\emptyset^2_{1(1)}$	$\emptyset^2_{1(4)}$	$\emptyset^2_{1(5)}$	$\emptyset^2_{1(6)}$
$\emptyset^2_{1(1)}$	0.921				
$\emptyset^2_{1(4)}$	0.436	0.382			
$\emptyset^2_{1(5)}$	0.643	0.604	0.426		
$\emptyset^2_{1(6)}$	0.835	0.837	0.409	0.688	
$\emptyset^2_{1(7)}$	0.816	0.808	0.437	0.703	0.94

	$\emptyset^3_{1(0)}$	$\emptyset^3_{1(5)}$	$\emptyset^3_{1(6)}$	$\emptyset^3_{1(7)}$
$\emptyset^3_{1(5)}$	0.881			
$\emptyset^3_{1(6)}$	0.72	0.704		
$\emptyset^3_{1(7)}$	0.822	0.785	0.657	
$\emptyset^3_{1(8)}$	0.923	0.846	0.704	0.847

	$\emptyset^4_{1(0)}$	$\emptyset^4_{1(2)}$	$\emptyset^4_{1(3)}$	$\emptyset^4_{1(5)}$	$\emptyset^4_{1(6)}$
$\emptyset^4_{1(2)}$	0.553				
$\emptyset^4_{1(3)}$	0.67	0.87			
$\emptyset^4_{1(5)}$	0.639	0.872	0.927		
$\emptyset^4_{1(6)}$	0.277	0.414	0.411	0.434	
$\emptyset^4_{1(7)}$	0.723	0.837	0.958	0.926	0.407

	$\emptyset^5_{1(0)}$	$\emptyset^5_{1(4)}$	$\emptyset^5_{1(5)}$
$\emptyset^5_{1(4)}$	0.641		
$\emptyset^5_{1(5)}$	0.652	0.876	
$\emptyset^5_{1(6)}$	0.659	0.927	0.876

	$\emptyset^6_{1(0)}$	$\emptyset^6_{1(4)}$	$\emptyset^6_{1(5)}$	$\emptyset^6_{1(6)}$
$\emptyset^6_{1(4)}$	0.395			
$\emptyset^6_{1(5)}$	0.848	0.413		
$\emptyset^6_{1(6)}$	0.923	0.434	0.823	
$\emptyset^6_{1(7)}$	0.706	0.278	0.714	0.64

	$\emptyset^7_{1(0)}$	$\emptyset^7_{1(2)}$	$\emptyset^7_{1(3)}$	$\emptyset^7_{1(5)}$	$\emptyset^7_{1(6)}$
$\emptyset^7_{1(2)}$	0.553				
$\emptyset^7_{1(3)}$	0.87	0.67			
$\emptyset^7_{1(5)}$	0.872	0.639	0.927		
$\emptyset^7_{1(6)}$	0.535	0.386	0.555	0.572	
$\emptyset^7_{1(7)}$	0.794	0.728	0.881	0.858	0.551

	$\emptyset^8_{1(0)}$	$\emptyset^8_{1(1)}$	$\emptyset^8_{1(4)}$	$\emptyset^8_{1(5)}$	$\emptyset^8_{1(6)}$
$\emptyset^8_{1(1)}$	0.921				
$\emptyset^8_{1(4)}$	0.382	0.436			
$\emptyset^8_{1(5)}$	0.604	0.643	0.426		
$\emptyset^8_{1(6)}$	0.836	0.834	0.41	0.686	
$\emptyset^8_{1(7)}$	0.808	0.816	0.437	0.703	0.939

	$\emptyset^9_{1(0)}$	$\emptyset^9_{1(4)}$	$\emptyset^9_{1(5)}$	$\emptyset^9_{1(6)}$
$\emptyset^9_{1(4)}$	0.404			
$\emptyset^9_{1(5)}$	0.417	0.643		
$\emptyset^9_{1(6)}$	0.435	0.927	0.663	
$\emptyset^9_{1(7)}$	0.395	0.997	0.636	0.924

	$\emptyset^{10}_{1(0)}$	$\emptyset^{10}_{1(6)}$	$\emptyset^{10}_{1(7)}$
$\emptyset^{10}_{1(6)}$	0.653		
$\emptyset^{10}_{1(7)}$	0.845	0.668	
$\emptyset^{10}_{1(8)}$	0.923	0.675	0.88

Table A.16.1. *PCA of the GSTARIMA model (1,0,0) from LOCF imputation*

Eigenvalue	539580	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{1}_{1(0)}$	1	0	0	0	0	0
$\varnothing^{1}_{1(3)}$	0	1	0	0	0	0
$\varnothing^{1}_{1(4)}$	0	0	0	0.953	-0.005	0.303
$\varnothing^{1}_{1(5)}$	0	0	0	-0.208	-0.737	0.643
$\varnothing^{1}_{1(6)}$	0	0	0	-0.22	0.676	0.704
$\varnothing^{1}_{1(7)}$	0	0	1	0	0	0

Eigenvalue	7502.9	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{2}_{1(0)}$	1	-0.003	0	0	0	0
$\varnothing^{2}_{1(1)}$	0.003	1	0	0	0	0
$\varnothing^{2}_{1(4)}$	0	0	0	0	0	-1
$\varnothing^{2}_{1(5)}$	0	0	0	0	-1	0
$\varnothing^{2}_{1(6)}$	0	0	-1	0	0	0
$\varnothing^{2}_{1(7)}$	0	0	0	-1	0	0

Eigenvalue	2.13E+12	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{3}_{1(0)}$	1	0	0	0	0
$\varnothing^{3}_{1(5)}$	0	0	0	1	0
$\varnothing^{3}_{1(6)}$	0	1	0	0	0
$\varnothing^{3}_{1(7)}$	0	0	0	0	1
$\varnothing^{3}_{1(8)}$	0	0	-1	0	0

Eigenvalue	63108587	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{4}_{1(0)}$	1	0	0	0	0	0
$\varnothing^{4}_{1(2)}$	0	1	0	0	0	0
$\varnothing^{4}_{1(3)}$	0	0	-1	0	0	0
$\varnothing^{4}_{1(5)}$	0	0	0	0	-1	0
$\varnothing^{4}_{1(6)}$	0	0	0	0	0	-1
$\varnothing^{4}_{1(7)}$	0	0	0	-1	0	0

Eigenvalue	55498021	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\varnothing^{5}_{1(0)}$	1	0	0	0
$\varnothing^{5}_{1(4)}$	0	-0.97	0.245	-0.001
$\varnothing^{5}_{1(5)}$	0	0.245	0.97	0
$\varnothing^{5}_{1(6)}$	0	0.001	0	-1

Eigenvalue	111787	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{6}_{1(0)}$	1	0	0	0	0
$\varnothing^{6}_{1(4)}$	0	1	0	0	0
$\varnothing^{6}_{1(5)}$	0	0	0	1	0
$\varnothing^{6}_{1(6)}$	0	0	0	0	-1
$\varnothing^{6}_{1(7)}$	0	0	1	0	0

Eigenvalue	1.45E+10	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{7}_{1(0)}$	1	0	0	0	0	0
$\varnothing^{7}_{1(2)}$	0	1	0	0	0	0
$\varnothing^{7}_{1(3)}$	0	0	0	1	0	0
$\varnothing^{7}_{1(5)}$	0	0	0	0	1	0
$\varnothing^{7}_{1(6)}$	0	0	0	0	0	-1
$\varnothing^{7}_{1(7)}$	0	0	1	0	0	0

Eigenvalue	7345.4	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{8}_{1(0)}$	1	0.003	0	0	0	0
$\varnothing^{8}_{1(1)}$	0.003	-1	0	0	0	0
$\varnothing^{8}_{1(4)}$	0	0	-1	0	0	0
$\varnothing^{8}_{1(5)}$	0	0	0	0	1	0
$\varnothing^{8}_{1(6)}$	0	0	0	0	0	-1
$\varnothing^{8}_{1(7)}$	0	0	0	-1	0	0

Eigenvalue	2822343	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{9}_{1(0)}$	1	0	0	0	0
$\varnothing^{9}_{1(4)}$	0	0	-0.019	0	1
$\varnothing^{9}_{1(5)}$	0	1	0	0	0
$\varnothing^{9}_{1(6)}$	0	0	-1	0	-0.019
$\varnothing^{9}_{1(7)}$	0	0	0	1	0

Eigenvalue	7951.7	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\varnothing^{10}_{1(6)}$	1	0	0	0
$\varnothing^{10}_{1(7)}$	0	1	0	0
$\varnothing^{10}_{1(8)}$	0	0	1	0
$\varnothing^{10}_{1(8)}$	0	0	0	1

Table A.17.1. *PCA of the GSTARIMA model (1,0,0) from MA imputation*

Eigenvalue	539498	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{1}_{1(0)}$	1	0	0	0	0	0
$\varnothing^{1}_{1(3)}$	0	1	0	0	0	0
$\varnothing^{1}_{1(4)}$	0	0	0	0.973	-0.232	0
$\varnothing^{1}_{1(5)}$	0	0	0	-0.232	-0.973	0
$\varnothing^{1}_{1(6)}$	0	0	-1	0	0	0
$\varnothing^{1}_{1(7)}$	0	0	0	0	0	1

Eigenvalue	7487.1	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{2}_{1(0)}$	1	-0.003	0	0	0	0
$\varnothing^{2}_{1(1)}$	0.003	1	0	0	0	0
$\varnothing^{2}_{1(4)}$	0	0	0	0	-1	0
$\varnothing^{2}_{1(5)}$	0	0	0	-1	0	0
$\varnothing^{2}_{1(6)}$	0	0	-1	0	0	0
$\varnothing^{2}_{1(7)}$	0	0	0	0	0	-1

Eigenvalue	2.13E+12	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{3}_{1(0)}$	1	0	0	0	0
$\varnothing^{3}_{1(5)}$	0	0	0	1	0
$\varnothing^{3}_{1(6)}$	0	1	0	0	0
$\varnothing^{3}_{1(7)}$	0	0	0	0	1
$\varnothing^{3}_{1(8)}$	0	0	-1	0	0

Eigenvalue	62933046	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{4}_{1(0)}$	1	0	0	0	0	0
$\varnothing^{4}_{1(2)}$	0	1	0	0	0	0
$\varnothing^{4}_{1(3)}$	0	0	1	0	0	0
$\varnothing^{4}_{1(5)}$	0	0	0	-1	0	0
$\varnothing^{4}_{1(6)}$	0	0	0	0	0	-1
$\varnothing^{4}_{1(7)}$	0	0	0	0	1	0

Eigenvalue	55480492	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\varnothing^{5}_{1(0)}$	1	0	0	0
$\varnothing^{5}_{1(4)}$	0	-0.97	0.243	-0.001
$\varnothing^{5}_{1(5)}$	0	0.243	0.97	0
$\varnothing^{5}_{1(6)}$	0	0.001	0	-1

Eigenvalue	111411	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{6}_{1(0)}$	1	0	0	0	0
$\varnothing^{6}_{1(4)}$	0	0	0	0	1
$\varnothing^{6}_{1(5)}$	0	-1	0	0	0
$\varnothing^{6}_{1(6)}$	0	0	1	0	0
$\varnothing^{6}_{1(7)}$	0	0	0	1	0

Eigenvalue	1.45E+10	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{7}_{1(0)}$	1	0	0	0	0	0
$\varnothing^{7}_{1(2)}$	0	1	0	0	0	0
$\varnothing^{7}_{1(3)}$	0	0	0	0	-1	0
$\varnothing^{7}_{1(5)}$	0	0	0	0	0	-1
$\varnothing^{7}_{1(6)}$	0	0	-1	0	0	0
$\varnothing^{7}_{1(7)}$	0	0	0	1	0	0

Eigenvalue	7312.5	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{8}_{1(0)}$	1	0.003	0	0	0	0
$\varnothing^{8}_{1(1)}$	0.003	-1	0	0	0	0
$\varnothing^{8}_{1(4)}$	0	0	0	0	-0.002	-1
$\varnothing^{8}_{1(5)}$	0	0	0	0	1	-0.002
$\varnothing^{8}_{1(6)}$	0	0	-1	0	0	0
$\varnothing^{8}_{1(7)}$	0	0	0	-1	0	0

Eigenvalue	2823633	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{9}_{1(0)}$	1	0	0	0	0
$\varnothing^{9}_{1(4)}$	0	1	0	0	-0.019
$\varnothing^{9}_{1(5)}$	0	0	0	1	0
$\varnothing^{9}_{1(6)}$	0	-0.019	0	0	-1
$\varnothing^{9}_{1(7)}$	0	0	1	0	0

Eigenvalue	7924.8	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\varnothing^{10}_{1(6)}$	1	0	0	0
$\varnothing^{10}_{1(7)}$	0	1	0	0
$\varnothing^{10}_{1(8)}$	0	0	1	0
$\varnothing^{10}_{1(8)}$	0	0	0	1

Table A.18.1. *PCA of the GSTARIMA model (1,1,0) from LOCF imputation*

Eigenvalue	3123.2	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\emptyset^{1}_{1(0)}$	1	0	0	0	0	0
$\emptyset^{1}_{1(3)}$	0	1	0	0	0	0
$\emptyset^{1}_{1(4)}$	0	0	1	0.001	-0.018	0
$\emptyset^{1}_{1(5)}$	0	0	0.016	-0.542	0.84	0
$\emptyset^{1}_{1(6)}$	0	0	0.009	0.841	0.542	0
$\emptyset^{1}_{1(7)}$	0	0	0	0	0	1

Eigenvalue	45.909	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\emptyset^{2}_{1(0)}$	1	-0.003	0	0	0	0
$\emptyset^{2}_{1(1)}$	0.003	1	0	0	0	0
$\emptyset^{2}_{1(4)}$	0	0	-0.003	1	0	0
$\emptyset^{2}_{1(5)}$	0	0	0	0	-1	0
$\emptyset^{2}_{1(6)}$	0	0	-1	-0.003	0	0
$\emptyset^{2}_{1(7)}$	0	0	0	0	0	-1

Eigenvalue	1.33E+10	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\emptyset^{3}_{1(0)}$	1	0	0	0	0
$\emptyset^{3}_{1(5)}$	0	0	0	-1	0
$\emptyset^{3}_{1(6)}$	0	-1	0	0	0
$\emptyset^{3}_{1(7)}$	0	0	0	0	1
$\emptyset^{3}_{1(8)}$	0	0	-1	0	0

Eigenvalue	544022	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\emptyset^{4}_{1(0)}$	1	0	0	0	0	0
$\emptyset^{4}_{1(2)}$	0	1	0	0	0	0
$\emptyset^{4}_{1(3)}$	0	0	-1	0	0	0
$\emptyset^{4}_{1(5)}$	0	0	0	0	-1	0
$\emptyset^{4}_{1(6)}$	0	0	0	0	0	-1
$\emptyset^{4}_{1(7)}$	0	0	0	-1	0	0

Eigenvalue	597650	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\emptyset^{5}_{1(0)}$	1	0	0	0
$\emptyset^{5}_{1(4)}$	0	-1	0	0
$\emptyset^{5}_{1(5)}$	0	0	1	0
$\emptyset^{5}_{1(6)}$	0	0	0	-1

Eigenvalue	966.08	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\emptyset^{6}_{1(0)}$	1	0	0	0	0
$\emptyset^{6}_{1(4)}$	0	-1	0	0	-0.005
$\emptyset^{6}_{1(5)}$	0	0.005	0	0	-1
$\emptyset^{6}_{1(6)}$	0	0	0	1	0
$\emptyset^{6}_{1(7)}$	0	0	1	0	0

Eigenvalue	1.18E+08	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\emptyset^{7}_{1(0)}$	1	0	0	0	0	0
$\emptyset^{7}_{1(2)}$	0	1	0	0	0	0
$\emptyset^{7}_{1(3)}$	0	0	0	1	0	0
$\emptyset^{7}_{1(5)}$	0	0	0	0	0.001	-1
$\emptyset^{7}_{1(6)}$	0	0	0	0	1	0.001
$\emptyset^{7}_{1(7)}$	0	0	-1	0	0	0

Eigenvalue	51.442	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\emptyset^{8}_{1(0)}$	1	-0.003	0	0	0	0
$\emptyset^{8}_{1(1)}$	0.003	1	0	0	0	0
$\emptyset^{8}_{1(4)}$	0	0	0	1	0	0
$\emptyset^{8}_{1(5)}$	0	0	0	0	-1	0
$\emptyset^{8}_{1(6)}$	0	0	-1	0	0	0
$\emptyset^{8}_{1(7)}$	0	0	0	0	0	-1

Eigenvalue	4512	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\emptyset^{9}_{1(0)}$	1	0	0	0	0
$\emptyset^{9}_{1(4)}$	0	1	0	0	0
$\emptyset^{9}_{1(5)}$	0	0	0	0	1
$\emptyset^{9}_{1(6)}$	0	0	0	1	0
$\emptyset^{9}_{1(7)}$	0	0	1	0	0

Eigenvalue	68.688	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\emptyset^{10}_{1(6)}$	1	0	0	0
$\emptyset^{10}_{1(7)}$	0	1	0	0
$\emptyset^{10}_{1(8)}$	0	0	1	0
$\emptyset^{10}_{1(8)}$	0	0	0	1

Table A.19.1. *PCA of the GSTARIMA model (1,1,0) from MA imputation*

Eigenvalue	2963.3	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\phi^{1}_{1(0)}$	1	0	0	0	0	0
$\phi^{1}_{1(3)}$	0	-1	0	0	0	0
$\phi^{1}_{1(4)}$	0	0	0	0.001	0.063	0.998
$\phi^{1}_{1(5)}$	0	0	0	-0.971	-0.239	0.016
$\phi^{1}_{1(6)}$	0	0	0	0.239	-0.969	0.061
$\phi^{1}_{1(7)}$	0	0	1	0	0	0

Eigenvalue	44.053	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\phi^{2}_{1(0)}$	1	-0.003	0	0	0	0
$\phi^{2}_{1(1)}$	0.003	1	0	0	0	0
$\phi^{2}_{1(4)}$	0	0	0	1	0	0.01
$\phi^{2}_{1(5)}$	0	0	-1	0	0	0
$\phi^{2}_{1(6)}$	0	0	0	0.01	0	-1
$\phi^{2}_{1(7)}$	0	0	0	0	-1	0

Eigenvalue	1.26E+10	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\phi^{3}_{1(0)}$	1	0	0	0	0
$\phi^{3}_{1(5)}$	0	0	0	-1	0
$\phi^{3}_{1(6)}$	0	-1	0	0	0
$\phi^{3}_{1(7)}$	0	0	0	0	1
$\phi^{3}_{1(8)}$	0	0	-1	0	0

Eigenvalue	517177	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\phi^{4}_{1(0)}$	1	0	0	0	0	0
$\phi^{4}_{1(2)}$	0	1	0	0	0	0
$\phi^{4}_{1(3)}$	0	0	0	1	0	0
$\phi^{4}_{1(5)}$	0	0	-1	0	0	0
$\phi^{4}_{1(6)}$	0	0	0	0	0	-1
$\phi^{4}_{1(7)}$	0	0	0	0	-1	0

Eigenvalue	573948	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\phi^{5}_{1(0)}$	1	0	0	0
$\phi^{5}_{1(4)}$	0	0.378	0	-0.926
$\phi^{5}_{1(5)}$	0	0.926	0	0.378
$\phi^{5}_{1(6)}$	0	0	-1	0

Eigenvalue	930.72	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\phi^{6}_{1(0)}$	1	0	0	0	0
$\phi^{6}_{1(4)}$	0	-0.809	0	0	-0.587
$\phi^{6}_{1(5)}$	0	0	0	1	0
$\phi^{6}_{1(6)}$	0	-0.587	0	0	0.809
$\phi^{6}_{1(7)}$	0	0	1	0	0

Eigenvalue	1.11E+08	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\phi^{7}_{1(0)}$	1	0	0	0	0	0
$\phi^{7}_{1(2)}$	0	1	0	0	0	0
$\phi^{7}_{1(3)}$	0	0	0	1	0	0
$\phi^{7}_{1(5)}$	0	0	0	0	0.004	-1
$\phi^{7}_{1(6)}$	0	0	0	0	1	0.004
$\phi^{7}_{1(7)}$	0	0	-1	0	0	0

Eigenvalue	49.668	0	0	0	0	0
Proportion	1	0	0	0	0	0
Cumulative	1	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\phi^{8}_{1(0)}$	1	-0.003	0	0	0	0
$\phi^{8}_{1(1)}$	0.003	1	0	0	0	0
$\phi^{8}_{1(4)}$	0	0	-0.001	1	0	0
$\phi^{8}_{1(5)}$	0	0	0	0	-1	0
$\phi^{8}_{1(6)}$	0	0	-1	-0.001	0	0
$\phi^{8}_{1(7)}$	0	0	0	0	0	-1

Eigenvalue	4293.7	0	0	0	0
Proportion	1	0	0	0	0
Cumulative	1	1	1	1	1
Variable	PC1	PC2	PC3	PC4	PC5
$\phi^{9}_{1(0)}$	1	0	0	0	0
$\phi^{9}_{1(4)}$	0	1	0	0	0
$\phi^{9}_{1(5)}$	0	0	0	0	1
$\phi^{9}_{1(6)}$	0	0	0	1	0
$\phi^{9}_{1(7)}$	0	0	1	0	0

Eigenvalue	66.153	0	0	0
Proportion	1	0	0	0
Cumulative	1	1	1	1
Variable	PC1	PC2	PC3	PC4
$\phi^{10}_{1(6)}$	1	0	0	0
$\phi^{10}_{1(7)}$	0	1	0	0
$\phi^{10}_{1(8)}$	0	0	1	0
$\phi^{10}_{1(8)}$	0	0	0	1

Table A.20.1. *Parameter estimation of GSTARIMA (1,0,0) with PCA from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset_{1(0)}^{1}$	1.000267	0.000168	5971	<2e-16	$\emptyset_{1(0)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(3)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{7}$	1.000212	0.000192	5203	<2e-16
$\emptyset_{1(0)}^{2}$	1.00021	0.000155	6450	<2e-16	$\emptyset_{1(2)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(1)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(3)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{8}$	1.0002	0.000147	6797	<2e-16
$\emptyset_{1(0)}^{3}$	1.000225	0.000169	5917	<2e-16	$\emptyset_{1(1)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(8)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(0)}^{4}$	1.00017	0.000136	7369	<2e-16	$\emptyset_{1(0)}^{9}$	1.000654	0.000301	3323	<2e-16
$\emptyset_{1(2)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(3)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{10}$	1.000219	0.000168	5971	<2e-16
$\emptyset_{1(0)}^{5}$	1.000101	0.000247	4051	<2e-16	$\emptyset_{1(6)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(8)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{5}$	NA	NA	NA	NA					

Table A.21.1. *Parameter estimation of GSTARIMA (1,0,0) with PCA from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset_{1(0)}^{1}$	1.000268	0.000163	6130	<2e-16	$\emptyset_{1(0)}^{6}$	1.000219	0.000164	6084	<2e-16
$\emptyset_{1(3)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{7}$	1.000214	0.000187	5348	<2e-16
$\emptyset_{1(0)}^{2}$	1.000211	0.000152	6585	<2e-16	$\emptyset_{1(2)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(1)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(3)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{8}$	1.000201	0.000145	6917	<2e-16
$\emptyset_{1(0)}^{3}$	1.000226	0.000165	6066	<2e-16	$\emptyset_{1(1)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(8)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(0)}^{4}$	1.000171	0.000132	7558	<2e-16	$\emptyset_{1(0)}^{9}$	1.000657	0.000294	3408	<2e-16
$\emptyset_{1(2)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(3)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{10}$	1.00022	0.000164	6085	<2e-16
$\emptyset_{1(0)}^{5}$	1.000103	0.000242	4133	<2e-16	$\emptyset_{1(6)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(8)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{5}$	NA	NA	NA	NA					

