SutteARIMA: Short-term Forecasting Method, a Case: Covid-19 and Stock Market in Spain

Ansari Saleh Ahmar[a,b]
[a]Business School, Faculty of Economics and Business, Universitat de Barcelona, Spain
[b]Department of Statistics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Indonesia
Email: aahmarah9@alumnes.ub.edu

Eva Boj del Val[c]
[c]Department of Economic, Financial and Actuarial Mathematics,
Faculty of Economics and Business, Universitat de Barcelona, Spain
Email: evaboj@ub.edu

Abstract

The purpose of our research is to predict the short-term of confirmed cases of covid-19 and IBEX in Spain by using SutteARIMA method. Covid-19 Spanish confirmed data obtained from Worldometer and Spain Stock Market data (IBEX 35) data obtained from Yahoo Finance. Data starts from 12 February 2020 – 09 April 2020 (the date on Covid-19 was detected in Spain). The data from 12 February 2020 – 02 April 2020 using to fitting with data from 03 April – 09 April 2020. Based on the fitting data, we can doing short forecast for 3 future period (10 April – 12 April 2020 for Covid-19 and 14 April – 16 April 2020 for IBEX). In this study, the SutteARIMA method will be used. For the evaluation of the forecasting methods we applied forecasting accuracy measures, mean absolute percentage error (MAPE). Based on the results of ARIMA and SutteARIMA forecasting methods, we conclude that the SutteARIMA method is most suitable than ARIMA to calculate the daily forecasts of confirmed cases of Covid-19 and IBEX in Spain. The MAPE value of 0.1905 (smaller than 0.04 compared to MAPE value of ARIMA) for confirmed cases of Covid-19 in Spain and 0,0202 for IBEX stock. At the end of the analysis, using the SutteARIMA method, we calculate daily forecasts of confirmed cases of Covid-19 in Spain from 10 April 2020 until 12 April 2020 and Spain Stock Market from 14 April until 16 April 2020.

Keyword: Covid-19, short-term forecast, IBEX, SutteARIMA.

1. Introduction

IMF (2018) explained that in 2017, world growth has strengthened to 3.8 percent and has significantly increased in a global trade. Global growth was projected to rise to 3.9 percent in 2018 and 2019 before 3.8 percent in 2017. This growth was driven by an increase in the projected growth in developing markets and developing economies as well as rapid growth in developed countries. IMF also expected growth for 2018 and 2019 to increase by 0.2 percent annually compared to World Economics Outlook (WEO) in October 2017. In addition, IMF explained that the increase was also driven by the recovery in investment in developed countries, strong economic growth in developing countries in Asia, progress in developing countries of Europe, and signs of recovery in some commodity exporters. Furthermore, this growth was also supported by a strong impetus, the good market sentiment, the accommodative financial conditions, as well as domestic and international impact of the expansionary fiscal policy in the United States. Recovery in some commodity prices should allow a gradual increase in commodity exporters.

Today, the world is shocked by the epidemic called Covid-19. Covid-19 is a contagious and deadly disease that currently exists in the world by WHO. Covid-19 was first reported in Wuhan, Hubei Province, China in December 2019. Covid-19 is an infectious disease caused by a new coronavirus (SARS-CoV-2) discovered in China (Yang et al., 2020). Based on WHO (2020) data, as of 6 April 2020, there were 1210956 confirmed cases and 67594 confirmed deaths. In Spain, Covid-19 cases began to be detected on 12 February 2020. The highest addition of Covid-19 cases occurred on 26 March 2020, as many as 8271 cases (Worldometer, 2020). Based on data presented by Worldometer on 8 April 2020, the number of confirmed cases of Covid-19 in Spain was 148,220 people with 14,792 deaths, and 48,021 people recovered and was the second highest country in the world with confirmed cases of covid-19 (Worldometer, 2020).

To anticipate the many confirmed cases of Covid-19, Spain began lockdown on 14 March 2020 (France24, 2020), this lockdown also resulted in all restaurants, bars, hotels, schools and universities all being closed and of course this will have an impact on the economy of the Spanish country especially Spain Market Index (IBEX 35) which experienced a decline of up to 14% at the closing of shares (McMurtry, 2020).