Table A.22.1. *Parameter estimation of GSTARIMA (1,1,0) with PCA from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	-0.03644	0.02617	-1.392	0.164	$\emptyset^{6}_{1(0)}$	-0.01477	0.02619	-0.564	0.573
$\emptyset^{1}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(0)}$	-0.0836	0.0261	-3.203	0.00139
$\emptyset^{2}_{1(0)}$	-0.02715	0.02618	-1.037	0.3	$\emptyset^{7}_{1(2)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(1)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(3)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(0)}$	-0.04109	0.02617	-1.57	0.117
$\emptyset^{3}_{1(0)}$	-0.03074	0.02618	-1.174	0.24	$\emptyset^{8}_{1(1)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(8)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(0)}$	-0.02326	0.02619	-0.888	0.375	$\emptyset^{9}_{1(0)}$	0.06735	0.02613	2.577	0.0101
$\emptyset^{4}_{1(2)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(0)}$	-0.0151	0.02619	-0.576	0.564
$\emptyset^{5}_{1(0)}$	-0.04734	0.02616	-1.81	0.0706	$\emptyset^{10}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{5}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{5}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(8)}$	NA	NA	NA	NA
$\emptyset^{5}_{1(6)}$	NA	NA	NA	NA					

Table A.23.1. *Parameter estimation of GSTARIMA (1,1,0) with PCA from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset_{1(0)}^{1}$	-0.17466	0.02577	-6.778	1.76E-11	$\emptyset_{1(0)}^{6}$	-0.1522	0.02587	-5.884	4.97E-09
$\emptyset_{1(3)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{7}$	-0.22311	0.02549	-8.752	<2e-16
$\emptyset_{1(0)}^{2}$	-0.17325	0.02576	-6.726	2.50E-11	$\emptyset_{1(2)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(1)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(3)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{8}$	-0.18872	0.02569	-7.347	3.35E-13
$\emptyset_{1(0)}^{3}$	-0.19268	0.02566	-7.507	1.05E-13	$\emptyset_{1(1)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(8)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(0)}^{4}$	-0.20067	0.02565	-7.824	9.78E-15	$\emptyset_{1(0)}^{9}$	-0.02617	0.02617	-1	0.317
$\emptyset_{1(2)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(3)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{10}$	-0.15245	0.02587	-5.894	4.68E-09
$\emptyset_{1(0)}^{5}$	-0.20579	0.02562	-8.033	1.95E-15	$\emptyset_{1(6)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(8)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{5}$	NA	NA	NA	NA					

Table A.24.1. *Parameter estimation of GSTARIMAX (1,0,0) with PCA from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	1.000157	0.000179	5586.045	<2e-16	$\beta^{(3)}_{3}$	-83.4296	99.172	-0.841	0.4	$\emptyset^{7}_{1(5)}$	NA	NA	NA	NA
$\beta^{(1)}_{1}$	NA	NA	NA	NA	$\beta^{(3)}_{4}$	460.9457	351.3877	1.312	0.19	$\emptyset^{7}_{1(6)}$	NA	NA	NA	NA
$\beta^{(1)}_{2}$	NA	NA	NA	NA	$\beta^{(3)}_{5}$	67.54416	129.9282	0.52	0.603	$\emptyset^{7}_{1(7)}$	NA	NA	NA	NA
$\beta^{(1)}_{3}$	NA	NA	NA	NA	$\emptyset^{4}_{1(2)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(0)}$	0.997945	0.001609	620.249	<2e-16
$\beta^{(1)}_{4}$	7.861952	4.540669	1.731	0.0836	$\emptyset^{4}_{1(3)}$	NA	NA	NA	NA	$\beta^{(8)}_{1}$	-7.16663	7.182097	-0.998	0.319
$\beta^{(1)}_{5}$	NA	NA	NA	NA	$\emptyset^{4}_{1(5)}$	NA	NA	NA	NA	$\beta^{(8)}_{2}$	0.175359	1.395559	0.126	0.9
$\emptyset^{1}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(6)}$	NA	NA	NA	NA	$\beta^{(8)}_{3}$	0.018768	1.124723	0.017	0.987
$\emptyset^{1}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(7)}$	NA	NA	NA	NA	$\beta^{(8)}_{4}$	2.877358	2.055585	1.4	0.162
$\emptyset^{1}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{5}_{1(0)}$	0.995373	0.002722	365.736	<2e-16	$\beta^{(8)}_{5}$	1.599311	1.806147	0.885	0.376
$\emptyset^{1}_{1(6)}$	NA	NA	NA	NA	$\beta^{(5)}_{1}$	1.237578	346.4669	0.004	0.9972	$\emptyset^{8}_{1(1)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(7)}$	NA	NA	NA	NA	$\beta^{(5)}_{2}$	-80.0151	85.63495	-0.934	0.3503	$\emptyset^{8}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(0)}$	1.000219	0.000165	6056.334	<2e-16	$\beta^{(5)}_{3}$	-70.5125	258.6249	-0.273	0.7852	$\emptyset^{8}_{1(5)}$	NA	NA	NA	NA
$\beta^{(2)}_{1}$	NA	NA	NA	NA	$\beta^{(5)}_{4}$	392.5611	222.9065	1.761	0.0784	$\emptyset^{8}_{1(6)}$	NA	NA	NA	NA
$\beta^{(2)}_{2}$	2.60293	4.802434	0.542	0.588	$\beta^{(5)}_{5}$	19.30135	74.47273	0.259	0.7955	$\emptyset^{8}_{1(7)}$	NA	NA	NA	NA
$\beta^{(2)}_{3}$	-0.25087	6.783126	-0.037	0.971	$\emptyset^{5}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(0)}$	1.00016	0.00109	917.39	<2e-16
$\beta^{(2)}_{4}$	-0.11805	0.552009	-0.214	0.831	$\emptyset^{5}_{1(5)}$	NA	NA	NA	NA	$\beta^{(9)}_{1}$	-5.84207	6.64903	-0.879	0.38
$\beta^{(2)}_{5}$	NA	NA	NA	NA	$\emptyset^{5}_{1(6)}$	NA	NA	NA	NA	$\beta^{(9)}_{2}$	-5.78502	3.95635	-1.462	0.144
$\emptyset^{2}_{1(1)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(0)}$	0.995298	0.002452	405.898	<2e-16	$\beta^{(9)}_{3}$	6.35707	12.21425	0.52	0.603
$\emptyset^{2}_{1(4)}$	NA	NA	NA	NA	$\beta^{(6)}_{1}$	8.994635	18.05391	0.498	0.618	$\beta^{(9)}_{4}$	5.07148	6.29519	0.806	0.421
$\emptyset^{2}_{1(5)}$	NA	NA	NA	NA	$\beta^{(6)}_{2}$	-0.78553	1.950734	-0.403	0.687	$\beta^{(9)}_{5}$	-0.03306	9.37196	-0.004	0.997
$\emptyset^{2}_{1(6)}$	NA	NA	NA	NA	$\beta^{(6)}_{3}$	-1.77638	3.568624	-0.498	0.619	$\emptyset^{9}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(7)}$	NA	NA	NA	NA	$\beta^{(6)}_{4}$	24.22406	11.95953	2.026	0.043	$\emptyset^{9}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(0)}$	9.95E-01	2.55E-03	391.043	<2e-16	$\beta^{(6)}_{5}$	-0.06405	1.782068	-0.036	0.971	$\emptyset^{9}_{1(6)}$	NA	NA	NA	NA
$\beta^{(3)}_{1}$	-4.46E+03	8.43E+03	-0.529	0.597	$\emptyset^{6}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(7)}$	NA	NA	NA	NA
$\beta^{(3)}_{2}$	-1.14E+04	1.11E+04	-1.03	0.3032	$\emptyset^{6}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(0)}$	0.995355	0.002452	405.917	<2e-16
$\beta^{(3)}_{3}$	7.52E+03	6.10E+03	1.233	0.2177	$\emptyset^{6}_{1(6)}$	NA	NA	NA	NA	$\beta^{(10)}_{1}$	0.72024	0.698537	1.031	0.3027
$\beta^{(3)}_{4}$	9.26E+04	4.67E+04	1.986	0.0472	$\emptyset^{6}_{1(7)}$	NA	NA	NA	NA	$\beta^{(10)}_{2}$	-0.95965	1.057372	-0.908	0.3642
$\beta^{(3)}_{5}$	1.16E+04	7.20E+03	1.607	0.1082	$\emptyset^{7}_{1(0)}$	1.00E+00	2.18E-04	4590.827	<2e-16	$\beta^{(10)}_{3}$	0.271537	0.447833	0.606	0.5444
$\emptyset^{3}_{1(5)}$	NA	NA	NA	NA	$\beta^{(7)}_{1}$	NA	NA	NA	NA	$\beta^{(10)}_{4}$	6.332797	3.448485	1.836	0.0665
$\emptyset^{3}_{1(6)}$	NA	NA	NA	NA	$\beta^{(7)}_{2}$	NA	NA	NA	NA	$\beta^{(10)}_{5}$	0.146951	0.458893	0.32	0.7488
$\emptyset^{3}_{1(7)}$	NA	NA	NA	NA	$\beta^{(7)}_{3}$	NA	NA	NA	NA	$\emptyset^{10}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(8)}$	NA	NA	NA	NA	$\beta^{(7)}_{4}$	-4.20E+02	7.14E+02	-0.589	0.556	$\emptyset^{10}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(0)}$	0.996951	0.002472	403.22	<2e-16	$\beta^{(7)}_{5}$	-2.69E+02	1.50E+03	-0.179	0.858	$\emptyset^{10}_{1(8)}$	NA	NA	NA	NA
$\beta^{(4)}_{1}$	92.18166	198.8338	0.464	0.643	$\emptyset^{7}_{1(2)}$	NA	NA	NA	NA					
$\beta^{(4)}_{2}$	-33.6648	88.7535	-0.379	0.705	$\emptyset^{7}_{1(3)}$	NA	NA	NA	NA					

Table A.25.1. *Parameter estimation of GSTARIMAX (1,0,0) with PCA from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	1.000195	0.000175	5731.75	<2e-16	$\beta^{(3)}_{3}$	-1.26E+02	9.66E+01	-1.308	0.191	$\emptyset^{7}_{1(5)}$	NA	NA	NA	NA
$\beta^{(1)}_{1}$	NA	NA	NA	NA	$\beta^{(3)}_{4}$	4.72E+02	3.43E+02	1.378	0.168	$\emptyset^{7}_{1(6)}$	NA	NA	NA	NA
$\beta^{(1)}_{2}$	NA	NA	NA	NA	$\beta^{(3)}_{5}$	1.37E+02	1.27E+02	1.082	0.28	$\emptyset^{7}_{1(7)}$	NA	NA	NA	NA
$\beta^{(1)}_{3}$	NA	NA	NA	NA	$\emptyset^{4}_{1(2)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(0)}$	0.997753	0.001582	630.497	<2e-16
$\beta^{(1)}_{4}$	5.217947	4.425529	1.179	0.239	$\emptyset^{4}_{1(3)}$	NA	NA	NA	NA	$\beta^{(8)}_{1}$	-7.17678	7.057034	-1.017	0.309
$\beta^{(1)}_{5}$	NA	NA	NA	NA	$\emptyset^{4}_{1(5)}$	NA	NA	NA	NA	$\beta^{(8)}_{2}$	-0.5475	1.37127	-0.399	0.69
$\emptyset^{1}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(6)}$	NA	NA	NA	NA	$\beta^{(8)}_{3}$	-0.28997	1.105142	-0.262	0.793
$\emptyset^{1}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(7)}$	NA	NA	NA	NA	$\beta^{(8)}_{4}$	3.166118	2.021756	1.566	0.118
$\emptyset^{1}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{5}_{1(0)}$	0.99567	0.002668	373.188	<2e-16	$\beta^{(8)}_{5}$	-0.11908	1.774735	-0.067	0.947
$\emptyset^{1}_{1(6)}$	NA	NA	NA	NA	$\beta^{(5)}_{1}$	120.2758	339.5945	0.354	0.7233	$\emptyset^{8}_{1(1)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(7)}$	NA	NA	NA	NA	$\beta^{(5)}_{2}$	-44.1361	83.93722	-0.526	0.5991	$\emptyset^{8}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(0)}$	1.0002	0.000162	6181.929	<2e-16	$\beta^{(5)}_{3}$	-93.8418	253.4992	-0.37	0.7113	$\emptyset^{8}_{1(5)}$	NA	NA	NA	NA
$\beta^{(2)}_{1}$	NA	NA	NA	NA	$\beta^{(5)}_{4}$	368.7485	218.5135	1.688	0.0917	$\emptyset^{8}_{1(6)}$	NA	NA	NA	NA
$\beta^{(2)}_{2}$	0.448714	4.704616	0.095	0.924	$\beta^{(5)}_{5}$	-15.4043	72.99739	-0.211	0.8329	$\emptyset^{8}_{1(7)}$	NA	NA	NA	NA
$\beta^{(2)}_{3}$	2.521604	6.644955	0.379	0.704	$\emptyset^{5}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(0)}$	0.999808	0.001062	941.021	<2e-16
$\beta^{(2)}_{4}$	0.090315	0.540763	0.167	0.867	$\emptyset^{5}_{1(5)}$	NA	NA	NA	NA	$\beta^{(9)}_{1}$	2.864802	6.481393	0.442	0.6586
$\beta^{(2)}_{5}$	NA	NA	NA	NA	$\emptyset^{5}_{1(6)}$	NA	NA	NA	NA	$\beta^{(9)}_{2}$	-7.466	3.857379	-1.936	0.0531
$\emptyset^{2}_{1(1)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(0)}$	0.995587	0.002411	412.984	<2e-16	$\beta^{(9)}_{3}$	11.46006	11.90871	0.962	0.336
$\emptyset^{2}_{1(4)}$	NA	NA	NA	NA	$\beta^{(6)}_{1}$	8.07E+00	1.77E+01	0.455	0.6488	$\beta^{(9)}_{4}$	6.56454	6.136897	1.07	0.2849
$\emptyset^{2}_{1(5)}$	NA	NA	NA	NA	$\beta^{(6)}_{2}$	-1.59105	1.91439	-0.831	0.4061	$\beta^{(9)}_{5}$	3.240825	9.137287	0.355	0.7229
$\emptyset^{2}_{1(6)}$	NA	NA	NA	NA	$\beta^{(6)}_{3}$	1.43607	3.502403	0.41	0.6818	$\emptyset^{9}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(7)}$	NA	NA	NA	NA	$\beta^{(6)}_{4}$	22.59926	11.75755	1.922	0.0548	$\emptyset^{9}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(0)}$	9.95E-01	2.49E-03	400.005	<2e-16	$\beta^{(6)}_{5}$	7.05E-01	1.75E+00	0.403	0.6871	$\emptyset^{9}_{1(6)}$	NA	NA	NA	NA
$\beta^{(3)}_{1}$	9.90E+02	8.23E+03	0.12	0.9043	$\emptyset^{6}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(7)}$	NA	NA	NA	NA
$\beta^{(3)}_{2}$	-8.55E+03	1.08E+04	-0.792	0.4286	$\emptyset^{6}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(0)}$	0.995805	0.002412	412.903	<2e-16
$\beta^{(3)}_{3}$	3.57E+03	5.95E+03	0.6	0.5487	$\emptyset^{6}_{1(6)}$	NA	NA	NA	NA	$\beta^{(10)}_{1}$	0.174653	0.685769	0.255	0.799
$\beta^{(3)}_{4}$	8.95E+04	4.56E+04	1.963	0.0499	$\emptyset^{6}_{1(7)}$	NA	NA	NA	NA	$\beta^{(10)}_{2}$	-0.74459	1.038002	-0.717	0.4733
$\beta^{(3)}_{5}$	8.01E+03	7.04E+03	1.138	0.2552	$\emptyset^{7}_{1(0)}$	1.00E+00	2.12E-04	4718.591	<2e-16	$\beta^{(10)}_{3}$	0.386314	0.439649	0.879	0.3797
$\emptyset^{3}_{1(5)}$	NA	NA	NA	NA	$\beta^{(7)}_{1}$	NA	NA	NA	NA	$\beta^{(10)}_{4}$	6.18117	3.389771	1.823	0.0684
$\emptyset^{3}_{1(6)}$	NA	NA	NA	NA	$\beta^{(7)}_{2}$	NA	NA	NA	NA	$\beta^{(10)}_{5}$	-0.19331	0.450505	-0.429	0.6679
$\emptyset^{3}_{1(7)}$	NA	NA	NA	NA	$\beta^{(7)}_{3}$	NA	NA	NA	NA	$\emptyset^{10}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(8)}$	NA	NA	NA	NA	$\beta^{(7)}_{4}$	-1.36E+02	6.95E+02	-0.195	0.845	$\emptyset^{10}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(0)}$	9.97E-01	2.41E-03	413.396	<2e-16	$\beta^{(7)}_{5}$	-6.00E+02	1.46E+03	-0.41	0.682	$\emptyset^{10}_{1(8)}$	NA	NA	NA	NA
$\beta^{(4)}_{1}$	1.64E+02	1.94E+02	0.847	0.397	$\emptyset^{7}_{1(2)}$	NA	NA	NA	NA					
$\beta^{(4)}_{2}$	-2.40E+01	8.65E+01	-0.278	0.781	$\emptyset^{7}_{1(3)}$	NA	NA	NA	NA					

Table A.26.1. *Parameter estimation of GSTARIMAX (1,1,0) with PCA from LOCF imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	-0.03752	0.02614	-1.435	0.1515	$\beta^{(3)}_{3}$	-77.1288	99.1026	-0.778	0.437	$\emptyset^{7}_{1(5)}$	NA	NA	NA	NA
$\beta^{(1)}_{1}$	NA	NA	NA	NA	$\beta^{(3)}_{4}$	28.85539	20.50898	1.407	0.16	$\emptyset^{7}_{1(6)}$	NA	NA	NA	NA
$\beta^{(1)}_{2}$	NA	NA	NA	NA	$\beta^{(3)}_{5}$	48.23403	128.417	0.376	0.707	$\emptyset^{7}_{1(7)}$	NA	NA	NA	NA
$\beta^{(1)}_{3}$	NA	NA	NA	NA	$\emptyset^{4}_{1(2)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(0)}$	-0.04504	0.02625	-1.716	0.0864
$\beta^{(1)}_{4}$	9.38714	4.2461	2.211	0.0272	$\emptyset^{4}_{1(3)}$	NA	NA	NA	NA	$\beta^{(8)}_{1}$	-7.93763	7.17941	-1.106	0.2691
$\beta^{(1)}_{5}$	NA	NA	NA	NA	$\emptyset^{4}_{1(5)}$	NA	NA	NA	NA	$\beta^{(8)}_{2}$	0.16162	1.39475	0.116	0.9078
$\emptyset^{1}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(6)}$	NA	NA	NA	NA	$\beta^{(8)}_{3}$	0.04211	1.12423	0.037	0.9701
$\emptyset^{1}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(7)}$	NA	NA	NA	NA	$\beta^{(8)}_{4}$	0.27532	0.1936	1.422	0.1552
$\emptyset^{1}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{5}_{1(0)}$	-0.04796	0.02624	-1.828	0.0678	$\beta^{(8)}_{5}$	1.67251	1.80709	0.926	0.3548
$\emptyset^{1}_{1(6)}$	NA	NA	NA	NA	$\beta^{(5)}_{1}$	-0.69479	346.5226	-0.002	0.9984	$\emptyset^{8}_{1(1)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(7)}$	NA	NA	NA	NA	$\beta^{(5)}_{2}$	-81.4009	85.66808	-0.95	0.3422	$\emptyset^{8}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(0)}$	-0.02754	0.02621	-1.051	0.294	$\beta^{(5)}_{3}$	-4.23E+01	2.59E+02	-0.163	0.8704	$\emptyset^{8}_{1(5)}$	NA	NA	NA	NA
$\beta^{(2)}_{1}$	NA	NA	NA	NA	$\beta^{(5)}_{4}$	16.13646	21.91242	0.736	0.4616	$\emptyset^{8}_{1(6)}$	NA	NA	NA	NA
$\beta^{(2)}_{2}$	2.83148	4.80536	0.589	0.556	$\beta^{(5)}_{5}$	11.68682	74.39238	0.157	0.8752	$\emptyset^{8}_{1(7)}$	NA	NA	NA	NA
$\beta^{(2)}_{3}$	-0.01625	6.78436	-0.002	0.998	$\emptyset^{5}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(0)}$	0.06289	0.02633	2.388	0.0171
$\beta^{(2)}_{4}$	1.34E-01	5.20E-01	0.259	0.796	$\emptyset^{5}_{1(5)}$	NA	NA	NA	NA	$\beta^{(9)}_{1}$	-4.91765	6.41657	-0.766	0.4436
$\beta^{(2)}_{5}$	NA	NA	NA	NA	$\emptyset^{5}_{1(6)}$	NA	NA	NA	NA	$\beta^{(9)}_{2}$	-5.66286	3.95055	-1.433	0.1519
$\emptyset^{2}_{1(1)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(0)}$	-1.63E-02	2.63E-02	-0.621	0.535	$\beta^{(9)}_{3}$	5.78435	12.19633	0.474	0.6354
$\emptyset^{2}_{1(4)}$	NA	NA	NA	NA	$\beta^{(6)}_{1}$	5.86E+00	1.80E+01	0.325	0.745	$\beta^{(9)}_{4}$	5.71483	2.16554	2.639	0.0084
$\emptyset^{2}_{1(5)}$	NA	NA	NA	NA	$\beta^{(6)}_{2}$	-0.65127	1.95475	-0.333	0.739	$\beta^{(9)}_{5}$	-2.30554	9.36961	-0.246	0.8057
$\emptyset^{2}_{1(6)}$	NA	NA	NA	NA	$\beta^{(6)}_{3}$	-1.33866	3.58563	-0.373	0.709	$\emptyset^{9}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(7)}$	NA	NA	NA	NA	$\beta^{(6)}_{4}$	1.41497	1.12034	1.263	0.207	$\emptyset^{9}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(0)}$	-3.24E-02	2.62E-02	-1.237	0.216	$\beta^{(6)}_{5}$	-6.13E-02	1.79E+00	-0.034	0.973	$\emptyset^{9}_{1(6)}$	NA	NA	NA	NA
$\beta^{(3)}_{1}$	-8.89E+03	8.12E+03	-1.095	0.274	$\emptyset^{6}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(7)}$	NA	NA	NA	NA
$\beta^{(3)}_{2}$	-6.84E+03	1.09E+04	-0.63	0.529	$\emptyset^{6}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(0)}$	-0.01777	0.02625	-0.677	0.499
$\beta^{(3)}_{3}$	7.56E+03	6.11E+03	1.238	0.216	$\emptyset^{6}_{1(6)}$	NA	NA	NA	NA	$\beta^{(10)}_{1}$	0.6835	0.69933	0.977	0.329
$\beta^{(3)}_{4}$	5.21E+03	1.17E+04	0.445	0.656	$\emptyset^{6}_{1(7)}$	NA	NA	NA	NA	$\beta^{(10)}_{2}$	-0.86915	1.05766	-0.822	0.411
$\beta^{(3)}_{5}$	5.87E+03	6.58E+03	0.892	0.373	$\emptyset^{7}_{1(0)}$	-0.08374	0.02614	-3.204	0.00139	$\beta^{(10)}_{3}$	0.34002	0.44798	0.759	0.448
$\emptyset^{3}_{1(5)}$	NA	NA	NA	NA	$\beta^{(7)}_{1}$	NA	NA	NA	NA	$\beta^{(10)}_{4}$	0.2767	1.28221	0.216	0.829
$\emptyset^{3}_{1(6)}$	NA	NA	NA	NA	$\beta^{(7)}_{2}$	NA	NA	NA	NA	$\beta^{(10)}_{5}$	0.09635	0.45907	0.21	0.834
$\emptyset^{3}_{1(7)}$	NA	NA	NA	NA	$\beta^{(7)}_{3}$	NA	NA	NA	NA	$\emptyset^{10}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(8)}$	NA	NA	NA	NA	$\beta^{(7)}_{4}$	19.89061	639.888	0.031	0.97521	$\emptyset^{10}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(0)}$	-0.0251	0.02627	-0.955	0.34	$\beta^{(7)}_{5}$	192.552	1480.77	0.13	0.89656	$\emptyset^{10}_{1(8)}$	NA	NA	NA	NA
$\beta^{(4)}_{1}$	8.02E+01	1.99E+02	0.403	0.687	$\emptyset^{7}_{1(2)}$	NA	NA	NA	NA					
$\beta^{(4)}_{2}$	-3.21E+01	8.88E+01	-0.362	0.718	$\emptyset^{7}_{1(3)}$	NA	NA	NA	NA					

Table A.27.1. *Parameter estimation of GSTARIMAX (1,1,0) with PCA from MA imputation*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	-0.17592	0.02575	-6.831	1.24E-11	$\beta^{(3)}_{3}$	-136.38	94.54647	-1.442	0.149	$\emptyset^{7}_{1(5)}$	NA	NA	NA	NA
$\beta^{(1)}_{1}$	NA	NA	NA	NA	$\beta^{(3)}_{4}$	31.71053	19.5641	1.621	0.105	$\emptyset^{7}_{1(6)}$	NA	NA	NA	NA
$\beta^{(1)}_{2}$	NA	NA	NA	NA	$\beta^{(3)}_{5}$	146.0172	122.3391	1.194	0.233	$\emptyset^{7}_{1(7)}$	NA	NA	NA	NA
$\beta^{(1)}_{3}$	NA	NA	NA	NA	$\emptyset^{4}_{1(2)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(0)}$	-0.19136	0.02578	-7.422	1.96E-13
$\beta^{(1)}_{4}$	7.69267	4.07432	1.888	0.0592	$\emptyset^{4}_{1(3)}$	NA	NA	NA	NA	$\beta^{(8)}_{1}$	-7.70473	6.92029	-1.113	0.2657
$\beta^{(1)}_{5}$	NA	NA	NA	NA	$\emptyset^{4}_{1(5)}$	NA	NA	NA	NA	$\beta^{(8)}_{2}$	-0.35993	1.34521	-0.268	0.7891
$\emptyset^{1}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(6)}$	NA	NA	NA	NA	$\beta^{(8)}_{3}$	-0.34377	1.0843	-0.317	0.7513
$\emptyset^{1}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{4}_{1(7)}$	NA	NA	NA	NA	$\beta^{(8)}_{4}$	0.34288	0.1867	1.837	0.0665
$\emptyset^{1}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{5}_{1(0)}$	-0.20623	0.02568	-8.03	1.99E-15	$\beta^{(8)}_{5}$	0.69585	1.74469	0.399	0.6901
$\emptyset^{1}_{1(6)}$	NA	NA	NA	NA	$\beta^{(5)}_{1}$	76.03041	332.6199	0.229	0.819	$\emptyset^{8}_{1(1)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(7)}$	NA	NA	NA	NA	$\beta^{(5)}_{2}$	-5.40E+01	8.22E+01	-0.657	0.511	$\emptyset^{8}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(0)}$	-0.17349	0.02579	-6.726	2.50E-11	$\beta^{(5)}_{3}$	-1.46E+01	2.48E+02	-0.059	0.953	$\emptyset^{8}_{1(5)}$	NA	NA	NA	NA
$\beta^{(2)}_{1}$	NA	NA	NA	NA	$\beta^{(5)}_{4}$	17.98701	21.03087	0.855	0.393	$\emptyset^{8}_{1(6)}$	NA	NA	NA	NA
$\beta^{(2)}_{2}$	1.54807	4.63259	0.334	0.738	$\beta^{(5)}_{5}$	-21.4775	71.39872	-0.301	0.764	$\emptyset^{8}_{1(7)}$	NA	NA	NA	NA
$\beta^{(2)}_{3}$	2.65E+00	6.54E+00	0.405	0.686	$\emptyset^{5}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(0)}$	-0.03284	0.02636	-1.246	0.21291
$\beta^{(2)}_{4}$	3.07E-01	5.01E-01	0.614	0.54	$\emptyset^{5}_{1(5)}$	NA	NA	NA	NA	$\beta^{(9)}_{1}$	2.23339	6.26427	0.357	0.7215
$\beta^{(2)}_{5}$	NA	NA	NA	NA	$\emptyset^{5}_{1(6)}$	NA	NA	NA	NA	$\beta^{(9)}_{2}$	-7.53058	3.85693	-1.952	0.05107
$\emptyset^{2}_{1(1)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(0)}$	-1.53E-01	2.59E-02	-5.913	4.17E-09	$\beta^{(9)}_{3}$	11.7914	11.90494	0.99	0.32211
$\emptyset^{2}_{1(4)}$	NA	NA	NA	NA	$\beta^{(6)}_{1}$	5.21727	17.45209	0.299	0.765	$\beta^{(9)}_{4}$	5.60746	2.11462	2.652	0.00809
$\emptyset^{2}_{1(5)}$	NA	NA	NA	NA	$\beta^{(6)}_{2}$	-1.42873	1.89454	-0.754	0.451	$\beta^{(9)}_{5}$	4.33975	9.14493	0.475	0.63518
$\emptyset^{2}_{1(6)}$	NA	NA	NA	NA	$\beta^{(6)}_{3}$	0.88725	3.47543	0.255	0.799	$\emptyset^{9}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(7)}$	NA	NA	NA	NA	$\beta^{(6)}_{4}$	1.41182	1.08586	1.3	0.194	$\emptyset^{9}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(0)}$	-1.95E-01	2.57E-02	-7.577	6.27E-14	$\beta^{(6)}_{5}$	0.57044	1.73005	0.33	0.742	$\emptyset^{9}_{1(6)}$	NA	NA	NA	NA
$\beta^{(3)}_{1}$	-3.75E+03	7.77E+03	-0.482	0.63	$\emptyset^{6}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(7)}$	NA	NA	NA	NA
$\beta^{(3)}_{2}$	-3.03E+03	1.04E+04	-0.292	0.77	$\emptyset^{6}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(0)}$	-0.15499	0.02593	-5.978	2.84E-09
$\beta^{(3)}_{3}$	3.77E+03	5.84E+03	0.645	0.519	$\emptyset^{6}_{1(6)}$	NA	NA	NA	NA	$\beta^{(10)}_{1}$	0.20606	0.67789	0.304	0.761
$\beta^{(3)}_{4}$	4647.15	11182.12	0.416	0.678	$\emptyset^{6}_{1(7)}$	NA	NA	NA	NA	$\beta^{(10)}_{2}$	-0.74798	1.02489	-0.73	0.466
$\beta^{(3)}_{5}$	3.49E+03	6.30E+03	0.555	0.579	$\emptyset^{7}_{1(0)}$	-0.22368	0.02554	-8.758	<2e-16	$\beta^{(10)}_{3}$	0.53529	0.4341	1.233	0.218
$\emptyset^{3}_{1(5)}$	NA	NA	NA	NA	$\beta^{(7)}_{1}$	NA	NA	NA	NA	$\beta^{(10)}_{4}$	0.63222	1.24265	0.509	0.611
$\emptyset^{3}_{1(6)}$	NA	NA	NA	NA	$\beta^{(7)}_{2}$	NA	NA	NA	NA	$\beta^{(10)}_{5}$	-0.10077	0.44507	-0.226	0.821
$\emptyset^{3}_{1(7)}$	NA	NA	NA	NA	$\beta^{(7)}_{3}$	NA	NA	NA	NA	$\emptyset^{10}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(8)}$	NA	NA	NA	NA	$\beta^{(7)}_{4}$	343.8677	607.992	0.566	0.572	$\emptyset^{10}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(0)}$	-0.2041	0.02567	-7.95	3.73E-15	$\beta^{(7)}_{5}$	200.6301	1407.432	0.143	0.887	$\emptyset^{10}_{1(8)}$	NA	NA	NA	NA
$\beta^{(4)}_{1}$	152.9377	189.59	0.807	0.42	$\emptyset^{7}_{1(2)}$	NA	NA	NA	NA					
$\beta^{(4)}_{2}$	-20.299	84.67387	-0.24	0.811	$\emptyset^{7}_{1(3)}$	NA	NA	NA	NA					

Table A.28.1. *Correlation between parameters of forecasting model in 1 month*

	$\emptyset^1_{1(0)}$	$\emptyset^1_{1(3)}$	$\emptyset^1_{1(4)}$	$\emptyset^1_{1(5)}$	$\emptyset^1_{1(6)}$
$\emptyset^1_{1(3)}$	0.98				
$\emptyset^1_{1(4)}$	0.94	0.96			
$\emptyset^1_{1(5)}$	0.98	0.98	0.97		
$\emptyset^1_{1(6)}$	0.88	0.91	0.92	0.93	
$\emptyset^1_{1(7)}$	0.98	0.98	0.97	0.98	0.92

	$\emptyset^2_{1(0)}$	$\emptyset^2_{1(1)}$	$\emptyset^2_{1(4)}$	$\emptyset^2_{1(5)}$	$\emptyset^2_{1(6)}$
$\emptyset^2_{1(1)}$	0.99				
$\emptyset^2_{1(4)}$	0.89	0.90			
$\emptyset^2_{1(5)}$	0.95	0.96	0.91		
$\emptyset^2_{1(6)}$	0.99	0.99	0.88	0.96	
$\emptyset^2_{1(7)}$	0.97	0.98	0.92	0.98	0.99

	$\emptyset^3_{1(0)}$	$\emptyset^3_{1(5)}$	$\emptyset^3_{1(6)}$	$\emptyset^3_{1(7)}$
$\emptyset^3_{1(5)}$	0.98			
$\emptyset^3_{1(6)}$	0.98	0.97		
$\emptyset^3_{1(7)}$	0.98	0.99	0.96	
$\emptyset^3_{1(8)}$	0.98	0.98	0.97	0.99

	$\emptyset^4_{1(0)}$	$\emptyset^4_{1(2)}$	$\emptyset^4_{1(3)}$	$\emptyset^4_{1(5)}$	$\emptyset^4_{1(6)}$
$\emptyset^4_{1(2)}$	0.97				
$\emptyset^4_{1(3)}$	0.96	0.98			
$\emptyset^4_{1(5)}$	0.98	0.98	0.98		
$\emptyset^4_{1(6)}$	0.94	0.89	0.87	0.92	
$\emptyset^4_{1(7)}$	0.98	0.99	0.98	0.99	0.90

	$\emptyset^5_{1(0)}$	$\emptyset^5_{1(4)}$	$\emptyset^5_{1(5)}$
$\emptyset^5_{1(4)}$	0.94		
$\emptyset^5_{1(5)}$	0.96	0.98	
$\emptyset^5_{1(6)}$	0.97	0.98	0.98

	$\emptyset^6_{1(0)}$	$\emptyset^6_{1(4)}$	$\emptyset^6_{1(5)}$	$\emptyset^6_{1(6)}$
$\emptyset^6_{1(4)}$	0.90			
$\emptyset^6_{1(5)}$	0.99	0.89		
$\emptyset^6_{1(6)}$	0.98	0.92	0.98	
$\emptyset^6_{1(7)}$	0.98	0.94	0.97	0.98

	$\emptyset^7_{1(0)}$	$\emptyset^7_{1(2)}$	$\emptyset^7_{1(3)}$	$\emptyset^7_{1(5)}$	$\emptyset^7_{1(6)}$
$\emptyset^7_{1(2)}$	0.97				
$\emptyset^7_{1(3)}$	0.98	0.96			
$\emptyset^7_{1(5)}$	0.98	0.98	0.98		
$\emptyset^7_{1(6)}$	0.91	0.95	0.88	0.93	
$\emptyset^7_{1(7)}$	0.99	0.98	0.99	0.98	0.91

	$\emptyset^8_{1(0)}$	$\emptyset^8_{1(1)}$	$\emptyset^8_{1(4)}$	$\emptyset^8_{1(5)}$	$\emptyset^8_{1(6)}$
$\emptyset^8_{1(1)}$	0.99				
$\emptyset^8_{1(4)}$	0.90	0.89			
$\emptyset^8_{1(5)}$	0.96	0.95	0.91		
$\emptyset^8_{1(6)}$	0.99	0.99	0.88	0.96	
$\emptyset^8_{1(7)}$	0.98	0.97	0.92	0.98	0.99

	$\emptyset^9_{1(0)}$	$\emptyset^9_{1(4)}$	$\emptyset^9_{1(5)}$	$\emptyset^9_{1(6)}$
$\emptyset^9_{1(4)}$	0.90			
$\emptyset^9_{1(5)}$	0.90	0.97		
$\emptyset^9_{1(6)}$	0.92	0.99	0.97	
$\emptyset^9_{1(7)}$	0.90	1.00	0.97	0.99

	$\emptyset^{10}_{1(0)}$	$\emptyset^{10}_{1(6)}$	$\emptyset^{10}_{1(7)}$
$\emptyset^{10}_{1(6)}$	0.97		
$\emptyset^{10}_{1(7)}$	0.98	0.97	
$\emptyset^{10}_{1(8)}$	0.98	0.97	0.98

Table A.29.1. *Correlation between parameters of forecasting model in 2 years*

	$\emptyset^1_{1(0)}$	$\emptyset^1_{1(3)}$	$\emptyset^1_{1(4)}$	$\emptyset^1_{1(5)}$	$\emptyset^1_{1(6)}$
$\emptyset^1_{1(3)}$	0.98				
$\emptyset^1_{1(4)}$	0.94	0.96			
$\emptyset^1_{1(5)}$	0.98	0.98	0.97		
$\emptyset^1_{1(6)}$	0.88	0.91	0.92	0.93	
$\emptyset^1_{1(7)}$	0.98	0.98	0.97	0.98	0.92

	$\emptyset^2_{1(0)}$	$\emptyset^2_{1(1)}$	$\emptyset^2_{1(4)}$	$\emptyset^2_{1(5)}$	$\emptyset^2_{1(6)}$
$\emptyset^2_{1(1)}$	0.99				
$\emptyset^2_{1(4)}$	0.89	0.90			
$\emptyset^2_{1(5)}$	0.95	0.96	0.91		
$\emptyset^2_{1(6)}$	0.99	0.99	0.88	0.96	
$\emptyset^2_{1(7)}$	0.97	0.98	0.92	0.98	0.99

	$\emptyset^3_{1(0)}$	$\emptyset^3_{1(5)}$	$\emptyset^3_{1(6)}$	$\emptyset^3_{1(7)}$
$\emptyset^3_{1(5)}$	0.98			
$\emptyset^3_{1(6)}$	0.98	0.97		
$\emptyset^3_{1(7)}$	0.98	0.99	0.96	
$\emptyset^3_{1(8)}$	0.98	0.98	0.97	0.99

	$\emptyset^4_{1(0)}$	$\emptyset^4_{1(2)}$	$\emptyset^4_{1(3)}$	$\emptyset^4_{1(5)}$	$\emptyset^4_{1(6)}$
$\emptyset^4_{1(2)}$	0.97				
$\emptyset^4_{1(3)}$	0.96	0.98			
$\emptyset^4_{1(5)}$	0.98	0.98	0.98		
$\emptyset^4_{1(6)}$	0.94	0.89	0.87	0.92	
$\emptyset^4_{1(7)}$	0.98	0.99	0.98	0.99	0.90

	$\emptyset^5_{1(0)}$	$\emptyset^5_{1(4)}$	$\emptyset^5_{1(5)}$
$\emptyset^5_{1(4)}$	0.94		
$\emptyset^5_{1(5)}$	0.96	0.98	
$\emptyset^5_{1(6)}$	0.97	0.98	0.98

	$\emptyset^6_{1(0)}$	$\emptyset^6_{1(4)}$	$\emptyset^6_{1(5)}$	$\emptyset^6_{1(6)}$
$\emptyset^6_{1(4)}$	0.90			
$\emptyset^6_{1(5)}$	0.99	0.89		
$\emptyset^6_{1(6)}$	0.98	0.92	0.98	
$\emptyset^6_{1(7)}$	0.98	0.94	0.97	0.98

	$\emptyset^7_{1(0)}$	$\emptyset^7_{1(2)}$	$\emptyset^7_{1(3)}$	$\emptyset^7_{1(5)}$	$\emptyset^7_{1(6)}$
$\emptyset^7_{1(2)}$	0.97				
$\emptyset^7_{1(3)}$	0.98	0.96			
$\emptyset^7_{1(5)}$	0.98	0.98	0.98		
$\emptyset^7_{1(6)}$	0.91	0.95	0.88	0.93	
$\emptyset^7_{1(7)}$	0.99	0.98	0.99	0.98	0.91

	$\emptyset^8_{1(0)}$	$\emptyset^8_{1(1)}$	$\emptyset^8_{1(4)}$	$\emptyset^8_{1(5)}$	$\emptyset^8_{1(6)}$
$\emptyset^8_{1(1)}$	0.99				
$\emptyset^8_{1(4)}$	0.90	0.89			
$\emptyset^8_{1(5)}$	0.96	0.95	0.91		
$\emptyset^8_{1(6)}$	0.99	0.99	0.88	0.96	
$\emptyset^8_{1(7)}$	0.98	0.97	0.92	0.98	0.98

	$\emptyset^9_{1(0)}$	$\emptyset^9_{1(4)}$	$\emptyset^9_{1(5)}$	$\emptyset^9_{1(6)}$
$\emptyset^9_{1(4)}$	0.90			
$\emptyset^9_{1(5)}$	0.90	0.97		
$\emptyset^9_{1(6)}$	0.92	0.99	0.97	
$\emptyset^9_{1(7)}$	0.90	1.00	0.97	0.99

	$\emptyset^{10}_{1(0)}$	$\emptyset^{10}_{1(6)}$	$\emptyset^{10}_{1(7)}$
$\emptyset^{10}_{1(6)}$	0.97		
$\emptyset^{10}_{1(7)}$	0.98	0.97	
$\emptyset^{10}_{1(8)}$	0.98	0.97	0.98

Table A.30.1. *PCA of forecasting model in 1 month*

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	2808222.00	0.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{1}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0.00
$\varnothing^{1}_{1(3)}$	0.00	1.00	0.00	0.00	0.00	0.00
$\varnothing^{1}_{1(4)}$	0.00	0.00	0.00	0.00	1.00	0.01
$\varnothing^{1}_{1(5)}$	0.00	0.00	0.00	0.00	0.01	-1.00
$\varnothing^{1}_{1(6)}$	0.00	0.00	-1.00	0.00	0.00	0.00
$\varnothing^{1}_{1(7)}$	0.00	0.00	0.00	1.00	0.00	0.00

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	41172.00	0.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{2}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0.00
$\varnothing^{2}_{1(1)}$	0.00	1.00	0.00	0.00	0.00	0.00
$\varnothing^{2}_{1(4)}$	0.00	0.00	0.00	0.00	1.00	0.00
$\varnothing^{2}_{1(5)}$	0.00	0.00	0.00	-1.00	0.00	0.00
$\varnothing^{2}_{1(6)}$	0.00	0.00	0.00	0.00	0.00	-1.00
$\varnothing^{2}_{1(7)}$	0.00	0.00	-1.00	0.00	0.00	0.00

	PC1	PC2	PC3	PC4	PC5
Eigenvalue	1644210000000 0.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{3}_{1(0)}$	1.00	0.00	0.00	0.00	0.00
$\varnothing^{3}_{1(5)}$	0.00	0.00	0.00	-1.00	0.00
$\varnothing^{3}_{1(6)}$	0.00	-1.00	0.00	0.00	0.00
$\varnothing^{3}_{1(7)}$	0.00	0.00	0.00	0.00	1.00
$\varnothing^{3}_{1(8)}$	0.00	0.00	-1.00	0.00	0.00

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	662853245.00	0.00	0.00	0.00	0.00	0
Proportion	1.00	0.00	0.00	0.00	0.00	0
Cumulative	1.00	1.00	1.00	1.00	1.00	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{4}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0
$\varnothing^{4}_{1(2)}$	0.00	1.00	0.00	0.00	0.00	0
$\varnothing^{4}_{1(3)}$	0.00	0.00	0.00	-1.00	0.00	0
$\varnothing^{4}_{1(5)}$	0.00	0.00	0.00	0.00	-1.00	0
$\varnothing^{4}_{1(6)}$	0.00	0.00	0.00	0.00	0.00	-1
$\varnothing^{4}_{1(7)}$	0.00	0.00	-1.00	0.00	0.00	0

	PC1	PC2	PC3	PC4
Eigenvalue	618305545.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4
$\varnothing^{5}_{1(0)}$	1.00	0.00	0.00	0.00
$\varnothing^{5}_{1(4)}$	0.00	0.00	0.00	-1.00
$\varnothing^{5}_{1(5)}$	0.00	1.00	0.00	0.00
$\varnothing^{5}_{1(6)}$	0.00	0.00	-1.00	0.00

	PC1	PC2	PC3	PC4	PC5
Eigenvalue	887458.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{6}_{1(0)}$	1.00	0.00	0.00	0.00	0.00
$\varnothing^{6}_{1(4)}$	0.00	0.00	-0.02	-0.09	1.00
$\varnothing^{6}_{1(5)}$	0.00	1.00	0.00	0.00	0.00
$\varnothing^{6}_{1(6)}$	0.00	0.00	-1.00	0.00	-0.02
$\varnothing^{6}_{1(7)}$	0.00	0.00	0.00	1.00	0.09

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	94304145007. 00	0.00	0.00	0.00	0.00	0
Proportion	1.00	0.00	0.00	0.00	0.00	0
Cumulative	1.00	1.00	1.00	1.00	1.00	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{7}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0
$\varnothing^{7}_{1(2)}$	0.00	1.00	0.00	0.00	0.00	0
$\varnothing^{7}_{1(3)}$	0.00	0.00	0.00	0.00	-1.00	0
$\varnothing^{7}_{1(5)}$	0.00	0.00	0.00	0.00	0.00	-1
$\varnothing^{7}_{1(6)}$	0.00	0.00	-1.00	0.00	0.00	0
$\varnothing^{7}_{1(7)}$	0.00	0.00	0.00	1.00	0.00	0

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	38279.00	0.00	0.00	0.00	0.00	0
Proportion	1.00	0.00	0.00	0.00	0.00	0
Cumulative	1.00	1.00	1.00	1.00	1.00	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{8}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0
$\varnothing^{8}_{1(1)}$	0.00	-1.00	0.00	0.00	0.00	0
$\varnothing^{8}_{1(4)}$	0.00	0.00	0.00	1.00	0.00	0
$\varnothing^{8}_{1(5)}$	0.00	0.00	1.00	0.00	0.00	0
$\varnothing^{8}_{1(6)}$	0.00	0.00	0.00	0.00	0.00	-1
$\varnothing^{8}_{1(7)}$	0.00	0.00	0.00	0.00	-1.00	0

	PC1	PC2	PC3	PC4	PC5
Eigenvalue	22001116.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{9}_{1(0)}$	1.00	0.00	0.00	0.00	0.00
$\varnothing^{9}_{1(4)}$	0.00	0.00	0.00	0.00	1.00
$\varnothing^{9}_{1(5)}$	0.00	1.00	0.00	0.00	0.00
$\varnothing^{9}_{1(6)}$	0.00	0.00	-1.00	0.00	0.00
$\varnothing^{9}_{1(7)}$	0.00	0.00	0.00	1.00	0.00

	PC1	PC2	PC3	PC4
Eigenvalue	63012.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4
$\varnothing^{10}_{1(6)}$	1.00	0.00	0.00	0.00
$\varnothing^{10}_{1(7)}$	0.00	1.00	0.00	0.00
$\varnothing^{10}_{1(8)}$	0.00	0.00	1.00	0.00
$\varnothing^{10}_{1(8)}$	0.00	0.00	0.00	1.00

Table A.31.1. *PCA of forecasting model in 2 year*

Eigenvalue	2808828.00	0.00	0.00	0.00	0.00	0
Proportion	1.00	0.00	0.00	0.00	0.00	0
Cumulative	1.00	1.00	1.00	1.00	1.00	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{1}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0
$\varnothing^{1}_{1(3)}$	0.00	1.00	0.00	0.00	0.00	0
$\varnothing^{1}_{1(4)}$	0.00	0.00	-0.01	1.00	0.00	0
$\varnothing^{1}_{1(5)}$	0.00	0.00	1.00	0.01	0.00	0
$\varnothing^{1}_{1(6)}$	0.00	0.00	0.00	0.00	0.00	1
$\varnothing^{1}_{1(7)}$	0.00	0.00	0.00	0.00	-1.00	0