To see more about the impact of lockdown and Covid-19, it is necessary to forecast the data. Time series data changes from time to time and sometimes in an abruptly manner. To view these changes from time to time, estimates of the data need to be done. Forecasting or predictions related to Covid-19 have been studied by various researchers: (Fanelli and Piazza, 2020) studying the forecasting of the spread of covid-19 in China, Italy, and France using the SIRD model, (Roosa et al., 2020) studying about Covid-19 real-time forecast in China with generalized logistic growth model (GLM), (Benvenuto et al., 2020) examines the forecast of Covid-19 using ARIMA, and (Koczkodaj et al., 2020) predicts Covid-19 outside of China by using a simple heuristic (exponential curve).

2. Literature

2.1. Autoregressive Integrate Moving Average (ARIMA)

Autoregressive Integrate Moving Average (ARIMA) Model first introduced by George Box and Gwilym Jenkins in 1976. The general, the model of ARIMA written with notation ARIMA (p,d,q), with p represents the order of the autoregressive (AR) process, d represents the differencing, and q states the order of the moving average (MA) process.

2.1.1. White Noise Process

In forming a time series model, the data must be stationary.

Definisi 2.1 Stationary. The time series process $\{Z_t, t \in \mathbb{Z}\}$ define stationarity (or weak stationarity) as follows (Brockwell and Davis, 2016; Montgomery et al., 2015) :

(1) the expected value of the time series does not depend on time, $E(Z_t)$ is independent of t, where t = time.

(2) the autocovariance function defined as $Cov(Y_t, Y_{t+k})$ for any lag k is only a function of k and not time; that is, $\gamma(Y_t, Y_{t+k})$, or $\gamma(Y_t, Y_{t+k})$ is independent of t for each k.

Definisi 2.2 $\{a_t\}$ process define ***white noise*** with mean 0 and variance σ^2, (Brockwel and Davis, 2006):

$$\{a_t\} \sim WN(0, \sigma^2).$$

If and only if $\{a_t\}$ meets:

$$\gamma(t) = \begin{cases} \sigma^2, & t = 0, \\ 0, & t \neq 0. \end{cases} \tag{2.1}$$

(Wei, 1994) added that white noise process $\{a_t\}$ stationary with autocorrelation function:

$$\rho_k = \begin{cases} 1, & k = 0 \\ 0, & k \neq 0, \end{cases}$$

and partial autocorrelation function:

$$\phi_{kk} = \begin{cases} 1, & k = 0 \\ 0, & k \neq 0. \end{cases}$$

2.1.2. Autoregressive Model (AR)

The autoregressive model is a form of regression that links the observations of a particular moment with the values of previous observations at a specific time interval.

The generally, form of autoregressive process the data order p (AR(p)) formulate as (Wei, 1994):

$$
\begin{aligned}
&Z_t = \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \ldots + \phi_p Z_{t-p} + a_t, a_t \sim WN\left(0, \sigma^2\right), \phi_i \in \square, t \in \square \\
&Z_t = \phi_1 B Z_t + \phi_2 B^2 Z_t + \ldots + \phi_p B^p Z_t + a_t, a_t \sim WN\left(0, \sigma^2\right), \phi_i \in \square, t \in \square \\
&\left(1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p\right) Z_t = a_t, a_t \sim WN\left(0, \sigma^2\right), \phi_i \in \square, t \in \square.
\end{aligned}
\tag{2.2}
$$

The equation (2.2) can be simplified $\phi_p(B) Z_t = a_t$, with $\phi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p$.

2.1.3. Moving Average Model (MA)

The moving average process is a process that the time series value at time t is influenced by the current error element and may be weighted in the past.

The general form of the process of moving average order q is expressed by MA (q) (Wei, 1994):

$$
\begin{aligned}
&Z_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q}, a_t \sim WN\left(0, \sigma^2\right), \theta_i \in \square, t \in \square. \\
&Z_t = \sum_{i=0}^{q} \phi_i a_{t-i}, \theta_0 = 1, a_t \sim WN\left(0, \sigma^2\right), \phi_i \in \square, t \in \square.
\end{aligned}
\tag{2.3}
$$

or can simplified $z_t = \theta_q\left(B\right) a_t, a_t \sim WN\left(0, \sigma^2\right), \theta_q \in \square, t \in \square.$

with $\theta_q(B) = (1 - \theta_1 B - \theta_2 B^2 - \ldots - \theta_q B^q)$.