Eigenvalue	41155.00	0.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{2}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0.00
$\varnothing^{2}_{1(1)}$	0.00	1.00	0.00	0.00	0.00	0.00
$\varnothing^{2}_{1(4)}$	0.00	0.00	0.00	1.00	0.00	0.00
$\varnothing^{2}_{1(5)}$	0.00	0.00	0.00	0.00	-1.00	0.00
$\varnothing^{2}_{1(6)}$	0.00	0.00	-1.00	0.00	0.00	0.00
$\varnothing^{2}_{1(7)}$	0.00	0.00	0.00	0.00	0.00	-1.00

Eigenvalue	16445600000000.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{3}_{1(0)}$	1.00	0.00	0.00	0.00	0.00
$\varnothing^{3}_{1(5)}$	0.00	0.00	0.00	-1.00	0.00
$\varnothing^{3}_{1(6)}$	0.00	-1.00	0.00	0.00	0.00
$\varnothing^{3}_{1(7)}$	0.00	0.00	0.00	0.00	1.00
$\varnothing^{3}_{1(8)}$	0.00	0.00	-1.00	0.00	0.00

Eigenvalue	662786561.00	0.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{4}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0.00
$\varnothing^{4}_{1(2)}$	0.00	1.00	0.00	0.00	0.00	0.00
$\varnothing^{4}_{1(3)}$	0.00	0.00	-1.00	0.00	0.00	0.00
$\varnothing^{4}_{1(5)}$	0.00	0.00	0.00	-1.00	0.00	0.00
$\varnothing^{4}_{1(6)}$	0.00	0.00	0.00	0.00	0.00	-1.00
$\varnothing^{4}_{1(7)}$	0.00	0.00	0.00	0.00	-1.00	0.00

Eigenvalue	618540845.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4
$\varnothing^{5}_{1(0)}$	1.00	0.00	0.00	0.00
$\varnothing^{5}_{1(4)}$	0.00	0.00	0.00	-1.00
$\varnothing^{5}_{1(5)}$	0.00	1.00	0.00	0.00
$\varnothing^{5}_{1(6)}$	0.00	0.00	-1.00	0.00

Eigenvalue	887451.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{6}_{1(0)}$	1.00	0.00	0.00	0.00	0.00
$\varnothing^{6}_{1(4)}$	0.00	0.00	-0.02	0.02	1.00
$\varnothing^{6}_{1(5)}$	0.00	1.00	0.00	0.00	0.00
$\varnothing^{6}_{1(6)}$	0.00	0.00	-1.00	0.00	-0.02
$\varnothing^{6}_{1(7)}$	0.00	0.00	0.00	1.00	-0.02

Eigenvalue	94310223553.00	0.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{7}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0.00
$\varnothing^{7}_{1(2)}$	0.00	1.00	0.00	0.00	0.00	0.00
$\varnothing^{7}_{1(3)}$	0.00	0.00	1.00	0.00	0.00	0.00
$\varnothing^{7}_{1(5)}$	0.00	0.00	0.00	0.00	-1.00	0.00
$\varnothing^{7}_{1(6)}$	0.00	0.00	0.00	1.00	0.00	0.00
$\varnothing^{7}_{1(7)}$	0.00	0.00	0.00	0.00	0.00	-1.00

Eigenvalue	38261.00	0.00	0.00	0.00	0.00	0
Proportion	1.00	0.00	0.00	0.00	0.00	0
Cumulative	1.00	1.00	1.00	1.00	1.00	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
$\varnothing^{8}_{1(0)}$	1.00	0.00	0.00	0.00	0.00	0
$\varnothing^{8}_{1(1)}$	0.00	-1.00	0.00	0.00	0.00	0
$\varnothing^{8}_{1(4)}$	0.00	0.00	0.00	0.00	0.00	-1
$\varnothing^{8}_{1(5)}$	0.00	0.00	0.00	0.00	1.00	0
$\varnothing^{8}_{1(6)}$	0.00	0.00	-1.00	0.00	0.00	0
$\varnothing^{8}_{1(7)}$	0.00	0.00	0.00	-1.00	0.00	0

Eigenvalue	21997165.00	0.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4	PC5
$\varnothing^{9}_{1(0)}$	1.00	0.00	0.00	0.00	0.00
$\varnothing^{9}_{1(4)}$	0.00	0.00	0.00	0.00	1.00
$\varnothing^{9}_{1(5)}$	0.00	1.00	0.00	0.00	0.00
$\varnothing^{9}_{1(6)}$	0.00	0.00	-1.00	0.00	0.00
$\varnothing^{9}_{1(7)}$	0.00	0.00	0.00	1.00	0.00

Eigenvalue	63012.00	0.00	0.00	0.00
Proportion	1.00	0.00	0.00	0.00
Cumulative	1.00	1.00	1.00	1.00
Variable	PC1	PC2	PC3	PC4
$\varnothing^{10}_{1(6)}$	1.00	0.00	0.00	0.00
$\varnothing^{10}_{1(7)}$	0.00	1.00	0.00	0.00
$\varnothing^{10}_{1(8)}$	0.00	0.00	1.00	0.00
$\varnothing^{10}_{1(8)}$	0.00	0.00	0.00	1.00

Table A.32.1. *Parameter estimation of forecasting model in 1 month*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset_{1(0)}^{1}$	1.0001	0.0001	6047	<2e-16	$\emptyset_{1(0)}^{6}$	1.0002	0.0001	5992	<2e-16
$\emptyset_{1(3)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{6}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{1}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{7}$	1.0002	0.0001	5486	<2e-16
$\emptyset_{1(0)}^{2}$	1.0001	0.0001	6477	<2e-16	$\emptyset_{1(2)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(1)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(3)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{7}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{2}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{8}$	1.0001	0.0001	6662	<2e-16
$\emptyset_{1(0)}^{3}$	1.0002	0.0001	5712	<2e-16	$\emptyset_{1(1)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(8)}^{3}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{8}$	NA	NA	NA	NA
$\emptyset_{1(0)}^{4}$	1.0002	0.0001	6594	<2e-16	$\emptyset_{1(0)}^{9}$	1.0009	0.0005	1718	<2e-16
$\emptyset_{1(2)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(4)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(3)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(5)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(6)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{9}$	NA	NA	NA	NA
$\emptyset_{1(7)}^{4}$	NA	NA	NA	NA	$\emptyset_{1(0)}^{10}$	1.0002	0.0001	5995	<2e-16
$\emptyset_{1(0)}^{5}$	1.0002	0.0002	4649	<2e-16	$\emptyset_{1(6)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(4)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(7)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(5)}^{5}$	NA	NA	NA	NA	$\emptyset_{1(8)}^{10}$	NA	NA	NA	NA
$\emptyset_{1(6)}^{5}$	NA	NA	NA	NA					

Table A.33.1. *Parameter estimation of forecasting model in 1 year*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset_{1(0)}^{1}$	9.90E-01	7.25E-03	136.6	<2e-16	$\emptyset_{1(0)}^{6}$	9.68E-01	7.95E-03	121.738	<2e-16
$\emptyset_{1(3)}^{1}$	9.53E+04	3.28E+04	2.905	0.00371	$\emptyset_{1(4)}^{6}$	-1.30E+10	1.14E+10	-1.138	0.25527
$\emptyset_{1(4)}^{1}$	-3.87E+10	3.10E+10	-1.248	0.21225	$\emptyset_{1(5)}^{6}$	2.85E+16	2.83E+16	1.005	0.31508
$\emptyset_{1(5)}^{1}$	1.26E+13	4.87E+12	2.581	0.00992	$\emptyset_{1(6)}^{6}$	1.29E+17	4.73E+16	2.737	0.00625
$\emptyset_{1(6)}^{1}$	-9.44E+19	4.53E+19	-2.086	0.03713	$\emptyset_{1(7)}^{6}$	1.50E+24	7.42E+23	2.018	0.04367
$\emptyset_{1(7)}^{1}$	-1.98E+27	5.66E+26	-3.495	0.00048	$\emptyset_{1(0)}^{7}$	1.00E+00	7.27E-03	137.589	<2e-16
$\emptyset_{1(0)}^{2}$	1.01E+00	7.34E-03	138.18	<2e-16	$\emptyset_{1(2)}^{7}$	1.50E+04	2.31E+04	0.646	0.518
$\emptyset_{1(1)}^{2}$	-2.62E+00	2.35E+00	-1.114	0.26547	$\emptyset_{1(3)}^{7}$	-1.33E+08	1.35E+09	-0.098	0.922
$\emptyset_{1(4)}^{2}$	-1.78E+10	1.07E+10	-1.663	0.09655	$\emptyset_{1(5)}^{7}$	-5.30E+12	1.20E+15	-0.004	0.996
$\emptyset_{1(5)}^{2}$	-2.50E+14	1.77E+14	-1.413	0.1579	$\emptyset_{1(6)}^{7}$	-9.64E+21	2.15E+22	-0.449	0.654
$\emptyset_{1(6)}^{2}$	-6.23E+20	2.68E+20	-2.329	0.01996	$\emptyset_{1(7)}^{7}$	-8.05E+27	2.80E+28	-0.287	0.774
$\emptyset_{1(7)}^{2}$	9.20E+21	3.36E+21	2.738	0.00624	$\emptyset_{1(0)}^{8}$	9.84E-01	7.34E-03	134.149	<2e-16
$\emptyset_{1(0)}^{3}$	1.01E+00	5.84E-03	172.24	<2e-16	$\emptyset_{1(1)}^{8}$	6.10E+00	2.78E+00	2.197	0.02815
$\emptyset_{1(5)}^{3}$	3.08E+17	2.13E+17	1.448	0.1478	$\emptyset_{1(4)}^{8}$	-1.94E+10	7.68E+09	-2.522	0.01174
$\emptyset_{1(6)}^{3}$	-2.73E+22	5.23E+22	-0.522	0.6014	$\emptyset_{1(5)}^{8}$	-2.37E+14	1.49E+14	-1.593	0.11126
$\emptyset_{1(7)}^{3}$	2.39E+29	4.24E+29	0.564	0.5726	$\emptyset_{1(6)}^{8}$	-4.93E+20	2.46E+20	-2.004	0.04524
$\emptyset_{1(8)}^{3}$	-5.63E+35	2.24E+35	-2.519	0.0118	$\emptyset_{1(7)}^{8}$	8.50E+21	2.88E+21	2.947	0.00324
$\emptyset_{1(0)}^{4}$	1.01E+00	5.52E-03	182.12	<2e-16	$\emptyset_{1(0)}^{9}$	9.97E-01	2.67E-03	373.878	<2e-16
$\emptyset_{1(2)}^{4}$	3.17E+02	1.75E+02	1.815	0.06969	$\emptyset_{1(4)}^{9}$	6.68E+10	5.97E+12	0.011	0.991
$\emptyset_{1(3)}^{4}$	9.21E+07	3.35E+08	0.275	0.78343	$\emptyset_{1(5)}^{9}$	1.19E+15	1.96E+15	0.604	0.546
$\emptyset_{1(5)}^{4}$	1.27E+14	1.01E+14	1.253	0.21048	$\emptyset_{1(6)}^{9}$	6.54E+17	6.92E+17	0.944	0.345
$\emptyset_{1(6)}^{4}$	-2.92E+21	2.35E+21	-1.244	0.2136	$\emptyset_{1(7)}^{9}$	-1.19E+27	7.11E+27	-0.167	0.867
$\emptyset_{1(7)}^{4}$	-1.87E+27	7.00E+26	-2.666	0.00773	$\emptyset_{1(0)}^{10}$	9.82E-01	5.48E-03	179.249	<2e-16
$\emptyset_{1(0)}^{5}$	9.92E-01	3.50E-03	283.4	<2e-16	$\emptyset_{1(6)}^{10}$	-1.22E+19	8.09E+18	-1.502	0.1331
$\emptyset_{1(4)}^{5}$	-1.23E+13	9.05E+12	-1.364	0.173	$\emptyset_{1(7)}^{10}$	1.48E+23	5.84E+22	2.539	0.0112
$\emptyset_{1(5)}^{5}$	4.09E+14	3.54E+14	1.154	0.248	$\emptyset_{1(8)}^{10}$	1.24E+27	8.06E+26	1.539	0.1239
$\emptyset_{1(6)}^{5}$	4.90E+18	3.30E+18	1.484	0.138					

Table A.34.1. *Parameter estimation of forecasting model in 2 years*

Par.	Estimate	Std. Error	t value	p-value	Par.	Estimate	Std. Error	t value	p-value
$\emptyset^{1}_{1(0)}$	1.0002	0.000162	6157	<2e-16	$\emptyset^{6}_{1(0)}$	1.0002	0.000165	6078	<2e-16
$\emptyset^{1}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{6}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{1}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(0)}$	1.0002	0.000178	5609	<2e-16
$\emptyset^{2}_{1(0)}$	1.0002	0.000152	6588	<2e-16	$\emptyset^{7}_{1(2)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(1)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(3)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{7}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{2}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(0)}$	1.0002	0.000148	6761	<2e-16
$\emptyset^{3}_{1(0)}$	1.0002	0.00017	5882	<2e-16	$\emptyset^{8}_{1(1)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{3}_{1(8)}$	NA	NA	NA	NA	$\emptyset^{8}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(0)}$	1.0002	0.000149	6699	<2e-16	$\emptyset^{9}_{1(0)}$	1.0010	0.000586	1708	<2e-16
$\emptyset^{4}_{1(2)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(4)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(3)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(5)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(6)}$	NA	NA	NA	NA	$\emptyset^{9}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{4}_{1(7)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(0)}$	1.0002	0.000165	6081	<2e-16
$\emptyset^{5}_{1(0)}$	1.0002	0.000208	4817	<2e-16	$\emptyset^{10}_{1(6)}$	NA	NA	NA	NA
$\emptyset^{5}_{1(4)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(7)}$	NA	NA	NA	NA
$\emptyset^{5}_{1(5)}$	NA	NA	NA	NA	$\emptyset^{10}_{1(8)}$	NA	NA	NA	NA
$\emptyset^{5}_{1(6)}$	NA	NA	NA	NA					

Table A.35.1. *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jan-22	11510	1594	25771134	207965	134891	6780	2147025	1649	23512	1807
2-Jan-22	11504	1594	25777335	207978	134947	6780	2147345	1649	23503	1808
3-Jan-22	11498	1594	25783293	207991	135004	6781	2147669	1648	23494	1809
4-Jan-22	11493	1594	25789011	208005	135062	6781	2147996	1647	23484	1810
5-Jan-22	11487	1594	25794494	208020	135121	6781	2148326	1646	23475	1811
6-Jan-22	11482	1594	25799746	208035	135180	6781	2148659	1646	23465	1812
7-Jan-22	11476	1594	25804771	208051	135239	6782	2148995	1645	23456	1813
8-Jan-22	11471	1594	25809574	208068	135299	6782	2149334	1644	23446	1814
9-Jan-22	11465	1594	25814158	208085	135360	6782	2149676	1644	23437	1814
10-Jan-22	11460	1594	25818528	208102	135421	6783	2150020	1643	23427	1815
11-Jan-22	11454	1594	25822687	208120	135483	6783	2150368	1643	23417	1816
12-Jan-22	11449	1595	25826640	208139	135545	6783	2150718	1642	23408	1817
13-Jan-22	11443	1595	25830391	208158	135608	6784	2151072	1642	23398	1818
14-Jan-22	11438	1595	25833944	208178	135671	6784	2151428	1641	23388	1819
15-Jan-22	11432	1595	25837302	208198	135734	6784	2151787	1641	23378	1820
16-Jan-22	11427	1595	25840470	208218	135799	6785	2152148	1640	23368	1820
17-Jan-22	11421	1596	25843451	208239	135863	6785	2152512	1640	23358	1821
18-Jan-22	11416	1596	25846250	208260	135928	6786	2152879	1639	23349	1822
19-Jan-22	11410	1596	25848870	208282	135993	6786	2153249	1639	23339	1823
20-Jan-22	11404	1596	25851314	208304	136059	6786	2153621	1639	23328	1824
21-Jan-22	11399	1597	25853588	208326	136125	6787	2153996	1638	23318	1824
22-Jan-22	11393	1597	25855694	208349	136192	6787	2154373	1638	23308	1825
23-Jan-22	11388	1597	25857636	208372	136259	6788	2154752	1638	23298	1826
24-Jan-22	11382	1598	25859419	208396	136326	6788	2155134	1638	23288	1827
25-Jan-22	11377	1598	25861045	208419	136394	6789	2155519	1637	23278	1827
26-Jan-22	11371	1598	25862518	208443	136462	6789	2155906	1637	23268	1828
27-Jan-22	11366	1599	25863842	208467	136530	6790	2156295	1637	23257	1829
28-Jan-22	11361	1599	25865021	208492	136599	6790	2156686	1637	23247	1829
29-Jan-22	11355	1600	25866057	208516	136667	6791	2157080	1636	23237	1830
30-Jan-22	11350	1600	25866956	208541	136737	6791	2157476	1636	23226	1831
31-Jan-22	11344	1600	25867719	208566	136806	6792	2157874	1636	23216	1831

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Feb-22	11339	1601	25868351	208591	136876	6792	2158274	1636	23206	1832
2-Feb-22	11333	1601	25868855	208617	136946	6793	2158677	1636	23195	1833
3-Feb-22	11328	1602	25869235	208642	137016	6793	2159081	1636	23185	1833
4-Feb-22	11322	1602	25869494	208668	137087	6794	2159488	1636	23174	1834
5-Feb-22	11317	1603	25869635	208694	137158	6794	2159896	1636	23164	1834
6-Feb-22	11312	1603	25869662	208720	137229	6795	2160307	1636	23153	1835
7-Feb-22	11306	1604	25869577	208746	137300	6795	2160719	1636	23143	1836
8-Feb-22	11301	1604	25869386	208772	137372	6796	2161133	1636	23132	1836
9-Feb-22	11295	1605	25869089	208799	137444	6796	2161550	1636	23122	1837
10-Feb-22	11290	1605	25868692	208825	137516	6797	2161968	1636	23111	1837
11-Feb-22	11285	1606	25868197	208852	137588	6797	2162387	1636	23101	1838
12-Feb-22	11279	1606	25867607	208878	137660	6798	2162809	1636	23090	1838
13-Feb-22	11274	1607	25866926	208905	137733	6798	2163232	1636	23079	1839
14-Feb-22	11269	1608	25866156	208931	137806	6799	2163657	1636	23069	1839
15-Feb-22	11263	1608	25865302	208958	137879	6800	2164083	1636	23058	1840
16-Feb-22	11258	1609	25864365	208985	137952	6800	2164511	1636	23047	1840
17-Feb-22	11253	1610	25863349	209011	138025	6801	2164940	1636	23037	1841
18-Feb-22	11248	1610	25862257	209038	138098	6801	2165371	1636	23026	1841
19-Feb-22	11243	1611	25861093	209065	138172	6802	2165804	1637	23015	1842
20-Feb-22	11237	1612	25859858	209091	138246	6802	2166238	1637	23004	1842
21-Feb-22	11232	1612	25858557	209118	138319	6803	2166673	1637	22994	1843
22-Feb-22	11227	1613	25857192	209144	138393	6804	2167109	1637	22983	1843
23-Feb-22	11222	1614	25855766	209171	138468	6804	2167547	1637	22972	1844
24-Feb-22	11217	1614	25854282	209197	138542	6805	2167986	1638	22961	1844
25-Feb-22	11212	1615	25852743	209224	138616	6805	2168426	1638	22951	1844
26-Feb-22	11206	1616	25851152	209250	138691	6806	2168867	1638	22940	1845
27-Feb-22	11201	1617	25849511	209276	138765	6807	2169309	1638	22929	1845
28-Feb-22	11196	1617	25847824	209302	138840	6807	2169752	1639	22918	1846

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Mar-22	11191	1618	25846093	209328	138915	6808	2170197	1639	22907	1846
2-Mar-22	11186	1619	25844321	209354	138989	6809	2170642	1639	22897	1846
3-Mar-22	11181	1620	25842511	209380	139064	6809	2171088	1640	22886	1847
4-Mar-22	11176	1621	25840665	209406	139139	6810	2171535	1640	22875	1847
5-Mar-22	11171	1621	25838787	209431	139214	6810	2171982	1640	22864	1847
6-Mar-22	11166	1622	25836879	209457	139290	6811	2172431	1641	22854	1848
7-Mar-22	11162	1623	25834944	209482	139365	6812	2172880	1641	22843	1848
8-Mar-22	11157	1624	25832983	209507	139440	6812	2173329	1642	22832	1849
9-Mar-22	11152	1625	25831001	209532	139515	6813	2173780	1642	22821	1849
10-Mar-22	11147	1626	25829000	209556	139591	6814	2174231	1642	22810	1849
11-Mar-22	11142	1627	25826981	209581	139666	6814	2174682	1643	22800	1849
12-Mar-22	11138	1628	25824949	209605	139742	6815	2175133	1643	22789	1850
13-Mar-22	11133	1629	25822904	209629	139817	6816	2175586	1644	22778	1850
14-Mar-22	11128	1630	25820851	209653	139893	6816	2176038	1644	22767	1850
15-Mar-22	11123	1630	25818791	209677	139968	6817	2176490	1645	22757	1851
16-Mar-22	11119	1631	25816726	209700	140044	6818	2176943	1645	22746	1851
17-Mar-22	11114	1632	25814660	209723	140120	6818	2177396	1646	22735	1851
18-Mar-22	11110	1633	25812595	209746	140195	6819	2177849	1646	22724	1852
19-Mar-22	11105	1634	25810533	209769	140271	6820	2178302	1647	22714	1852
20-Mar-22	11101	1635	25808477	209791	140347	6820	2178755	1647	22703	1852
21-Mar-22	11096	1636	25806429	209813	140422	6821	2179208	1648	22692	1852
22-Mar-22	11092	1638	25804391	209835	140498	6822	2179661	1648	22682	1853
23-Mar-22	11087	1639	25802366	209856	140574	6822	2180113	1649	22671	1853
24-Mar-22	11083	1640	25800357	209877	140649	6823	2180566	1650	22660	1853
25-Mar-22	11078	1641	25798364	209898	140725	6824	2181018	1650	22650	1853
26-Mar-22	11074	1642	25796392	209919	140801	6825	2181469	1651	22639	1854
27-Mar-22	11070	1643	25794441	209939	140876	6825	2181920	1652	22629	1854
28-Mar-22	11065	1644	25792515	209959	140952	6826	2182371	1652	22618	1854
29-Mar-22	11061	1645	25790615	209978	141028	6827	2182820	1653	22608	1854
30-Mar-22	11057	1646	25788744	209997	141103	6828	2183270	1654	22597	1855
31-Mar-22	11053	1648	25786904	210016	141179	6828	2183718	1654	22587	1855

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Apr-22	11049	1649	25785098	210034	141255	6829	2184166	1655	22576	1855
2-Apr-22	11045	1650	25783327	210052	141330	6830	2184613	1656	22566	1855
3-Apr-22	11041	1651	25781593	210070	141406	6831	2185059	1656	22555	1855
4-Apr-22	11037	1652	25779899	210087	141481	6831	2185503	1657	22545	1856
5-Apr-22	11033	1654	25778247	210104	141557	6832	2185947	1658	22535	1856
6-Apr-22	11029	1655	25776640	210120	141632	6833	2186390	1659	22524	1856
7-Apr-22	11025	1656	25775078	210136	141708	6834	2186831	1660	22514	1856
8-Apr-22	11021	1657	25773564	210151	141783	6834	2187271	1660	22504	1856
9-Apr-22	11017	1659	25772101	210166	141859	6835	2187710	1661	22494	1857
10-Apr-22	11013	1660	25770690	210181	141934	6836	2188147	1662	22484	1857
11-Apr-22	11010	1661	25769333	210194	142009	6837	2188583	1663	22473	1857
12-Apr-22	11006	1663	25768033	210208	142084	6838	2189017	1664	22463	1857
13-Apr-22	11002	1664	25766791	210221	142159	6838	2189450	1665	22453	1857
14-Apr-22	10999	1665	25765609	210233	142235	6839	2189881	1665	22443	1857
15-Apr-22	10995	1667	25764490	210245	142310	6840	2190309	1666	22433	1858
16-Apr-22	10991	1668	25763436	210256	142385	6841	2190736	1667	22423	1858
17-Apr-22	10988	1670	25762447	210267	142460	6842	2191161	1668	22413	1858
18-Apr-22	10984	1671	25761527	210277	142534	6843	2191584	1669	22403	1858
19-Apr-22	10981	1673	25760677	210287	142609	6844	2192005	1670	22394	1858
20-Apr-22	10978	1674	25759900	210296	142684	6844	2192423	1671	22384	1858
21-Apr-22	10974	1675	25759196	210304	142759	6845	2192839	1672	22374	1858
22-Apr-22	10971	1677	25758568	210312	142833	6846	2193253	1673	22364	1859
23-Apr-22	10968	1678	25758018	210319	142908	6847	2193664	1674	22355	1859
24-Apr-22	10964	1680	25757547	210326	142982	6848	2194072	1675	22345	1859
25-Apr-22	10961	1682	25757158	210332	143057	6849	2194478	1676	22336	1859
26-Apr-22	10958	1683	25756853	210337	143131	6850	2194881	1677	22326	1859
27-Apr-22	10955	1685	25756632	210341	143205	6851	2195281	1678	22317	1859
28-Apr-22	10952	1686	25756499	210345	143280	6852	2195678	1679	22307	1859
29-Apr-22	10949	1688	25756454	210348	143354	6853	2196072	1680	22298	1859
30-Apr-22	10946	1689	25756500	210350	143428	6854	2196462	1682	22289	1860

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-May-22	10943	1691	25756639	210352	143502	6855	2196850	1683	22279	1860
2-May-22	10940	1693	25756871	210353	143575	6856	2197234	1684	22270	1860
3-May-22	10937	1694	25757200	210353	143649	6857	2197615	1685	22261	1860
4-May-22	10935	1696	25757626	210352	143723	6858	2197992	1686	22252	1860
5-May-22	10932	1698	25758151	210350	143797	6859	2198365	1687	22243	1860
6-May-22	10929	1700	25758778	210348	143870	6860	2198734	1689	22234	1860
7-May-22	10926	1701	25759507	210345	143943	6861	2199100	1690	22225	1860
8-May-22	10924	1703	25760341	210340	144017	6862	2199461	1691	22216	1860
9-May-22	10921	1705	25761282	210335	144090	6863	2199819	1692	22208	1861
10-May-22	10919	1707	25762330	210330	144163	6864	2200172	1694	22199	1861
11-May-22	10916	1709	25763488	210323	144236	6865	2200521	1695	22190	1861
12-May-22	10914	1710	25764757	210315	144309	6866	2200865	1696	22182	1861
13-May-22	10911	1712	25766139	210306	144382	6867	2201205	1697	22173	1861
14-May-22	10909	1714	25767636	210297	144455	6868	2201540	1699	22165	1861
15-May-22	10907	1716	25769249	210286	144528	6869	2201870	1700	22156	1861
16-May-22	10905	1718	25770980	210275	144600	6870	2202195	1702	22148	1861
17-May-22	10902	1720	25772831	210262	144673	6872	2202516	1703	22140	1861
18-May-22	10900	1722	25774803	210248	144745	6873	2202831	1704	22132	1861
19-May-22	10898	1724	25776898	210234	144817	6874	2203140	1706	22124	1861
20-May-22	10896	1726	25779117	210218	144889	6875	2203445	1707	22116	1861
21-May-22	10894	1728	25781462	210201	144961	6876	2203743	1709	22108	1862
22-May-22	10892	1730	25783935	210183	145033	6877	2204036	1710	22100	1862
23-May-22	10890	1732	25786537	210164	145105	6879	2204324	1712	22092	1862
24-May-22	10888	1734	25789270	210143	145177	6880	2204605	1713	22084	1862
25-May-22	10886	1736	25792135	210122	145249	6881	2204880	1715	22077	1862
26-May-22	10884	1738	25795134	210099	145320	6882	2205149	1716	22069	1862
27-May-22	10883	1740	25798269	210075	145392	6884	2205411	1718	22062	1862
28-May-22	10881	1743	25801541	210050	145463	6885	2205667	1719	22055	1862
29-May-22	10879	1745	25804952	210023	145534	6886	2205917	1721	22047	1862
30-May-22	10878	1747	25808503	209996	145605	6887	2206159	1723	22040	1862
31-May-22	10876	1749	25812195	209966	145676	6889	2206395	1724	22033	1862

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jun-22	10875	1752	25816031	209936	145747	6890	2206623	1726	22026	1862
2-Jun-22	10873	1754	25820012	209904	145818	6891	2206844	1728	22019	1862
3-Jun-22	10872	1756	25824139	209871	145888	6893	2207058	1729	22012	1862
4-Jun-22	10870	1758	25828414	209836	145959	6894	2207265	1731	22005	1863
5-Jun-22	10869	1761	25832838	209800	146029	6895	2207463	1733	21999	1863
6-Jun-22	10868	1763	25837414	209763	146099	6897	2207654	1735	21992	1863
7-Jun-22	10866	1766	25842142	209724	146170	6898	2207836	1736	21986	1863
8-Jun-22	10865	1768	25847024	209683	146240	6900	2208011	1738	21979	1863
9-Jun-22	10864	1770	25852062	209641	146310	6901	2208177	1740	21973	1863
10-Jun-22	10863	1773	25857256	209597	146379	6902	2208334	1742	21967	1863
11-Jun-22	10862	1775	25862609	209552	146449	6904	2208483	1744	21961	1863
12-Jun-22	10861	1778	25868123	209505	146519	6905	2208623	1746	21955	1863
13-Jun-22	10860	1781	25873797	209456	146588	6907	2208754	1747	21949	1863
14-Jun-22	10859	1783	25879635	209406	146657	6908	2208875	1749	21943	1863
15-Jun-22	10858	1786	25885638	209354	146726	6910	2208988	1751	21938	1863
16-Jun-22	10857	1788	25891807	209300	146796	6911	2209090	1753	21932	1863
17-Jun-22	10856	1791	25898143	209244	146864	6913	2209183	1755	21927	1863
18-Jun-22	10855	1794	25904648	209187	146933	6914	2209266	1757	21921	1863
19-Jun-22	10854	1797	25911324	209128	147002	6916	2209339	1759	21916	1863
20-Jun-22	10854	1799	25918172	209067	147070	6917	2209401	1762	21911	1863
21-Jun-22	10853	1802	25925194	209003	147139	6919	2209453	1764	21906	1863
22-Jun-22	10852	1805	25932391	208938	147207	6921	2209494	1766	21901	1864
23-Jun-22	10852	1808	25939765	208871	147275	6922	2209524	1768	21896	1864
24-Jun-22	10851	1811	25947316	208802	147343	6924	2209543	1770	21892	1864
25-Jun-22	10851	1813	25955048	208731	147411	6925	2209551	1772	21887	1864
26-Jun-22	10850	1816	25962960	208658	147479	6927	2209547	1775	21883	1864
27-Jun-22	10850	1819	25971056	208583	147547	6929	2209532	1777	21878	1864
28-Jun-22	10849	1822	25979335	208505	147614	6930	2209504	1779	21874	1864
29-Jun-22	10849	1825	25987800	208426	147682	6932	2209464	1781	21870	1864
30-Jun-22	10849	1828	25996453	208344	147749	6934	2209412	1784	21866	1864

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jul-22	10849	1832	26005294	208260	147816	6935	2209347	1786	21863	1864
2-Jul-22	10848	1835	26014325	208173	147883	6937	2209270	1788	21859	1864
3-Jul-22	10848	1838	26023549	208085	147950	6939	2209179	1791	21855	1864
4-Jul-22	10848	1841	26032965	207993	148016	6941	2209075	1793	21852	1864
5-Jul-22	10848	1844	26042577	207900	148083	6942	2208957	1796	21849	1864
6-Jul-22	10848	1847	26052385	207804	148149	6944	2208826	1798	21846	1864
7-Jul-22	10848	1851	26062391	207705	148216	6946	2208681	1801	21843	1864
8-Jul-22	10848	1854	26072596	207604	148282	6948	2208521	1803	21840	1864
9-Jul-22	10848	1857	26083003	207500	148348	6950	2208347	1806	21837	1864
10-Jul-22	10848	1861	26093612	207394	148414	6951	2208158	1809	21834	1864
11-Jul-22	10848	1864	26104425	207285	148479	6953	2207954	1811	21832	1864
12-Jul-22	10848	1868	26115444	207173	148545	6955	2207735	1814	21830	1864
13-Jul-22	10848	1871	26126671	207059	148610	6957	2207500	1817	21828	1864
14-Jul-22	10848	1875	26138107	206941	148676	6959	2207249	1819	21826	1864
15-Jul-22	10848	1878	26149753	206821	148741	6961	2206983	1822	21824	1864
16-Jul-22	10849	1882	26161611	206698	148806	6963	2206700	1825	21822	1864
17-Jul-22	10849	1886	26173683	206572	148871	6965	2206400	1828	21821	1864
18-Jul-22	10849	1889	26185970	206443	148935	6967	2206084	1830	21819	1864
19-Jul-22	10850	1893	26198474	206311	149000	6969	2205750	1833	21818	1864
20-Jul-22	10850	1897	26211197	206175	149064	6971	2205399	1836	21817	1864
21-Jul-22	10850	1901	26224140	206037	149128	6973	2205030	1839	21816	1864
22-Jul-22	10851	1904	26237305	205895	149193	6975	2204643	1842	21815	1864
23-Jul-22	10851	1908	26250694	205751	149256	6977	2204238	1845	21815	1864
24-Jul-22	10852	1912	26264308	205602	149320	6979	2203814	1848	21814	1864
25-Jul-22	10852	1916	26278149	205451	149384	6981	2203372	1851	21814	1864
26-Jul-22	10853	1920	26292218	205296	149447	6983	2202910	1855	21814	1864
27-Jul-22	10853	1924	26306518	205138	149511	6985	2202428	1858	21814	1864
28-Jul-22	10854	1928	26321049	204976	149574	6987	2201927	1861	21814	1864
29-Jul-22	10855	1933	26335815	204810	149637	6989	2201405	1864	21814	1864
30-Jul-22	10855	1937	26350816	204641	149700	6991	2200863	1867	21815	1864
31-Jul-22	10856	1941	26366054	204468	149763	6993	2200300	1871	21816	1864

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Aug-22	10856	1945	26381531	204292	149825	6995	2199715	1874	21817	1864
2-Aug-22	10857	1950	26397248	204111	149888	6997	2199110	1877	21818	1864
3-Aug-22	10858	1954	26413209	203927	149950	6999	2198482	1881	21819	1864
4-Aug-22	10859	1958	26429413	203739	150012	7002	2197832	1884	21821	1864
5-Aug-22	10859	1963	26445864	203547	150074	7004	2197160	1888	21822	1864
6-Aug-22	10860	1967	26462562	203351	150136	7006	2196464	1891	21824	1864
7-Aug-22	10861	1972	26479511	203150	150197	7008	2195746	1895	21826	1864
8-Aug-22	10862	1977	26496711	202946	150259	7010	2195003	1899	21828	1864
9-Aug-22	10863	1981	26514164	202737	150320	7013	2194237	1902	21831	1864
10-Aug-22	10863	1986	26531873	202524	150381	7015	2193446	1906	21833	1864
11-Aug-22	10864	1991	26549839	202307	150442	7017	2192631	1910	21836	1864
12-Aug-22	10865	1996	26568064	202085	150503	7019	2191790	1914	21839	1864
13-Aug-22	10866	2000	26586551	201858	150563	7021	2190923	1917	21843	1864
14-Aug-22	10867	2005	26605300	201627	150624	7024	2190031	1921	21846	1864
15-Aug-22	10868	2010	26624314	201392	150684	7026	2189112	1925	21850	1864
16-Aug-22	10869	2015	26643596	201152	150744	7028	2188167	1929	21853	1864
17-Aug-22	10870	2020	26663146	200906	150804	7031	2187194	1933	21858	1864
18-Aug-22	10871	2026	26682968	200656	150864	7033	2186194	1937	21862	1864
19-Aug-22	10872	2031	26703062	200401	150923	7035	2185166	1941	21866	1864
20-Aug-22	10873	2036	26723432	200141	150982	7038	2184109	1945	21871	1864
21-Aug-22	10874	2041	26744078	199876	151042	7040	2183023	1950	21876	1864
22-Aug-22	10875	2047	26765004	199606	151101	7042	2181908	1954	21881	1864
23-Aug-22	10876	2052	26786212	199330	151159	7045	2180764	1958	21886	1863
24-Aug-22	10876	2058	26807702	199050	151218	7047	2179589	1963	21892	1863
25-Aug-22	10877	2063	26829479	198763	151277	7049	2178383	1967	21898	1863
26-Aug-22	10878	2069	26851543	198472	151335	7052	2177146	1971	21904	1863
27-Aug-22	10879	2074	26873898	198174	151393	7054	2175877	1976	21910	1863
28-Aug-22	10880	2080	26896545	197871	151451	7057	2174577	1980	21917	1863
29-Aug-22	10881	2086	26919486	197563	151508	7059	2173243	1985	21924	1863
30-Aug-22	10882	2092	26942724	197248	151566	7061	2171877	1990	21931	1863
31-Aug-22	10883	2098	26966261	196927	151623	7064	2170477	1994	21938	1863

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Sep-22	10884	2104	26990099	196601	151680	7066	2169043	1999	21946	1862
2-Sep-22	10885	2110	27014242	196268	151737	7069	2167574	2004	21953	1862
3-Sep-22	10886	2116	27038690	195930	151794	7071	2166070	2009	21961	1862
4-Sep-22	10887	2122	27063447	195585	151850	7074	2164531	2014	21970	1862
5-Sep-22	10888	2128	27088515	195233	151907	7076	2162955	2019	21978	1862
6-Sep-22	10889	2135	27113896	194875	151963	7078	2161343	2024	21987	1862
7-Sep-22	10890	2141	27139593	194511	152019	7081	2159693	2029	21996	1862
8-Sep-22	10891	2148	27165608	194140	152074	7083	2158006	2034	22005	1861
9-Sep-22	10892	2154	27191944	193762	152130	7086	2156280	2039	22015	1861
10-Sep-22	10893	2161	27218604	193377	152185	7088	2154515	2045	22025	1861
11-Sep-22	10894	2168	27245589	192985	152240	7091	2152711	2050	22035	1861
12-Sep-22	10894	2174	27272904	192587	152295	7093	2150867	2055	22046	1861
13-Sep-22	10895	2181	27300549	192181	152349	7096	2148982	2061	22056	1860
14-Sep-22	10896	2188	27328528	191768	152404	7098	2147056	2066	22067	1860
15-Sep-22	10897	2195	27356845	191347	152458	7101	2145088	2072	22079	1860
16-Sep-22	10898	2202	27385500	190919	152512	7103	2143077	2077	22090	1860
17-Sep-22	10898	2209	27414498	190483	152565	7106	2141023	2083	22102	1860
18-Sep-22	10899	2217	27443840	190040	152619	7108	2138926	2089	22114	1859
19-Sep-22	10900	2224	27473530	189589	152672	7111	2136784	2095	22127	1859
20-Sep-22	10901	2231	27503571	189130	152725	7113	2134597	2101	22140	1859
21-Sep-22	10901	2239	27533966	188663	152778	7116	2132364	2107	22153	1859
22-Sep-22	10902	2246	27564717	188188	152830	7118	2130085	2113	22166	1858
23-Sep-22	10902	2254	27595827	187704	152883	7121	2127759	2119	22180	1858
24-Sep-22	10903	2262	27627300	187212	152935	7123	2125385	2125	22194	1858
25-Sep-22	10903	2270	27659139	186712	152986	7126	2122963	2131	22208	1857
26-Sep-22	10904	2278	27691346	186203	153038	7129	2120492	2138	22223	1857
27-Sep-22	10904	2286	27723925	185685	153089	7131	2117971	2144	22238	1857
28-Sep-22	10905	2294	27756879	185158	153140	7134	2115400	2151	22253	1856
29-Sep-22	10905	2302	27790211	184623	153191	7136	2112777	2157	22269	1856
30-Sep-22	10905	2310	27823924	184078	153241	7139	2110102	2164	22285	1856

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Oct-22	10906	2319	27858022	183524	153292	7141	2107375	2170	22302	1855
2-Oct-22	10906	2327	27892507	182960	153342	7144	2104594	2177	22318	1855
3-Oct-22	10906	2336	27927384	182387	153391	7146	2101759	2184	22335	1855
4-Oct-22	10906	2344	27962656	181805	153441	7149	2098868	2191	22353	1854
5-Oct-22	10906	2353	27998326	181212	153490	7151	2095922	2198	22371	1854
6-Oct-22	10906	2362	28034397	180610	153539	7154	2092920	2205	22389	1853
7-Oct-22	10906	2371	28070874	179997	153587	7156	2089860	2212	22407	1853
8-Oct-22	10906	2380	28107759	179374	153636	7159	2086741	2220	22426	1852
9-Oct-22	10906	2389	28145057	178741	153684	7161	2083564	2227	22446	1852
10-Oct-22	10906	2399	28182770	178097	153731	7164	2080327	2234	22465	1852
11-Oct-22	10906	2408	28220904	177443	153779	7166	2077029	2242	22485	1851
12-Oct-22	10905	2418	28259461	176778	153826	7169	2073669	2250	22506	1851
13-Oct-22	10905	2427	28298445	176102	153873	7171	2070247	2257	22527	1850
14-Oct-22	10905	2437	28337860	175414	153919	7174	2066762	2265	22548	1850
15-Oct-22	10904	2447	28377710	174716	153965	7176	2063212	2273	22570	1849
16-Oct-22	10904	2457	28418000	174006	154011	7178	2059597	2281	22592	1848
17-Oct-22	10903	2467	28458732	173284	154057	7181	2055916	2289	22614	1848
18-Oct-22	10902	2477	28499912	172551	154102	7183	2052168	2297	22637	1847
19-Oct-22	10901	2488	28541543	171805	154147	7186	2048352	2306	22661	1847
20-Oct-22	10901	2498	28583629	171048	154192	7188	2044467	2314	22684	1846
21-Oct-22	10900	2509	28626175	170278	154236	7191	2040513	2322	22709	1845
22-Oct-22	10899	2519	28669185	169496	154280	7193	2036487	2331	22733	1845
23-Oct-22	10897	2530	28712663	168701	154323	7195	2032389	2340	22758	1844
24-Oct-22	10896	2541	28756613	167893	154366	7198	2028219	2348	22784	1843
25-Oct-22	10895	2552	28801041	167073	154409	7200	2023975	2357	22810	1843
26-Oct-22	10894	2563	28845950	166239	154452	7202	2019656	2366	22836	1842
27-Oct-22	10892	2575	28891345	165392	154494	7205	2015260	2375	22863	1841
28-Oct-22	10891	2586	28937231	164532	154536	7207	2010788	2384	22890	1841
29-Oct-22	10889	2598	28983613	163657	154577	7209	2006238	2394	22918	1840
30-Oct-22	10887	2609	29030495	162769	154618	7212	2001608	2403	22947	1839
31-Oct-22	10885	2621	29077881	161867	154659	7214	1996899	2413	22975	1838

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Nov-22	10883	2633	29125778	160950	154699	7216	1992107	2422	23005	1837
2-Nov-22	10881	2645	29174189	160019	154739	7218	1987234	2432	23035	1837
3-Nov-22	10879	2658	29223120	159074	154778	7220	1982276	2442	23065	1836
4-Nov-22	10877	2670	29272577	158113	154818	7223	1977234	2452	23096	1835
5-Nov-22	10875	2683	29322563	157137	154856	7225	1972105	2462	23127	1834
6-Nov-22	10872	2695	29373084	156146	154894	7227	1966890	2472	23159	1833
7-Nov-22	10869	2708	29424146	155140	154932	7229	1961586	2482	23191	1832
8-Nov-22	10867	2721	29475753	154117	154970	7231	1956192	2493	23224	1831
9-Nov-22	10864	2735	29527912	153079	155007	7233	1950707	2504	23258	1830
10-Nov-22	10861	2748	29580628	152025	155043	7235	1945130	2514	23292	1829
11-Nov-22	10858	2761	29633906	150954	155079	7237	1939460	2525	23326	1828
12-Nov-22	10854	2775	29687752	149867	155115	7239	1933695	2536	23361	1827
13-Nov-22	10851	2789	29742171	148763	155150	7241	1927834	2547	23397	1826
14-Nov-22	10848	2803	29797170	147641	155185	7243	1921875	2558	23433	1825
15-Nov-22	10844	2817	29852754	146503	155219	7245	1915818	2570	23470	1824
16-Nov-22	10840	2831	29908929	145347	155253	7247	1909661	2581	23508	1823
17-Nov-22	10836	2846	29965702	144173	155287	7249	1903403	2593	23546	1821
18-Nov-22	10832	2861	30023078	142981	155320	7251	1897041	2605	23584	1820
19-Nov-22	10828	2875	30081063	141771	155352	7253	1890575	2616	23623	1819
20-Nov-22	10824	2890	30139665	140542	155384	7255	1884004	2628	23663	1818
21-Nov-22	10819	2906	30198888	139295	155415	7256	1877325	2641	23704	1816
22-Nov-22	10814	2921	30258740	138029	155446	7258	1870538	2653	23745	1815
23-Nov-22	10809	2937	30319227	136743	155477	7260	1863641	2666	23787	1814
24-Nov-22	10804	2952	30380355	135438	155506	7262	1856632	2678	23829	1812
25-Nov-22	10799	2968	30442132	134113	155536	7263	1849510	2691	23872	1811
26-Nov-22	10794	2984	30504564	132767	155564	7265	1842274	2704	23916	1810
27-Nov-22	10788	3001	30567659	131402	155593	7266	1834921	2717	23960	1808
28-Nov-22	10783	3017	30631422	130016	155620	7268	1827450	2730	24005	1807
29-Nov-22	10777	3034	30695861	128609	155647	7269	1819860	2744	24051	1805
30-Nov-22	10771	3051	30760983	127180	155674	7271	1812149	2757	24097	1804

Table A.35.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) and LOCF imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Dec-22	10765	3068	30826796	125731	155700	7272	1804315	2771	24144	1802
2-Dec-22	10758	3085	30893307	124259	155725	7274	1796357	2785	24192	1800
3-Dec-22	10751	3103	30960523	122766	155750	7275	1788272	2799	24241	1799
4-Dec-22	10745	3121	31028452	121250	155774	7276	1780060	2813	24290	1797
5-Dec-22	10738	3139	31097101	119711	155798	7277	1771718	2828	24340	1795
6-Dec-22	10730	3157	31166478	118149	155821	7279	1763245	2842	24391	1794
7-Dec-22	10723	3175	31236591	116565	155843	7280	1754639	2857	24442	1792
8-Dec-22	10715	3194	31307449	114956	155865	7281	1745898	2872	24495	1790
9-Dec-22	10708	3213	31379058	113324	155886	7282	1737020	2887	24548	1788
10-Dec-22	10699	3232	31451428	111667	155906	7283	1728003	2902	24601	1786
11-Dec-22	10691	3251	31524566	109986	155926	7284	1718846	2918	24656	1784
12-Dec-22	10683	3271	31598481	108280	155945	7285	1709547	2933	24711	1782
13-Dec-22	10674	3291	31673182	106548	155964	7286	1700104	2949	24768	1780
14-Dec-22	10665	3311	31748676	104792	155981	7287	1690514	2965	24825	1778
15-Dec-22	10656	3331	31824974	103009	155998	7287	1680775	2982	24883	1776
16-Dec-22	10646	3352	31902082	101200	156015	7288	1670887	2998	24941	1774
17-Dec-22	10637	3372	31980012	99364	156030	7289	1660846	3015	25001	1772
18-Dec-22	10627	3393	32058771	97501	156045	7289	1650651	3031	25061	1770
19-Dec-22	10616	3415	32138370	95611	156059	7290	1640300	3048	25123	1768
20-Dec-22	10606	3436	32218816	93693	156073	7290	1629790	3066	25185	1765
21-Dec-22	10595	3458	32300120	91747	156085	7291	1619119	3083	25248	1763
22-Dec-22	10584	3480	32382292	89773	156097	7291	1608285	3101	25312	1761
23-Dec-22	10573	3502	32465340	87770	156108	7292	1597286	3119	25377	1758
24-Dec-22	10561	3525	32549276	85738	156118	7292	1586120	3137	25443	1756
25-Dec-22	10550	3548	32634108	83676	156128	7292	1574785	3155	25510	1753
26-Dec-22	10538	3571	32719848	81583	156136	7292	1563277	3174	25577	1751
27-Dec-22	10525	3595	32806504	79461	156144	7292	1551596	3193	25646	1748
28-Dec-22	10513	3618	32894089	77308	156151	7292	1539738	3212	25716	1746
29-Dec-22	10500	3642	32982611	75123	156157	7292	1527701	3231	25786	1743
30-Dec-22	10486	3667	33072082	72907	156162	7292	1515482	3250	25858	1740
31-Dec-22	10473	3691	33162513	70659	156167	7292	1503080	3270	25931	1737