2.1.4. Autoregresive Integrated Moving Average or ARIMA (p,d,q)

The (Z_t) process are an autoregressive-moving average or ARMA (p, q) model if it fulfilled (Wei, 1994):

$$
\phi_p(B) Z_t = \theta_q(B) a_t, a_t \sim WN\left(0, \sigma^2\right), \phi_p, \theta_q \in \square, t \in \square. \tag{2.3}
$$

with $\phi_p(B) = (1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p)$ (for AR(p))

and $\theta_q(B) = (1 - \theta_1 B - \theta_2 B^2 - \ldots - \theta_q B^q)$ (for MA(q))

If there is a differencing then the ARIMA model becomes as follows:

$$
\phi_p(B)\left(1 - B\right)^d Z_t = \theta_q(B) a_t, a_t \sim WN\left(0, \sigma^2\right), \phi_p, \theta_q \in \square, t \in \square.
$$

with $\phi_p(B)=(1-\phi_1 B-\phi_2 B^2-...-\phi_p B^p)$ (for AR(p)), $(1-B)^d$ (for differencing non seasonal) and $\theta_q(B)=(1-\theta_1 B-\theta_2 B^2-...-\theta_q B^q$ (for MA(q)).

2.2. α-Sutte Indicator

α-Sutte Indicator was developed using the principle of the forecasting method of using the previous data (Ahmar et al., 2018). A was also developed using the adopted moving average method. The moving average method is used to predict the trend history of the data. The α-Sutte Indicator uses 4 previous data ($Z_{t-1}, Z_{t-2}, Z_{t-3}$, and Z_{t-4}) as supporting data for forecasting and making the decision (Ahmar, 2018).

The equation of the α-Sutte Indicator method are as follows (Ahmar, 2018):

$$Z_t = \frac{\gamma\left(\dfrac{\Delta x}{\frac{\gamma+\delta}{2}}\right)+\beta\left(\dfrac{\Delta y}{\frac{\beta+\gamma}{2}}\right)+\alpha\left(\dfrac{\Delta z}{\frac{\alpha+\beta}{2}}\right)}{3} \tag{2.4}$$

where:

$$\delta = Z_{t-4}$$
$$\gamma = Z_{t-3}$$
$$\beta = Z_{t-2}$$
$$\alpha = Z_{t-1}$$

$$\Delta x = \gamma - \delta = Z_{t-3} - Z_{t-4}$$
$$\Delta y = \beta - \gamma = Z_{t-2} - Z_{t-3}$$
$$\Delta z = \alpha - \beta = Z_{t-1} - Z_{t-2}$$

Z_t = data at t time

Z_{t-k} = data at $(t-k)$ time

2.3. SutteARIMA

SutteARIMA is a forecasting method that combines the α-Sutte Indicator with ARIMA. The result of SutteARIMA are the average forecast results from the α-Sutte Indicator and ARIMA.

The equation (2.3), we can describe:

$$\begin{aligned}&(1-\phi_1 B-\phi_2 B^2-\ldots-\phi_p B^p)Z_t=(1-\theta_1 B-\theta_2 B^2-\ldots-\theta_q B^q)a_t\\&Z_t-\phi_1 BZ_t-\phi_2 B^2 Z_t-\ldots-\phi_p B^p Z_t=a_t-\theta_1 Ba_t-\theta_2 B^2 a_t-\ldots-\theta_q B^q a_t\end{aligned}\tag{2.5}$$

If equation (2.5) we reduce using backward shift operator $\left(B^p Z_t=Z_{t-p}\right)$:

$$\begin{aligned}&Z_t-\phi_1 Z_{t-1}-\phi_2 Z_{t-2}-\ldots-\phi_p Z_{t-p}=a_t-\theta_1 a_{t-1}-\theta_2 a_{t-2}-\ldots-\theta_q a_{t-q}\\&Z_t=\phi_1 Z_{t-1}+\phi_2 Z_{t-2}+\ldots+\phi_p Z_{t-p}+a_t-\theta_1 a_{t-1}-\theta_2 a_{t-2}-\ldots-\theta_q a_{t-q}\end{aligned}\tag{2.6}$$

If we define:

$$\begin{aligned}&\delta=Z_{t-4}\\&\gamma=Z_{t-3}\\&\beta=Z_{t-2}\\&\alpha=Z_{t-1}\end{aligned}$$