Table A.36.1. *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jan-22	11517	1594	25770233	207997	134865	6781	2147149	1650	23545	1806
2-Jan-22	11519	1594	25775502	208041	134896	6783	2147594	1651	23569	1807
3-Jan-22	11521	1595	25780771	208085	134927	6784	2148038	1651	23592	1807
4-Jan-22	11523	1595	25786041	208130	134957	6785	2148483	1651	23616	1807
5-Jan-22	11525	1595	25791313	208174	134988	6786	2148928	1651	23639	1808
6-Jan-22	11527	1596	25796586	208218	135019	6788	2149373	1652	23663	1808
7-Jan-22	11529	1596	25801859	208263	135050	6789	2149818	1652	23687	1808
8-Jan-22	11531	1596	25807134	208307	135081	6790	2150263	1652	23710	1809
9-Jan-22	11533	1596	25812410	208351	135112	6792	2150709	1652	23734	1809
10-Jan-22	11535	1597	25817687	208396	135143	6793	2151154	1653	23758	1809
11-Jan-22	11536	1597	25822965	208440	135174	6794	2151600	1653	23781	1810
12-Jan-22	11538	1597	25828244	208484	135205	6796	2152045	1653	23805	1810
13-Jan-22	11540	1598	25833524	208529	135236	6797	2152491	1653	23829	1810
14-Jan-22	11542	1598	25838805	208573	135267	6798	2152937	1654	23853	1811
15-Jan-22	11544	1598	25844087	208618	135298	6800	2153382	1654	23876	1811
16-Jan-22	11546	1599	25849371	208662	135329	6801	2153828	1654	23900	1811
17-Jan-22	11548	1599	25854655	208706	135360	6802	2154274	1655	23924	1812
18-Jan-22	11550	1599	25859941	208751	135391	6804	2154721	1655	23948	1812
19-Jan-22	11552	1600	25865227	208795	135422	6805	2155167	1655	23972	1813
20-Jan-22	11554	1600	25870515	208840	135453	6806	2155613	1655	23996	1813
21-Jan-22	11556	1600	25875804	208884	135484	6808	2156060	1656	24020	1813
22-Jan-22	11558	1600	25881094	208929	135515	6809	2156506	1656	24044	1814
23-Jan-22	11560	1601	25886384	208973	135546	6810	2156953	1656	24068	1814
24-Jan-22	11562	1601	25891677	209017	135577	6812	2157399	1656	24092	1814
25-Jan-22	11564	1601	25896970	209062	135608	6813	2157846	1657	24116	1815
26-Jan-22	11566	1602	25902264	209106	135639	6814	2158293	1657	24140	1815
27-Jan-22	11568	1602	25907559	209151	135671	6816	2158740	1657	24164	1815
28-Jan-22	11570	1602	25912855	209195	135702	6817	2159187	1657	24188	1816
29-Jan-22	11572	1603	25918153	209240	135733	6818	2159634	1658	24212	1816
30-Jan-22	11574	1603	25923451	209285	135764	6820	2160081	1658	24237	1816
31-Jan-22	11575	1603	25928751	209329	135795	6821	2160529	1658	24261	1817

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Feb-22	11577	1603	25934052	209374	135826	6822	2160976	1658	24285	1817
2-Feb-22	11579	1604	25939353	209418	135857	6823	2161424	1659	24309	1817
3-Feb-22	11581	1604	25944656	209463	135888	6825	2161871	1659	24333	1818
4-Feb-22	11583	1604	25949960	209507	135919	6826	2162319	1659	24358	1818
5-Feb-22	11585	1605	25955265	209552	135951	6827	2162767	1659	24382	1818
6-Feb-22	11587	1605	25960571	209597	135982	6829	2163215	1660	24406	1819
7-Feb-22	11589	1605	25965878	209641	136013	6830	2163663	1660	24431	1819
8-Feb-22	11591	1606	25971187	209686	136044	6831	2164111	1660	24455	1820
9-Feb-22	11593	1606	25976496	209730	136075	6833	2164559	1660	24480	1820
10-Feb-22	11595	1606	25981806	209775	136106	6834	2165007	1661	24504	1820
11-Feb-22	11597	1607	25987118	209820	136138	6835	2165456	1661	24529	1821
12-Feb-22	11599	1607	25992431	209864	136169	6837	2165904	1661	24553	1821
13-Feb-22	11601	1607	25997744	209909	136200	6838	2166353	1662	24578	1821
14-Feb-22	11603	1607	26003059	209954	136231	6839	2166801	1662	24602	1822
15-Feb-22	11605	1608	26008375	209998	136262	6841	2167250	1662	24627	1822
16-Feb-22	11607	1608	26013692	210043	136294	6842	2167699	1662	24651	1822
17-Feb-22	11609	1608	26019010	210088	136325	6843	2168148	1663	24676	1823
18-Feb-22	11611	1609	26024329	210132	136356	6845	2168597	1663	24700	1823
19-Feb-22	11613	1609	26029649	210177	136387	6846	2169046	1663	24725	1823
20-Feb-22	11615	1609	26034971	210222	136419	6847	2169495	1663	24750	1824
21-Feb-22	11617	1610	26040293	210267	136450	6849	2169944	1664	24775	1824
22-Feb-22	11619	1610	26045616	210311	136481	6850	2170394	1664	24799	1824
23-Feb-22	11621	1610	26050941	210356	136512	6851	2170843	1664	24824	1825
24-Feb-22	11622	1611	26056267	210401	136544	6853	2171293	1664	24849	1825
25-Feb-22	11624	1611	26061593	210446	136575	6854	2171742	1665	24874	1826
26-Feb-22	11626	1611	26066921	210491	136606	6855	2172192	1665	24898	1826
27-Feb-22	11628	1611	26072250	210535	136638	6857	2172642	1665	24923	1826
28-Feb-22	11630	1612	26077580	210580	136669	6858	2173092	1665	24948	1827

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Mar-22	11632	1612	26082911	210625	136700	6859	2173542	1666	24973	1827
2-Mar-22	11634	1612	26088243	210670	136732	6861	2173992	1666	24998	1827
3-Mar-22	11636	1613	26093577	210715	136763	6862	2174442	1666	25023	1828
4-Mar-22	11638	1613	26098911	210759	136794	6863	2174893	1666	25048	1828
5-Mar-22	11640	1613	26104247	210804	136826	6865	2175343	1667	25073	1828
6-Mar-22	11642	1614	26109583	210849	136857	6866	2175793	1667	25098	1829
7-Mar-22	11644	1614	26114921	210894	136888	6867	2176244	1667	25123	1829
8-Mar-22	11646	1614	26120259	210939	136920	6869	2176695	1668	25148	1829
9-Mar-22	11648	1615	26125599	210984	136951	6870	2177145	1668	25173	1830
10-Mar-22	11650	1615	26130940	211029	136982	6871	2177596	1668	25198	1830
11-Mar-22	11652	1615	26136282	211074	137014	6873	2178047	1668	25224	1831
12-Mar-22	11654	1615	26141625	211119	137045	6874	2178498	1669	25249	1831
13-Mar-22	11656	1616	26146970	211163	137077	6875	2178949	1669	25274	1831
14-Mar-22	11658	1616	26152315	211208	137108	6877	2179401	1669	25299	1832
15-Mar-22	11660	1616	26157661	211253	137139	6878	2179852	1669	25325	1832
16-Mar-22	11662	1617	26163009	211298	137171	6879	2180304	1670	25350	1832
17-Mar-22	11664	1617	26168357	211343	137202	6881	2180755	1670	25375	1833
18-Mar-22	11666	1617	26173707	211388	137234	6882	2181207	1670	25400	1833
19-Mar-22	11668	1618	26179058	211433	137265	6883	2181658	1670	25426	1833
20-Mar-22	11670	1618	26184409	211478	137297	6885	2182110	1671	25451	1834
21-Mar-22	11672	1618	26189762	211523	137328	6886	2182562	1671	25477	1834
22-Mar-22	11674	1619	26195116	211568	137360	6887	2183014	1671	25502	1834
23-Mar-22	11676	1619	26200472	211613	137391	6889	2183466	1671	25528	1835
24-Mar-22	11678	1619	26205828	211658	137422	6890	2183918	1672	25553	1835
25-Mar-22	11680	1619	26211185	211703	137454	6891	2184371	1672	25579	1835
26-Mar-22	11681	1620	26216544	211748	137485	6893	2184823	1672	25604	1836
27-Mar-22	11683	1620	26221903	211794	137517	6894	2185275	1673	25630	1836
28-Mar-22	11685	1620	26227264	211839	137548	6895	2185728	1673	25655	1837
29-Mar-22	11687	1621	26232625	211884	137580	6897	2186181	1673	25681	1837
30-Mar-22	11689	1621	26237988	211929	137612	6898	2186633	1673	25706	1837
31-Mar-22	11691	1621	26243352	211974	137643	6899	2187086	1674	25732	1838

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Apr-22	11693	1622	26248717	212019	137675	6901	2187539	1674	25758	1838
2-Apr-22	11695	1622	26254083	212064	137706	6902	2187992	1674	25784	1838
3-Apr-22	11697	1622	26259450	212109	137738	6903	2188445	1674	25809	1839
4-Apr-22	11699	1623	26264819	212154	137769	6905	2188898	1675	25835	1839
5-Apr-22	11701	1623	26270188	212200	137801	6906	2189352	1675	25861	1839
6-Apr-22	11703	1623	26275558	212245	137832	6907	2189805	1675	25887	1840
7-Apr-22	11705	1623	26280930	212290	137864	6909	2190259	1675	25913	1840
8-Apr-22	11707	1624	26286303	212335	137896	6910	2190712	1676	25938	1840
9-Apr-22	11709	1624	26291676	212380	137927	6912	2191166	1676	25964	1841
10-Apr-22	11711	1624	26297051	212425	137959	6913	2191620	1676	25990	1841
11-Apr-22	11713	1625	26302427	212471	137990	6914	2192074	1676	26016	1842
12-Apr-22	11715	1625	26307804	212516	138022	6916	2192528	1677	26042	1842
13-Apr-22	11717	1625	26313183	212561	138054	6917	2192982	1677	26068	1842
14-Apr-22	11719	1626	26318562	212606	138085	6918	2193436	1677	26094	1843
15-Apr-22	11721	1626	26323942	212652	138117	6920	2193890	1678	26120	1843
16-Apr-22	11723	1626	26329324	212697	138149	6921	2194344	1678	26146	1843
17-Apr-22	11725	1627	26334706	212742	138180	6922	2194799	1678	26172	1844
18-Apr-22	11727	1627	26340090	212787	138212	6924	2195253	1678	26199	1844
19-Apr-22	11729	1627	26345475	212833	138244	6925	2195708	1679	26225	1844
20-Apr-22	11731	1628	26350860	212878	138275	6926	2196163	1679	26251	1845
21-Apr-22	11733	1628	26356247	212923	138307	6928	2196617	1679	26277	1845
22-Apr-22	11735	1628	26361635	212969	138339	6929	2197072	1679	26303	1845
23-Apr-22	11737	1628	26367025	213014	138370	6930	2197527	1680	26330	1846
24-Apr-22	11739	1629	26372415	213059	138402	6932	2197982	1680	26356	1846
25-Apr-22	11741	1629	26377806	213105	138434	6933	2198438	1680	26382	1847
26-Apr-22	11743	1629	26383199	213150	138465	6934	2198893	1680	26409	1847
27-Apr-22	11745	1630	26388592	213195	138497	6936	2199348	1681	26435	1847
28-Apr-22	11747	1630	26393987	213241	138529	6937	2199804	1681	26461	1848
29-Apr-22	11749	1630	26399383	213286	138561	6938	2200259	1681	26488	1848
30-Apr-22	11751	1631	26404780	213332	138592	6940	2200715	1681	26514	1848

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-May-22	11753	1631	26410178	213377	138624	6941	2201171	1682	26541	1849
2-May-22	11755	1631	26415577	213422	138656	6942	2201627	1682	26567	1849
3-May-22	11757	1632	26420977	213468	138688	6944	2202082	1682	26594	1849
4-May-22	11759	1632	26426378	213513	138720	6945	2202539	1683	26620	1850
5-May-22	11761	1632	26431781	213559	138751	6947	2202995	1683	26647	1850
6-May-22	11763	1632	26437184	213604	138783	6948	2203451	1683	26673	1851
7-May-22	11765	1633	26442589	213650	138815	6949	2203907	1683	26700	1851
8-May-22	11767	1633	26447995	213695	138847	6951	2204364	1684	26727	1851
9-May-22	11769	1633	26453401	213741	138879	6952	2204820	1684	26753	1852
10-May-22	11771	1634	26458809	213786	138910	6953	2205277	1684	26780	1852
11-May-22	11773	1634	26464218	213832	138942	6955	2205733	1684	26807	1852
12-May-22	11775	1634	26469628	213877	138974	6956	2206190	1685	26834	1853
13-May-22	11776	1635	26475040	213923	139006	6957	2206647	1685	26860	1853
14-May-22	11778	1635	26480452	213968	139038	6959	2207104	1685	26887	1853
15-May-22	11780	1635	26485866	214014	139070	6960	2207561	1685	26914	1854
16-May-22	11782	1636	26491280	214059	139101	6961	2208018	1686	26941	1854
17-May-22	11784	1636	26496696	214105	139133	6963	2208476	1686	26968	1854
18-May-22	11786	1636	26502113	214150	139165	6964	2208933	1686	26995	1855
19-May-22	11788	1637	26507530	214196	139197	6965	2209390	1686	27022	1855
20-May-22	11790	1637	26512949	214241	139229	6967	2209848	1687	27049	1856
21-May-22	11792	1637	26518370	214287	139261	6968	2210306	1687	27076	1856
22-May-22	11794	1637	26523791	214333	139293	6969	2210763	1687	27103	1856
23-May-22	11796	1638	26529213	214378	139325	6971	2211221	1688	27130	1857
24-May-22	11798	1638	26534637	214424	139357	6972	2211679	1688	27157	1857
25-May-22	11800	1638	26540061	214470	139389	6974	2212137	1688	27184	1857
26-May-22	11802	1639	26545487	214515	139421	6975	2212595	1688	27211	1858
27-May-22	11804	1639	26550913	214561	139452	6976	2213053	1689	27238	1858
28-May-22	11806	1639	26556341	214606	139484	6978	2213512	1689	27266	1858
29-May-22	11808	1640	26561770	214652	139516	6979	2213970	1689	27293	1859
30-May-22	11810	1640	26567200	214698	139548	6980	2214429	1689	27320	1859
31-May-22	11812	1640	26572632	214744	139580	6982	2214887	1690	27347	1859

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jun-22	11814	1641	26578064	214789	139612	6983	2215346	1690	27375	1860
2-Jun-22	11816	1641	26583497	214835	139644	6984	2215805	1690	27402	1860
3-Jun-22	11818	1641	26588932	214881	139676	6986	2216264	1690	27429	1861
4-Jun-22	11820	1642	26594367	214926	139708	6987	2216723	1691	27457	1861
5-Jun-22	11822	1642	26599804	214972	139740	6988	2217182	1691	27484	1861
6-Jun-22	11824	1642	26605242	215018	139772	6990	2217641	1691	27512	1862
7-Jun-22	11826	1642	26610681	215064	139804	6991	2218100	1692	27539	1862
8-Jun-22	11828	1643	26616121	215109	139836	6993	2218559	1692	27567	1862
9-Jun-22	11830	1643	26621562	215155	139868	6994	2219019	1692	27594	1863
10-Jun-22	11832	1643	26627005	215201	139901	6995	2219478	1692	27622	1863
11-Jun-22	11834	1644	26632448	215247	139933	6997	2219938	1693	27649	1863
12-Jun-22	11836	1644	26637893	215293	139965	6998	2220398	1693	27677	1864
13-Jun-22	11838	1644	26643338	215338	139997	6999	2220858	1693	27704	1864
14-Jun-22	11840	1645	26648785	215384	140029	7001	2221317	1693	27732	1865
15-Jun-22	11842	1645	26654233	215430	140061	7002	2221777	1694	27760	1865
16-Jun-22	11844	1645	26659682	215476	140093	7003	2222238	1694	27787	1865
17-Jun-22	11846	1646	26665132	215522	140125	7005	2222698	1694	27815	1866
18-Jun-22	11848	1646	26670583	215568	140157	7006	2223158	1694	27843	1866
19-Jun-22	11850	1646	26676035	215614	140189	7008	2223618	1695	27871	1866
20-Jun-22	11852	1647	26681489	215659	140221	7009	2224079	1695	27899	1867
21-Jun-22	11854	1647	26686943	215705	140254	7010	2224540	1695	27926	1867
22-Jun-22	11856	1647	26692399	215751	140286	7012	2225000	1696	27954	1867
23-Jun-22	11858	1648	26697856	215797	140318	7013	2225461	1696	27982	1868
24-Jun-22	11860	1648	26703314	215843	140350	7014	2225922	1696	28010	1868
25-Jun-22	11862	1648	26708773	215889	140382	7016	2226383	1696	28038	1869
26-Jun-22	11864	1648	26714233	215935	140414	7017	2226844	1697	28066	1869
27-Jun-22	11866	1649	26719694	215981	140447	7018	2227305	1697	28094	1869
28-Jun-22	11868	1649	26725157	216027	140479	7020	2227766	1697	28122	1870
29-Jun-22	11870	1649	26730620	216073	140511	7021	2228228	1697	28150	1870
30-Jun-22	11872	1650	26736085	216119	140543	7022	2228689	1698	28178	1870

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jul-22	11874	1650	26741550	216165	140575	7024	2229151	1698	28207	1871
2-Jul-22	11876	1650	26747017	216211	140607	7025	2229612	1698	28235	1871
3-Jul-22	11878	1651	26752485	216257	140640	7027	2230074	1698	28263	1871
4-Jul-22	11880	1651	26757954	216303	140672	7028	2230536	1699	28291	1872
5-Jul-22	11882	1651	26763424	216349	140704	7029	2230998	1699	28319	1872
6-Jul-22	11884	1652	26768896	216395	140736	7031	2231460	1699	28348	1873
7-Jul-22	11886	1652	26774368	216441	140769	7032	2231922	1700	28376	1873
8-Jul-22	11888	1652	26779842	216487	140801	7033	2232384	1700	28404	1873
9-Jul-22	11890	1653	26785316	216533	140833	7035	2232847	1700	28433	1874
10-Jul-22	11892	1653	26790792	216579	140865	7036	2233309	1700	28461	1874
11-Jul-22	11894	1653	26796269	216625	140898	7038	2233771	1701	28489	1874
12-Jul-22	11896	1653	26801747	216672	140930	7039	2234234	1701	28518	1875
13-Jul-22	11898	1654	26807226	216718	140962	7040	2234697	1701	28546	1875
14-Jul-22	11900	1654	26812707	216764	140995	7042	2235159	1701	28575	1875
15-Jul-22	11902	1654	26818188	216810	141027	7043	2235622	1702	28603	1876
16-Jul-22	11904	1655	26823670	216856	141059	7044	2236085	1702	28632	1876
17-Jul-22	11906	1655	26829154	216902	141092	7046	2236548	1702	28661	1877
18-Jul-22	11908	1655	26834639	216948	141124	7047	2237012	1702	28689	1877
19-Jul-22	11910	1656	26840125	216995	141156	7048	2237475	1703	28718	1877
20-Jul-22	11912	1656	26845612	217041	141189	7050	2237938	1703	28747	1878
21-Jul-22	11914	1656	26851100	217087	141221	7051	2238402	1703	28775	1878
22-Jul-22	11916	1657	26856589	217133	141253	7053	2238865	1704	28804	1878
23-Jul-22	11918	1657	26862079	217179	141286	7054	2239329	1704	28833	1879
24-Jul-22	11920	1657	26867571	217226	141318	7055	2239793	1704	28862	1879
25-Jul-22	11922	1658	26873063	217272	141350	7057	2240256	1704	28890	1879
26-Jul-22	11924	1658	26878557	217318	141383	7058	2240720	1705	28919	1880
27-Jul-22	11927	1658	26884052	217364	141415	7059	2241184	1705	28948	1880
28-Jul-22	11929	1659	26889548	217411	141448	7061	2241649	1705	28977	1881
29-Jul-22	11931	1659	26895045	217457	141480	7062	2242113	1705	29006	1881
30-Jul-22	11933	1659	26900543	217503	141512	7064	2242577	1706	29035	1881
31-Jul-22	11935	1659	26906043	217549	141545	7065	2243042	1706	29064	1882

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Aug-22	11937	1660	26911543	217596	141577	7066	2243506	1706	29093	1882
2-Aug-22	11939	1660	26917045	217642	141610	7068	2243971	1706	29122	1882
3-Aug-22	11941	1660	26922547	217688	141642	7069	2244435	1707	29151	1883
4-Aug-22	11943	1661	26928051	217735	141675	7070	2244900	1707	29180	1883
5-Aug-22	11945	1661	26933556	217781	141707	7072	2245365	1707	29209	1883
6-Aug-22	11947	1661	26939062	217827	141740	7073	2245830	1708	29238	1884
7-Aug-22	11949	1662	26944570	217874	141772	7075	2246295	1708	29268	1884
8-Aug-22	11951	1662	26950078	217920	141805	7076	2246760	1708	29297	1885
9-Aug-22	11953	1662	26955587	217966	141837	7077	2247226	1708	29326	1885
10-Aug-22	11955	1663	26961098	218013	141870	7079	2247691	1709	29355	1885
11-Aug-22	11957	1663	26966610	218059	141902	7080	2248157	1709	29385	1886
12-Aug-22	11959	1663	26972122	218106	141935	7081	2248622	1709	29414	1886
13-Aug-22	11961	1664	26977636	218152	141967	7083	2249088	1709	29443	1886
14-Aug-22	11963	1664	26983152	218198	142000	7084	2249554	1710	29473	1887
15-Aug-22	11965	1664	26988668	218245	142032	7086	2250019	1710	29502	1887
16-Aug-22	11967	1665	26994185	218291	142065	7087	2250485	1710	29532	1887
17-Aug-22	11969	1665	26999704	218338	142097	7088	2250951	1710	29561	1888
18-Aug-22	11971	1665	27005223	218384	142130	7090	2251418	1711	29591	1888
19-Aug-22	11973	1666	27010744	218431	142162	7091	2251884	1711	29620	1889
20-Aug-22	11975	1666	27016266	218477	142195	7092	2252350	1711	29650	1889
21-Aug-22	11977	1666	27021789	218524	142228	7094	2252817	1712	29679	1889
22-Aug-22	11979	1666	27027313	218570	142260	7095	2253283	1712	29709	1890
23-Aug-22	11981	1667	27032838	218617	142293	7097	2253750	1712	29739	1890
24-Aug-22	11983	1667	27038365	218663	142325	7098	2254217	1712	29768	1890
25-Aug-22	11985	1667	27043892	218710	142358	7099	2254683	1713	29798	1891
26-Aug-22	11987	1668	27049421	218756	142391	7101	2255150	1713	29828	1891
27-Aug-22	11989	1668	27054951	218803	142423	7102	2255617	1713	29858	1891
28-Aug-22	11991	1668	27060481	218850	142456	7103	2256084	1713	29887	1892
29-Aug-22	11993	1669	27066013	218896	142489	7105	2256552	1714	29917	1892
30-Aug-22	11995	1669	27071547	218943	142521	7106	2257019	1714	29947	1893
31-Aug-22	11997	1669	27077081	218989	142554	7108	2257486	1714	29977	1893

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Sep-22	11999	1670	27082616	219036	142586	7109	2257954	1715	30007	1893
2-Sep-22	12001	1670	27088153	219083	142619	7110	2258422	1715	30037	1894
3-Sep-22	12003	1670	27093691	219129	142652	7112	2258889	1715	30067	1894
4-Sep-22	12005	1671	27099229	219176	142685	7113	2259357	1715	30097	1894
5-Sep-22	12007	1671	27104769	219222	142717	7114	2259825	1716	30127	1895
6-Sep-22	12009	1671	27110311	219269	142750	7116	2260293	1716	30157	1895
7-Sep-22	12011	1672	27115853	219316	142783	7117	2260761	1716	30187	1896
8-Sep-22	12013	1672	27121396	219362	142815	7119	2261229	1716	30217	1896
9-Sep-22	12015	1672	27126941	219409	142848	7120	2261697	1717	30248	1896
10-Sep-22	12017	1673	27132486	219456	142881	7121	2262166	1717	30278	1897
11-Sep-22	12019	1673	27138033	219503	142914	7123	2262634	1717	30308	1897
12-Sep-22	12021	1673	27143581	219549	142946	7124	2263103	1717	30338	1897
13-Sep-22	12024	1673	27149130	219596	142979	7126	2263572	1718	30369	1898
14-Sep-22	12026	1674	27154680	219643	143012	7127	2264040	1718	30399	1898
15-Sep-22	12028	1674	27160231	219689	143045	7128	2264509	1718	30429	1898
16-Sep-22	12030	1674	27165784	219736	143077	7130	2264978	1719	30460	1899
17-Sep-22	12032	1675	27171337	219783	143110	7131	2265447	1719	30490	1899
18-Sep-22	12034	1675	27176892	219830	143143	7132	2265916	1719	30520	1900
19-Sep-22	12036	1675	27182448	219877	143176	7134	2266386	1719	30551	1900
20-Sep-22	12038	1676	27188005	219923	143209	7135	2266855	1720	30581	1900
21-Sep-22	12040	1676	27193563	219970	143241	7137	2267324	1720	30612	1901
22-Sep-22	12042	1676	27199122	220017	143274	7138	2267794	1720	30643	1901
23-Sep-22	12044	1677	27204683	220064	143307	7139	2268264	1720	30673	1901
24-Sep-22	12046	1677	27210244	220111	143340	7141	2268733	1721	30704	1902
25-Sep-22	12048	1677	27215807	220157	143373	7142	2269203	1721	30734	1902
26-Sep-22	12050	1678	27221371	220204	143406	7144	2269673	1721	30765	1903
27-Sep-22	12052	1678	27226935	220251	143438	7145	2270143	1722	30796	1903
28-Sep-22	12054	1678	27232502	220298	143471	7146	2270613	1722	30827	1903
29-Sep-22	12056	1679	27238069	220345	143504	7148	2271084	1722	30857	1904
30-Sep-22	12058	1679	27243637	220392	143537	7149	2271554	1722	30888	1904

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Oct-22	12060	1679	27249207	220439	143570	7151	2272024	1723	30919	1904
2-Oct-22	12062	1680	27254777	220486	143603	7152	2272495	1723	30950	1905
3-Oct-22	12064	1680	27260349	220533	143636	7153	2272965	1723	30981	1905
4-Oct-22	12066	1680	27265922	220580	143669	7155	2273436	1723	31012	1905
5-Oct-22	12068	1681	27271496	220626	143702	7156	2273907	1724	31043	1906
6-Oct-22	12070	1681	27277071	220673	143735	7157	2274378	1724	31074	1906
7-Oct-22	12072	1681	27282647	220720	143767	7159	2274849	1724	31105	1907
8-Oct-22	12074	1681	27288225	220767	143800	7160	2275320	1725	31136	1907
9-Oct-22	12076	1682	27293803	220814	143833	7162	2275791	1725	31167	1907
10-Oct-22	12078	1682	27299383	220861	143866	7163	2276262	1725	31198	1908
11-Oct-22	12080	1682	27304964	220908	143899	7164	2276734	1725	31229	1908
12-Oct-22	12083	1683	27310546	220955	143932	7166	2277205	1726	31260	1908
13-Oct-22	12085	1683	27316129	221002	143965	7167	2277677	1726	31292	1909
14-Oct-22	12087	1683	27321713	221049	143998	7169	2278149	1726	31323	1909
15-Oct-22	12089	1684	27327299	221096	144031	7170	2278620	1726	31354	1910
16-Oct-22	12091	1684	27332885	221144	144064	7171	2279092	1727	31385	1910
17-Oct-22	12093	1684	27338473	221191	144097	7173	2279564	1727	31417	1910
18-Oct-22	12095	1685	27344062	221238	144130	7174	2280036	1727	31448	1911
19-Oct-22	12097	1685	27349652	221285	144163	7176	2280509	1727	31479	1911
20-Oct-22	12099	1685	27355243	221332	144196	7177	2280981	1728	31511	1911
21-Oct-22	12101	1686	27360836	221379	144229	7178	2281453	1728	31542	1912
22-Oct-22	12103	1686	27366429	221426	144262	7180	2281926	1728	31574	1912
23-Oct-22	12105	1686	27372024	221473	144295	7181	2282398	1729	31605	1912
24-Oct-22	12107	1687	27377619	221520	144329	7183	2282871	1729	31637	1913
25-Oct-22	12109	1687	27383216	221568	144362	7184	2283344	1729	31668	1913
26-Oct-22	12111	1687	27388814	221615	144395	7185	2283817	1729	31700	1914
27-Oct-22	12113	1688	27394413	221662	144428	7187	2284289	1730	31732	1914
28-Oct-22	12115	1688	27400014	221709	144461	7188	2284763	1730	31763	1914
29-Oct-22	12117	1688	27405615	221756	144494	7190	2285236	1730	31795	1915
30-Oct-22	12119	1689	27411218	221803	144527	7191	2285709	1730	31827	1915
31-Oct-22	12121	1689	27416821	221851	144560	7192	2286182	1731	31859	1915

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Nov-22	12123	1689	27422426	221898	144593	7194	2286656	1731	31891	1916
2-Nov-22	12125	1690	27428032	221945	144626	7195	2287129	1731	31922	1916
3-Nov-22	12127	1690	27433640	221992	144660	7196	2287603	1732	31954	1917
4-Nov-22	12130	1690	27439248	222040	144693	7198	2288077	1732	31986	1917
5-Nov-22	12132	1690	27444857	222087	144726	7199	2288551	1732	32018	1917
6-Nov-22	12134	1691	27450468	222134	144759	7201	2289024	1732	32050	1918
7-Nov-22	12136	1691	27456080	222181	144792	7202	2289499	1733	32082	1918
8-Nov-22	12138	1691	27461693	222229	144825	7203	2289973	1733	32114	1918
9-Nov-22	12140	1692	27467307	222276	144859	7205	2290447	1733	32146	1919
10-Nov-22	12142	1692	27472922	222323	144892	7206	2290921	1733	32178	1919
11-Nov-22	12144	1692	27478538	222371	144925	7208	2291396	1734	32210	1920
12-Nov-22	12146	1693	27484156	222418	144958	7209	2291870	1734	32243	1920
13-Nov-22	12148	1693	27489774	222465	144991	7210	2292345	1734	32275	1920
14-Nov-22	12150	1693	27495394	222513	145025	7212	2292820	1735	32307	1921
15-Nov-22	12152	1694	27501015	222560	145058	7213	2293294	1735	32339	1921
16-Nov-22	12154	1694	27506637	222607	145091	7215	2293769	1735	32371	1921
17-Nov-22	12156	1694	27512260	222655	145124	7216	2294244	1735	32404	1922
18-Nov-22	12158	1695	27517885	222702	145158	7217	2294719	1736	32436	1922
19-Nov-22	12160	1695	27523510	222749	145191	7219	2295195	1736	32469	1923
20-Nov-22	12162	1695	27529137	222797	145224	7220	2295670	1736	32501	1923
21-Nov-22	12164	1696	27534765	222844	145257	7222	2296145	1736	32533	1923
22-Nov-22	12166	1696	27540394	222892	145291	7223	2296621	1737	32566	1924
23-Nov-22	12168	1696	27546024	222939	145324	7225	2297096	1737	32598	1924
24-Nov-22	12171	1697	27551655	222987	145357	7226	2297572	1737	32631	1924
25-Nov-22	12173	1697	27557288	223034	145391	7227	2298048	1738	32664	1925
26-Nov-22	12175	1697	27562921	223081	145424	7229	2298524	1738	32696	1925
27-Nov-22	12177	1698	27568556	223129	145457	7230	2299000	1738	32729	1926
28-Nov-22	12179	1698	27574192	223176	145491	7232	2299476	1738	32762	1926
29-Nov-22	12181	1698	27579829	223224	145524	7233	2299952	1739	32794	1926
30-Nov-22	12183	1699	27585467	223271	145557	7234	2300429	1739	32827	1927

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Dec-22	12185	1699	27591107	223319	145591	7236	2300905	1739	32860	1927
2-Dec-22	12187	1699	27596747	223367	145624	7237	2301381	1739	32893	1927
3-Dec-22	12189	1700	27602389	223414	145657	7239	2301858	1740	32925	1928
4-Dec-22	12191	1700	27608032	223462	145691	7240	2302335	1740	32958	1928
5-Dec-22	12193	1700	27613676	223509	145724	7241	2302812	1740	32991	1929
6-Dec-22	12195	1700	27619321	223557	145758	7243	2303288	1741	33024	1929
7-Dec-22	12197	1701	27624967	223604	145791	7244	2303765	1741	33057	1929
8-Dec-22	12199	1701	27630615	223652	145824	7246	2304243	1741	33090	1930
9-Dec-22	12201	1701	27636263	223700	145858	7247	2304720	1741	33123	1930
10-Dec-22	12203	1702	27641913	223747	145891	7248	2305197	1742	33156	1930
11-Dec-22	12205	1702	27647564	223795	145925	7250	2305674	1742	33189	1931
12-Dec-22	12208	1702	27653216	223842	145958	7251	2306152	1742	33222	1931
13-Dec-22	12210	1703	27658869	223890	145991	7253	2306629	1742	33256	1932
14-Dec-22	12212	1703	27664523	223938	146025	7254	2307107	1743	33289	1932
15-Dec-22	12214	1703	27670179	223985	146058	7255	2307585	1743	33322	1932
16-Dec-22	12216	1704	27675836	224033	146092	7257	2308063	1743	33355	1933
17-Dec-22	12218	1704	27681493	224081	146125	7258	2308541	1744	33389	1933
18-Dec-22	12220	1704	27687152	224128	146159	7260	2309019	1744	33422	1933
19-Dec-22	12222	1705	27692813	224176	146192	7261	2309497	1744	33455	1934
20-Dec-22	12224	1705	27698474	224224	146226	7262	2309975	1744	33489	1934
21-Dec-22	12226	1705	27704136	224271	146259	7264	2310454	1745	33522	1934
22-Dec-22	12228	1706	27709800	224319	146293	7265	2310932	1745	33556	1935
23-Dec-22	12230	1706	27715465	224367	146326	7267	2311411	1745	33589	1935
24-Dec-22	12232	1706	27721131	224415	146360	7268	2311889	1745	33623	1936
25-Dec-22	12234	1707	27726798	224462	146393	7270	2312368	1746	33656	1936
26-Dec-22	12236	1707	27732466	224510	146427	7271	2312847	1746	33690	1936
27-Dec-22	12238	1707	27738135	224558	146461	7272	2313326	1746	33724	1937
28-Dec-22	12241	1708	27743806	224606	146494	7274	2313805	1747	33757	1937
29-Dec-22	12243	1708	27749478	224654	146528	7275	2314284	1747	33791	1938
30-Dec-22	12245	1708	27755151	224701	146561	7277	2314764	1747	33825	1938
31-Dec-22	12247	1709	27760825	224749	146595	7278	2315243	1747	33858	1938

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jan-23	12249	1709	27766500	224797	146628	7279	2315722	1748	33892	1939
2-Jan-23	12251	1709	27772176	224845	146662	7281	2316202	1748	33926	1939
3-Jan-23	12253	1710	27777854	224893	146696	7282	2316682	1748	33960	1939
4-Jan-23	12255	1710	27783532	224941	146729	7284	2317161	1749	33994	1940
5-Jan-23	12257	1710	27789212	224989	146763	7285	2317641	1749	34028	1940
6-Jan-23	12259	1711	27794893	225036	146797	7287	2318121	1749	34062	1941
7-Jan-23	12261	1711	27800576	225084	146830	7288	2318601	1749	34096	1941
8-Jan-23	12263	1711	27806259	225132	146864	7289	2319081	1750	34130	1941
9-Jan-23	12265	1712	27811943	225180	146897	7291	2319562	1750	34164	1942
10-Jan-23	12267	1712	27817629	225228	146931	7292	2320042	1750	34198	1942
11-Jan-23	12270	1712	27823316	225276	146965	7294	2320523	1750	34232	1942
12-Jan-23	12272	1713	27829004	225324	146998	7295	2321003	1751	34266	1943
13-Jan-23	12274	1713	27834693	225372	147032	7296	2321484	1751	34301	1943
14-Jan-23	12276	1713	27840383	225420	147066	7298	2321965	1751	34335	1944
15-Jan-23	12278	1714	27846075	225468	147100	7299	2322445	1752	34369	1944
16-Jan-23	12280	1714	27851767	225516	147133	7301	2322926	1752	34403	1944
17-Jan-23	12282	1714	27857461	225564	147167	7302	2323407	1752	34438	1945
18-Jan-23	12284	1714	27863156	225612	147201	7304	2323889	1752	34472	1945
19-Jan-23	12286	1715	27868852	225660	147234	7305	2324370	1753	34507	1945
20-Jan-23	12288	1715	27874550	225708	147268	7306	2324851	1753	34541	1946
21-Jan-23	12290	1715	27880248	225756	147302	7308	2325333	1753	34576	1946
22-Jan-23	12292	1716	27885948	225804	147336	7309	2325814	1753	34610	1947
23-Jan-23	12294	1716	27891648	225852	147369	7311	2326296	1754	34645	1947
24-Jan-23	12296	1716	27897350	225900	147403	7312	2326778	1754	34679	1947
25-Jan-23	12299	1717	27903054	225948	147437	7313	2327259	1754	34714	1948
26-Jan-23	12301	1717	27908758	225996	147471	7315	2327741	1755	34748	1948
27-Jan-23	12303	1717	27914463	226044	147505	7316	2328224	1755	34783	1948
28-Jan-23	12305	1718	27920170	226092	147538	7318	2328706	1755	34818	1949
29-Jan-23	12307	1718	27925878	226141	147572	7319	2329188	1755	34853	1949
30-Jan-23	12309	1718	27931587	226189	147606	7321	2329670	1756	34887	1950
31-Jan-23	12311	1719	27937297	226237	147640	7322	2330153	1756	34922	1950

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Feb-23	12313	1719	27943008	226285	147674	7323	2330635	1756	34957	1950
2-Feb-23	12315	1719	27948720	226333	147707	7325	2331118	1756	34992	1951
3-Feb-23	12317	1720	27954434	226381	147741	7326	2331601	1757	35027	1951
4-Feb-23	12319	1720	27960149	226430	147775	7328	2332084	1757	35062	1951
5-Feb-23	12321	1720	27965865	226478	147809	7329	2332567	1757	35097	1952
6-Feb-23	12323	1721	27971582	226526	147843	7331	2333050	1758	35132	1952
7-Feb-23	12326	1721	27977300	226574	147877	7332	2333533	1758	35167	1953
8-Feb-23	12328	1721	27983020	226622	147911	7333	2334016	1758	35202	1953
9-Feb-23	12330	1722	27988740	226671	147945	7335	2334499	1758	35237	1953
10-Feb-23	12332	1722	27994462	226719	147978	7336	2334983	1759	35273	1954
11-Feb-23	12334	1722	28000185	226767	148012	7338	2335466	1759	35308	1954
12-Feb-23	12336	1723	28005909	226815	148046	7339	2335950	1759	35343	1954
13-Feb-23	12338	1723	28011635	226864	148080	7340	2336434	1760	35378	1955
14-Feb-23	12340	1723	28017361	226912	148114	7342	2336918	1760	35414	1955
15-Feb-23	12342	1724	28023089	226960	148148	7343	2337402	1760	35449	1956
16-Feb-23	12344	1724	28028818	227008	148182	7345	2337886	1760	35484	1956
17-Feb-23	12346	1724	28034548	227057	148216	7346	2338370	1761	35520	1956
18-Feb-23	12348	1725	28040279	227105	148250	7348	2338854	1761	35555	1957
19-Feb-23	12351	1725	28046011	227153	148284	7349	2339338	1761	35591	1957
20-Feb-23	12353	1725	28051745	227202	148318	7350	2339823	1761	35626	1958
21-Feb-23	12355	1726	28057479	227250	148352	7352	2340307	1762	35662	1958
22-Feb-23	12357	1726	28063215	227299	148386	7353	2340792	1762	35698	1958
23-Feb-23	12359	1726	28068952	227347	148420	7355	2341277	1762	35733	1959
24-Feb-23	12361	1727	28074690	227395	148454	7356	2341762	1763	35769	1959
25-Feb-23	12363	1727	28080430	227444	148488	7358	2342247	1763	35805	1959
26-Feb-23	12365	1727	28086170	227492	148522	7359	2342732	1763	35840	1960
27-Feb-23	12367	1728	28091912	227541	148556	7360	2343217	1763	35876	1960
28-Feb-23	12369	1728	28097655	227589	148590	7362	2343702	1764	35912	1961

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Mar-23	12371	1728	28103399	227637	148624	7363	2344188	1764	35948	1961
2-Mar-23	12373	1729	28109144	227686	148658	7365	2344673	1764	35984	1961
3-Mar-23	12376	1729	28114891	227734	148692	7366	2345159	1764	36020	1962
4-Mar-23	12378	1729	28120638	227783	148726	7368	2345644	1765	36056	1962
5-Mar-23	12380	1730	28126387	227831	148760	7369	2346130	1765	36092	1962
6-Mar-23	12382	1730	28132137	227880	148794	7371	2346616	1765	36128	1963
7-Mar-23	12384	1730	28137888	227928	148829	7372	2347102	1766	36164	1963
8-Mar-23	12386	1731	28143640	227977	148863	7373	2347588	1766	36200	1964
9-Mar-23	12388	1731	28149394	228025	148897	7375	2348074	1766	36236	1964
10-Mar-23	12390	1731	28155148	228074	148931	7376	2348560	1766	36272	1964
11-Mar-23	12392	1732	28160904	228122	148965	7378	2349047	1767	36308	1965
12-Mar-23	12394	1732	28166661	228171	148999	7379	2349533	1767	36345	1965
13-Mar-23	12396	1732	28172419	228219	149033	7381	2350020	1767	36381	1965
14-Mar-23	12399	1733	28178179	228268	149067	7382	2350506	1768	36417	1966
15-Mar-23	12401	1733	28183939	228317	149102	7383	2350993	1768	36454	1966
16-Mar-23	12403	1733	28189701	228365	149136	7385	2351480	1768	36490	1967
17-Mar-23	12405	1734	28195464	228414	149170	7386	2351967	1768	36526	1967
18-Mar-23	12407	1734	28201228	228462	149204	7388	2352454	1769	36563	1967
19-Mar-23	12409	1734	28206993	228511	149238	7389	2352941	1769	36599	1968
20-Mar-23	12411	1735	28212760	228560	149272	7391	2353429	1769	36636	1968
21-Mar-23	12413	1735	28218527	228608	149307	7392	2353916	1769	36672	1969
22-Mar-23	12415	1735	28224296	228657	149341	7393	2354403	1770	36709	1969
23-Mar-23	12417	1736	28230066	228706	149375	7395	2354891	1770	36746	1969
24-Mar-23	12420	1736	28235837	228754	149409	7396	2355379	1770	36782	1970
25-Mar-23	12422	1736	28241609	228803	149444	7398	2355866	1771	36819	1970
26-Mar-23	12424	1737	28247383	228852	149478	7399	2356354	1771	36856	1970
27-Mar-23	12426	1737	28253158	228900	149512	7401	2356842	1771	36893	1971
28-Mar-23	12428	1737	28258933	228949	149546	7402	2357330	1771	36930	1971
29-Mar-23	12430	1738	28264711	228998	149581	7404	2357819	1772	36966	1972
30-Mar-23	12432	1738	28270489	229047	149615	7405	2358307	1772	37003	1972
31-Mar-23	12434	1738	28276268	229095	149649	7406	2358795	1772	37040	1972

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Apr-23	12436	1739	28282049	229144	149683	7408	2359284	1773	37077	1973
2-Apr-23	12438	1739	28287830	229193	149718	7409	2359772	1773	37114	1973
3-Apr-23	12440	1739	28293613	229242	149752	7411	2360261	1773	37151	1974
4-Apr-23	12443	1740	28299398	229290	149786	7412	2360750	1773	37188	1974
5-Apr-23	12445	1740	28305183	229339	149821	7414	2361239	1774	37226	1974
6-Apr-23	12447	1740	28310969	229388	149855	7415	2361728	1774	37263	1975
7-Apr-23	12449	1741	28316757	229437	149889	7416	2362217	1774	37300	1975
8-Apr-23	12451	1741	28322546	229486	149924	7418	2362706	1774	37337	1975
9-Apr-23	12453	1741	28328336	229535	149958	7419	2363195	1775	37375	1976
10-Apr-23	12455	1742	28334127	229583	149992	7421	2363685	1775	37412	1976
11-Apr-23	12457	1742	28339920	229632	150027	7422	2364174	1775	37449	1977
12-Apr-23	12459	1742	28345713	229681	150061	7424	2364664	1776	37487	1977
13-Apr-23	12462	1743	28351508	229730	150096	7425	2365153	1776	37524	1977
14-Apr-23	12464	1743	28357304	229779	150130	7427	2365643	1776	37561	1978
15-Apr-23	12466	1743	28363101	229828	150164	7428	2366133	1776	37599	1978
16-Apr-23	12468	1744	28368899	229877	150199	7429	2366623	1777	37637	1978
17-Apr-23	12470	1744	28374699	229926	150233	7431	2367113	1777	37674	1979
18-Apr-23	12472	1744	28380500	229975	150268	7432	2367604	1777	37712	1979
19-Apr-23	12474	1745	28386302	230024	150302	7434	2368094	1778	37749	1980
20-Apr-23	12476	1745	28392105	230072	150336	7435	2368584	1778	37787	1980
21-Apr-23	12478	1745	28397909	230121	150371	7437	2369075	1778	37825	1980
22-Apr-23	12480	1746	28403714	230170	150405	7438	2369565	1778	37863	1981
23-Apr-23	12483	1746	28409521	230219	150440	7440	2370056	1779	37900	1981
24-Apr-23	12485	1746	28415329	230268	150474	7441	2370547	1779	37938	1982
25-Apr-23	12487	1747	28421138	230317	150509	7442	2371038	1779	37976	1982
26-Apr-23	12489	1747	28426948	230366	150543	7444	2371529	1780	38014	1982
27-Apr-23	12491	1747	28432759	230415	150578	7445	2372020	1780	38052	1983
28-Apr-23	12493	1748	28438572	230464	150612	7447	2372511	1780	38090	1983
29-Apr-23	12495	1748	28444386	230514	150647	7448	2373003	1780	38128	1983
30-Apr-23	12497	1748	28450201	230563	150681	7450	2373494	1781	38166	1984

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-May-23	12499	1749	28456017	230612	150716	7451	2373986	1781	38204	1984
2-May-23	12502	1749	28461834	230661	150750	7453	2374477	1781	38242	1985
3-May-23	12504	1749	28467653	230710	150785	7454	2374969	1781	38280	1985
4-May-23	12506	1750	28473472	230759	150820	7455	2375461	1782	38319	1985
5-May-23	12508	1750	28479293	230808	150854	7457	2375953	1782	38357	1986
6-May-23	12510	1750	28485115	230857	150889	7458	2376445	1782	38395	1986
7-May-23	12512	1751	28490939	230906	150923	7460	2376937	1783	38434	1987
8-May-23	12514	1751	28496763	230955	150958	7461	2377429	1783	38472	1987
9-May-23	12516	1751	28502589	231005	150992	7463	2377921	1783	38510	1987
10-May-23	12518	1752	28508416	231054	151027	7464	2378414	1783	38549	1988
11-May-23	12521	1752	28514244	231103	151062	7466	2378906	1784	38587	1988
12-May-23	12523	1752	28520073	231152	151096	7467	2379399	1784	38626	1988
13-May-23	12525	1753	28525903	231201	151131	7469	2379892	1784	38664	1989
14-May-23	12527	1753	28531735	231251	151165	7470	2380385	1785	38703	1989
15-May-23	12529	1753	28537568	231300	151200	7471	2380878	1785	38742	1990
16-May-23	12531	1754	28543402	231349	151235	7473	2381371	1785	38780	1990
17-May-23	12533	1754	28549237	231398	151269	7474	2381864	1785	38819	1990
18-May-23	12535	1754	28555073	231447	151304	7476	2382357	1786	38858	1991
19-May-23	12537	1755	28560911	231497	151339	7477	2382851	1786	38897	1991
20-May-23	12540	1755	28566750	231546	151373	7479	2383344	1786	38935	1992
21-May-23	12542	1755	28572590	231595	151408	7480	2383838	1787	38974	1992
22-May-23	12544	1756	28578431	231645	151443	7482	2384331	1787	39013	1992
23-May-23	12546	1756	28584273	231694	151478	7483	2384825	1787	39052	1993
24-May-23	12548	1756	28590117	231743	151512	7484	2385319	1787	39091	1993
25-May-23	12550	1757	28595961	231793	151547	7486	2385813	1788	39130	1994
26-May-23	12552	1757	28601807	231842	151582	7487	2386307	1788	39169	1994
27-May-23	12554	1757	28607655	231891	151616	7489	2386801	1788	39208	1994
28-May-23	12557	1758	28613503	231941	151651	7490	2387295	1788	39248	1995
29-May-23	12559	1758	28619352	231990	151686	7492	2387790	1789	39287	1995
30-May-23	12561	1758	28625203	232039	151721	7493	2388284	1789	39326	1995
31-May-23	12563	1759	28631055	232089	151755	7495	2388779	1789	39365	1996

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jun-23	12565	1759	28636908	232138	151790	7496	2389274	1790	39405	1996
2-Jun-23	12567	1759	28642762	232187	151825	7498	2389768	1790	39444	1997
3-Jun-23	12569	1760	28648618	232237	151860	7499	2390263	1790	39483	1997
4-Jun-23	12571	1760	28654475	232286	151895	7500	2390758	1790	39523	1997
5-Jun-23	12573	1760	28660333	232336	151929	7502	2391253	1791	39562	1998
6-Jun-23	12576	1761	28666192	232385	151964	7503	2391749	1791	39602	1998
7-Jun-23	12578	1761	28672052	232435	151999	7505	2392244	1791	39641	1999
8-Jun-23	12580	1761	28677913	232484	152034	7506	2392739	1792	39681	1999
9-Jun-23	12582	1762	28683776	232534	152069	7508	2393235	1792	39720	1999
10-Jun-23	12584	1762	28689640	232583	152104	7509	2393730	1792	39760	2000
11-Jun-23	12586	1762	28695505	232633	152138	7511	2394226	1792	39800	2000
12-Jun-23	12588	1763	28701371	232682	152173	7512	2394722	1793	39840	2000
13-Jun-23	12590	1763	28707239	232732	152208	7514	2395218	1793	39879	2001
14-Jun-23	12593	1763	28713108	232781	152243	7515	2395714	1793	39919	2001
15-Jun-23	12595	1764	28718977	232831	152278	7517	2396210	1794	39959	2002
16-Jun-23	12597	1764	28724849	232880	152313	7518	2396706	1794	39999	2002
17-Jun-23	12599	1764	28730721	232930	152348	7519	2397203	1794	40039	2002
18-Jun-23	12601	1765	28736594	232979	152383	7521	2397699	1794	40079	2003
19-Jun-23	12603	1765	28742469	233029	152417	7522	2398196	1795	40119	2003
20-Jun-23	12605	1765	28748345	233079	152452	7524	2398692	1795	40159	2004
21-Jun-23	12607	1766	28754222	233128	152487	7525	2399189	1795	40199	2004
22-Jun-23	12610	1766	28760100	233178	152522	7527	2399686	1796	40239	2004
23-Jun-23	12612	1766	28765980	233227	152557	7528	2400183	1796	40279	2005
24-Jun-23	12614	1767	28771860	233277	152592	7530	2400680	1796	40320	2005
25-Jun-23	12616	1767	28777742	233327	152627	7531	2401177	1796	40360	2006
26-Jun-23	12618	1767	28783625	233376	152662	7533	2401674	1797	40400	2006
27-Jun-23	12620	1768	28789510	233426	152697	7534	2402172	1797	40440	2006
28-Jun-23	12622	1768	28795395	233476	152732	7536	2402669	1797	40481	2007
29-Jun-23	12625	1768	28801282	233525	152767	7537	2403167	1797	40521	2007
30-Jun-23	12627	1769	28807170	233575	152802	7538	2403664	1798	40562	2007

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Jul-23	12629	1769	28813059	233625	152837	7540	2404162	1798	40602	2008
2-Jul-23	12631	1769	28818949	233675	152872	7541	2404660	1798	40643	2008
3-Jul-23	12633	1770	28824841	233724	152907	7543	2405158	1799	40683	2009
4-Jul-23	12635	1770	28830734	233774	152942	7544	2405656	1799	40724	2009
5-Jul-23	12637	1770	28836628	233824	152977	7546	2406154	1799	40765	2009
6-Jul-23	12639	1771	28842523	233874	153012	7547	2406653	1799	40805	2010
7-Jul-23	12642	1771	28848419	233923	153047	7549	2407151	1800	40846	2010
8-Jul-23	12644	1771	28854317	233973	153082	7550	2407650	1800	40887	2011
9-Jul-23	12646	1772	28860215	234023	153118	7552	2408148	1800	40928	2011
10-Jul-23	12648	1772	28866115	234073	153153	7553	2408647	1801	40969	2011
11-Jul-23	12650	1772	28872016	234123	153188	7555	2409146	1801	41009	2012
12-Jul-23	12652	1773	28877919	234172	153223	7556	2409645	1801	41050	2012
13-Jul-23	12654	1773	28883822	234222	153258	7558	2410144	1801	41091	2013
14-Jul-23	12657	1773	28889727	234272	153293	7559	2410643	1802	41132	2013
15-Jul-23	12659	1774	28895633	234322	153328	7560	2411142	1802	41173	2013
16-Jul-23	12661	1774	28901540	234372	153363	7562	2411641	1802	41215	2014
17-Jul-23	12663	1774	28907449	234422	153398	7563	2412141	1803	41256	2014
18-Jul-23	12665	1775	28913358	234472	153434	7565	2412640	1803	41297	2014
19-Jul-23	12667	1775	28919269	234521	153469	7566	2413140	1803	41338	2015
20-Jul-23	12669	1775	28925181	234571	153504	7568	2413640	1803	41379	2015
21-Jul-23	12671	1776	28931094	234621	153539	7569	2414140	1804	41421	2016
22-Jul-23	12674	1776	28937009	234671	153574	7571	2414639	1804	41462	2016
23-Jul-23	12676	1776	28942925	234721	153609	7572	2415140	1804	41504	2016
24-Jul-23	12678	1777	28948841	234771	153645	7574	2415640	1805	41545	2017
25-Jul-23	12680	1777	28954760	234821	153680	7575	2416140	1805	41586	2017
26-Jul-23	12682	1777	28960679	234871	153715	7577	2416640	1805	41628	2018
27-Jul-23	12684	1778	28966599	234921	153750	7578	2417141	1805	41670	2018
28-Jul-23	12686	1778	28972521	234971	153786	7580	2417641	1806	41711	2018
29-Jul-23	12689	1778	28978444	235021	153821	7581	2418142	1806	41753	2019
30-Jul-23	12691	1779	28984368	235071	153856	7583	2418643	1806	41794	2019
31-Jul-23	12693	1779	28990293	235121	153891	7584	2419144	1807	41836	2020

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Aug-23	12695	1779	28996220	235171	153927	7585	2419645	1807	41878	2020
2-Aug-23	12697	1780	29002148	235221	153962	7587	2420146	1807	41920	2020
3-Aug-23	12699	1780	29008077	235271	153997	7588	2420647	1807	41962	2021
4-Aug-23	12701	1780	29014007	235321	154032	7590	2421148	1808	42004	2021
5-Aug-23	12704	1781	29019938	235371	154068	7591	2421650	1808	42045	2022
6-Aug-23	12706	1781	29025871	235422	154103	7593	2422151	1808	42087	2022
7-Aug-23	12708	1781	29031805	235472	154138	7594	2422653	1809	42129	2022
8-Aug-23	12710	1782	29037740	235522	154174	7596	2423154	1809	42172	2023
9-Aug-23	12712	1782	29043676	235572	154209	7597	2423656	1809	42214	2023
10-Aug-23	12714	1783	29049614	235622	154244	7599	2424158	1809	42256	2023
11-Aug-23	12716	1783	29055552	235672	154280	7600	2424660	1810	42298	2024
12-Aug-23	12719	1783	29061492	235722	154315	7602	2425162	1810	42340	2024
13-Aug-23	12721	1784	29067433	235772	154350	7603	2425665	1810	42383	2025
14-Aug-23	12723	1784	29073376	235823	154386	7605	2426167	1811	42425	2025
15-Aug-23	12725	1784	29079319	235873	154421	7606	2426669	1811	42467	2025
16-Aug-23	12727	1785	29085264	235923	154457	7608	2427172	1811	42510	2026
17-Aug-23	12729	1785	29091210	235973	154492	7609	2427675	1811	42552	2026
18-Aug-23	12731	1785	29097157	236023	154527	7611	2428177	1812	42595	2027
19-Aug-23	12734	1786	29103105	236074	154563	7612	2428680	1812	42637	2027
20-Aug-23	12736	1786	29109055	236124	154598	7614	2429183	1812	42680	2027
21-Aug-23	12738	1786	29115006	236174	154634	7615	2429686	1812	42722	2028
22-Aug-23	12740	1787	29120958	236224	154669	7616	2430189	1813	42765	2028
23-Aug-23	12742	1787	29126911	236275	154704	7618	2430693	1813	42808	2029
24-Aug-23	12744	1787	29132866	236325	154740	7619	2431196	1813	42850	2029
25-Aug-23	12747	1788	29138821	236375	154775	7621	2431700	1814	42893	2029
26-Aug-23	12749	1788	29144778	236426	154811	7622	2432203	1814	42936	2030
27-Aug-23	12751	1788	29150736	236476	154846	7624	2432707	1814	42979	2030
28-Aug-23	12753	1789	29156696	236526	154882	7625	2433211	1814	43022	2031
29-Aug-23	12755	1789	29162656	236577	154917	7627	2433714	1815	43065	2031
30-Aug-23	12757	1789	29168618	236627	154953	7628	2434218	1815	43108	2031
31-Aug-23	12759	1790	29174581	236677	154988	7630	2434723	1815	43151	2032

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Sep-23	12762	1790	29180545	236728	155024	7631	2435227	1816	43194	2032
2-Sep-23	12764	1790	29186511	236778	155059	7633	2435731	1816	43237	2033
3-Sep-23	12766	1791	29192477	236828	155095	7634	2436236	1816	43280	2033
4-Sep-23	12768	1791	29198445	236879	155130	7636	2436740	1816	43323	2033
5-Sep-23	12770	1791	29204414	236929	155166	7637	2437245	1817	43367	2034
6-Sep-23	12772	1792	29210385	236980	155201	7639	2437749	1817	43410	2034
7-Sep-23	12775	1792	29216356	237030	155237	7640	2438254	1817	43453	2034
8-Sep-23	12777	1792	29222329	237081	155273	7642	2438759	1818	43497	2035
9-Sep-23	12779	1793	29228303	237131	155308	7643	2439264	1818	43540	2035
10-Sep-23	12781	1793	29234278	237182	155344	7645	2439769	1818	43584	2036
11-Sep-23	12783	1793	29240255	237232	155379	7646	2440275	1818	43627	2036
12-Sep-23	12785	1794	29246232	237283	155415	7648	2440780	1819	43671	2036
13-Sep-23	12787	1794	29252211	237333	155451	7649	2441286	1819	43714	2037
14-Sep-23	12790	1794	29258191	237384	155486	7651	2441791	1819	43758	2037
15-Sep-23	12792	1795	29264173	237434	155522	7652	2442297	1820	43802	2038
16-Sep-23	12794	1795	29270155	237485	155557	7654	2442803	1820	43845	2038
17-Sep-23	12796	1795	29276139	237535	155593	7655	2443308	1820	43889	2038
18-Sep-23	12798	1796	29282124	237586	155629	7657	2443814	1820	43933	2039
19-Sep-23	12800	1796	29288110	237636	155664	7658	2444321	1821	43977	2039
20-Sep-23	12803	1797	29294098	237687	155700	7660	2444827	1821	44021	2040
21-Sep-23	12805	1797	29300086	237737	155736	7661	2445333	1821	44065	2040
22-Sep-23	12807	1797	29306076	237788	155771	7662	2445839	1822	44109	2040
23-Sep-23	12809	1798	29312067	237839	155807	7664	2446346	1822	44153	2041
24-Sep-23	12811	1798	29318060	237889	155843	7665	2446853	1822	44197	2041
25-Sep-23	12813	1798	29324053	237940	155879	7667	2447359	1822	44241	2042
26-Sep-23	12816	1799	29330048	237991	155914	7668	2447866	1823	44285	2042
27-Sep-23	12818	1799	29336044	238041	155950	7670	2448373	1823	44329	2042
28-Sep-23	12820	1799	29342041	238092	155986	7671	2448880	1823	44374	2043
29-Sep-23	12822	1800	29348040	238142	156022	7673	2449387	1824	44418	2043
30-Sep-23	12824	1800	29354039	238193	156057	7674	2449894	1824	44462	2044

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Oct-23	12826	1800	29360040	238244	156093	7676	2450402	1824	44507	2044
2-Oct-23	12829	1801	29366042	238295	156129	7677	2450909	1824	44551	2044
3-Oct-23	12831	1801	29372046	238345	156165	7679	2451417	1825	44596	2045
4-Oct-23	12833	1801	29378050	238396	156200	7680	2451925	1825	44640	2045
5-Oct-23	12835	1802	29384056	238447	156236	7682	2452432	1825	44685	2046
6-Oct-23	12837	1802	29390063	238498	156272	7683	2452940	1826	44729	2046
7-Oct-23	12839	1802	29396071	238548	156308	7685	2453448	1826	44774	2046
8-Oct-23	12842	1803	29402081	238599	156344	7686	2453956	1826	44819	2047
9-Oct-23	12844	1803	29408092	238650	156379	7688	2454464	1826	44863	2047
10-Oct-23	12846	1803	29414104	238701	156415	7689	2454973	1827	44908	2048
11-Oct-23	12848	1804	29420117	238751	156451	7691	2455481	1827	44953	2048
12-Oct-23	12850	1804	29426131	238802	156487	7692	2455990	1827	44998	2048
13-Oct-23	12852	1804	29432147	238853	156523	7694	2456498	1828	45043	2049
14-Oct-23	12855	1805	29438164	238904	156559	7695	2457007	1828	45088	2049
15-Oct-23	12857	1805	29444182	238955	156595	7697	2457516	1828	45133	2050
16-Oct-23	12859	1805	29450201	239006	156630	7698	2458025	1828	45178	2050
17-Oct-23	12861	1806	29456222	239056	156666	7700	2458534	1829	45223	2050
18-Oct-23	12863	1806	29462244	239107	156702	7701	2459043	1829	45268	2051
19-Oct-23	12865	1806	29468267	239158	156738	7703	2459552	1829	45313	2051
20-Oct-23	12868	1807	29474291	239209	156774	7704	2460062	1830	45359	2052
21-Oct-23	12870	1807	29480316	239260	156810	7706	2460571	1830	45404	2052
22-Oct-23	12872	1808	29486343	239311	156846	7707	2461081	1830	45449	2052
23-Oct-23	12874	1808	29492371	239362	156882	7709	2461590	1831	45495	2053
24-Oct-23	12876	1808	29498400	239413	156918	7710	2462100	1831	45540	2053
25-Oct-23	12878	1809	29504431	239464	156954	7712	2462610	1831	45585	2054
26-Oct-23	12881	1809	29510462	239515	156990	7713	2463120	1831	45631	2054
27-Oct-23	12883	1809	29516495	239566	157026	7715	2463630	1832	45677	2054
28-Oct-23	12885	1810	29522529	239617	157062	7716	2464140	1832	45722	2055
29-Oct-23	12887	1810	29528565	239668	157098	7718	2464650	1832	45768	2055
30-Oct-23	12889	1810	29534601	239719	157134	7719	2465161	1833	45814	2056
31-Oct-23	12892	1811	29540639	239770	157170	7721	2465671	1833	45859	2056

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Nov-23	12894	1811	29546678	239821	157206	7722	2466182	1833	45905	2056
2-Nov-23	12896	1811	29552719	239872	157242	7724	2466693	1833	45951	2057
3-Nov-23	12898	1812	29558760	239923	157278	7725	2467204	1834	45997	2057
4-Nov-23	12900	1812	29564803	239974	157314	7727	2467715	1834	46043	2058
5-Nov-23	12902	1812	29570847	240025	157350	7728	2468226	1834	46089	2058
6-Nov-23	12905	1813	29576892	240076	157386	7730	2468737	1835	46135	2058
7-Nov-23	12907	1813	29582939	240127	157422	7731	2469248	1835	46181	2059
8-Nov-23	12909	1813	29588986	240178	157458	7733	2469759	1835	46227	2059
9-Nov-23	12911	1814	29595035	240229	157494	7734	2470271	1835	46273	2059
10-Nov-23	12913	1814	29601085	240281	157530	7736	2470782	1836	46319	2060
11-Nov-23	12915	1814	29607137	240332	157566	7737	2471294	1836	46365	2060
12-Nov-23	12918	1815	29613189	240383	157602	7739	2471806	1836	46412	2061
13-Nov-23	12920	1815	29619243	240434	157638	7740	2472318	1837	46458	2061
14-Nov-23	12922	1815	29625299	240485	157675	7742	2472830	1837	46504	2061
15-Nov-23	12924	1816	29631355	240536	157711	7743	2473342	1837	46551	2062
16-Nov-23	12926	1816	29637412	240588	157747	7745	2473854	1837	46597	2062
17-Nov-23	12929	1816	29643471	240639	157783	7746	2474366	1838	46644	2063
18-Nov-23	12931	1817	29649531	240690	157819	7748	2474879	1838	46690	2063
19-Nov-23	12933	1817	29655593	240741	157855	7749	2475391	1838	46737	2063
20-Nov-23	12935	1818	29661655	240792	157892	7751	2475904	1839	46784	2064
21-Nov-23	12937	1818	29667719	240844	157928	7752	2476417	1839	46830	2064
22-Nov-23	12939	1818	29673784	240895	157964	7754	2476930	1839	46877	2065
23-Nov-23	12942	1819	29679850	240946	158000	7755	2477442	1839	46924	2065
24-Nov-23	12944	1819	29685918	240997	158036	7757	2477956	1840	46971	2065
25-Nov-23	12946	1819	29691987	241049	158073	7758	2478469	1840	47018	2066
26-Nov-23	12948	1820	29698057	241100	158109	7760	2478982	1840	47065	2066
27-Nov-23	12950	1820	29704128	241151	158145	7761	2479495	1841	47112	2067
28-Nov-23	12953	1820	29710200	241203	158181	7763	2480009	1841	47159	2067
29-Nov-23	12955	1821	29716274	241254	158217	7764	2480522	1841	47206	2067
30-Nov-23	12957	1821	29722349	241305	158254	7766	2481036	1841	47253	2068

Table A.36.1. (Continued) *Gold prices forecasting using GSTARIMA (1,0,0) with PCA and MA imputation*

Date	China	France	Indonesia	Japan	Russia	S. Arabia	S. Korea	Switzerland	Türkiye	USA
1-Dec-23	12959	1821	29728425	241357	158290	7767	2481550	1842	47300	2068
2-Dec-23	12961	1822	29734503	241408	158326	7769	2482064	1842	47347	2069
3-Dec-23	12964	1822	29740581	241459	158363	7770	2482578	1842	47395	2069
4-Dec-23	12966	1822	29746661	241511	158399	7772	2483092	1843	47442	2070
5-Dec-23	12968	1823	29752743	241562	158435	7773	2483606	1843	47489	2070
6-Dec-23	12970	1823	29758825	241614	158471	7775	2484121	1843	47537	2070
7-Dec-23	12972	1823	29764909	241665	158508	7776	2484635	1843	47584	2071
8-Dec-23	12974	1824	29770994	241717	158544	7778	2485150	1844	47632	2071
9-Dec-23	12977	1824	29777080	241768	158580	7779	2485664	1844	47679	2072
10-Dec-23	12979	1824	29783167	241819	158617	7781	2486179	1844	47727	2072
11-Dec-23	12981	1825	29789256	241871	158653	7782	2486694	1845	47775	2072
12-Dec-23	12983	1825	29795346	241922	158689	7784	2487209	1845	47822	2073
13-Dec-23	12985	1826	29801437	241974	158726	7786	2487724	1845	47870	2073
14-Dec-23	12988	1826	29807529	242025	158762	7787	2488239	1846	47918	2074
15-Dec-23	12990	1826	29813623	242077	158799	7789	2488754	1846	47966	2074
16-Dec-23	12992	1827	29819718	242128	158835	7790	2489270	1846	48014	2074
17-Dec-23	12994	1827	29825814	242180	158871	7792	2489785	1846	48062	2075
18-Dec-23	12996	1827	29831911	242231	158908	7793	2490301	1847	48110	2075
19-Dec-23	12999	1828	29838010	242283	158944	7795	2490817	1847	48158	2076
20-Dec-23	13001	1828	29844110	242335	158981	7796	2491332	1847	48206	2076
21-Dec-23	13003	1828	29850211	242386	159017	7798	2491848	1848	48254	2076
22-Dec-23	13005	1829	29856313	242438	159053	7799	2492364	1848	48302	2077
23-Dec-23	13007	1829	29862417	242489	159090	7801	2492881	1848	48350	2077
24-Dec-23	13010	1829	29868521	242541	159126	7802	2493397	1848	48398	2078
25-Dec-23	13012	1830	29874628	242593	159163	7804	2493913	1849	48447	2078
26-Dec-23	13014	1830	29880735	242644	159199	7805	2494430	1849	48495	2078
27-Dec-23	13016	1830	29886843	242696	159236	7807	2494946	1849	48544	2079
28-Dec-23	13018	1831	29892953	242748	159272	7808	2495463	1850	48592	2079
29-Dec-23	13021	1831	29899064	242799	159309	7810	2495980	1850	48641	2080
30-Dec-23	13023	1831	29905177	242851	159345	7811	2496497	1850	48689	2080
31-Dec-23	13025	1832	29911290	242903	159382	7813	2497014	1850	48738	2080

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- Mubarak, F., Aslanargun, A., Sıklar, İ. (2021). High Order Spatial Weighting Matrix using Google Trends, International Journal of Research and Review, 8(11), 388-396.
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- 2019, Indonesian Student Association in Türkiye, Türkiye.
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