The equation (2.6):

$$Z_t=\phi_1\alpha+\phi_2\beta+\phi_3\gamma+\phi_4\delta+\ldots+\phi_p Z_{t-p}+a_t-\theta_1 a_{t-1}-\theta_2 a_{t-2}-\ldots-\theta_q a_{t-q}\tag{2.7}$$

and the equation (2.4) we can simplify:

$$Z_t=\frac{\gamma\left(\dfrac{\dfrac{\Delta x}{\gamma+\delta}}{2}\right)+\beta\left(\dfrac{\dfrac{\Delta y}{\beta+\gamma}}{2}\right)+\alpha\left(\dfrac{\dfrac{\Delta z}{\alpha+\beta}}{2}\right)}{3}$$

$$Z_t=\frac{\dfrac{\dfrac{\gamma\Delta x}{\gamma+\delta}}{2}+\dfrac{\dfrac{\beta\Delta y}{\beta+\gamma}}{2}+\dfrac{\dfrac{\alpha\Delta z}{\alpha+\beta}}{2}}{3}$$

$$Z_t=\frac{\gamma\Delta x}{\dfrac{3\gamma+3\delta}{2}}+\frac{\beta\Delta y}{\dfrac{3\beta+3\gamma}{2}}+\frac{\alpha\Delta z}{\dfrac{3\alpha+3\beta}{2}}$$

$$Z_t = \frac{2\gamma\Delta x}{3\gamma+3\delta} + \frac{2\beta\Delta y}{3\beta+3\gamma} + \frac{2\alpha\Delta z}{3\alpha+3\beta}$$

$$Z_t = \gamma\frac{2\Delta x}{3\gamma+3\delta} + \beta\frac{2\Delta y}{3\beta+3\gamma} + \alpha\frac{2\Delta z}{3\alpha+3\beta}$$

Let, Equation (2.4) added with Equation (2.7), we finding:

$$\begin{aligned} 2Z_t &= \phi_1\alpha + \phi_2\beta + \phi_3\gamma + \phi_4\delta + \ldots + \phi_p Z_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q} + \\ &\quad \gamma\frac{2\Delta x}{3\gamma+3\delta} + \beta\frac{2\Delta y}{3\beta+3\gamma} + \alpha\frac{2\Delta z}{3\alpha+3\beta} \end{aligned}$$

$$\begin{aligned} Z_t &= \alpha\left(\frac{\phi_1}{2} + \frac{\Delta z}{3\alpha+3\beta}\right) + \beta\left(\frac{\phi_3}{2} + \frac{2\Delta y}{3\beta+3\gamma}\right) + \gamma\left(\frac{\phi_3}{2} + \frac{2\Delta x}{3\gamma+3\delta}\right) + \\ &\quad \frac{\phi_4\delta}{2} + \ldots + \frac{\phi_p Z_{t-p}}{2} + \frac{a_t}{2} - \frac{\theta_1 a_{t-1}}{2} - \frac{\theta_2 a_{t-2}}{2} - \ldots - \frac{\theta_q a_{t-q}}{2} \end{aligned} \qquad (2.8)$$

So, the equation (2.8) is the formula of SutteARIMA.

3. Methods

a. Data

Covid-19 Spanish confirmed data obtained from Worldometer and Spain Stock Market data (IBEX 35) data obtained from Yahoo Finance. Data starts from 12 February 2020 – 09 April 2020 (the date on Covid-19 was detected in Spain). The data from 12 February 2020 – 02 April 2020 using to fitting with data from 03 April – 09 April 2020. Based on the fitting data, we can doing short forecast for 3 future period.

b. Statistical Analysis

In making predictions or forecasting, there are several types of methods that can be used, including ARIMA, Holt-Winters, Double Exponential Smoothing, α-Sutte, SutteARIMA, and others. In this study, the SutteARIMA and ARIMA method will be used. Based on preliminary research of (Ahmar, 2019), the SutteARIMA can predicted the Trend data.

The ARIMA method choose because this method is used by several health researchers to monitoring and predicting the development of a disease, for example: (Anokye et al., 2018) using ARIMA to forecast malaria in Kumasi; (Liu et al., 2011) using ARIMA to forecast incidence of hemorrhagic fever with renal syndrome in China; (Zhang et al., 2014) using two decomposition methods (regression and exponential smoothing), autoregressive integrated moving average (ARIMA) and support vector machine (SVM) to forecast epidemiological surveillance data in Mainland China; (Molina et al., 2018) using ARIMA and ARIMAX to predict bovine trichomoniasis (BT) and bovine genital campylobacteriosis (BGC) prevalence and persistence in La Pampa (Argentina); (Wang et al., 2018) compare ARIMA and GM(1,1) models to predict the hepatitis B in China. For the evaluation of the forecasting methods we applied two forecasting accuracy measures, mean absolute percentage error (MAPE) (Kim and Kim, 2016).

$$\text{MAPE} = \frac{1}{N}\sum_{t=1}^{N}\left|\frac{A_t - F_t}{At}\right| \tag{2.9}$$

where:

A_t = Actual values at data time t.

F_t = Forecast values at data time t.

The results of this forecasting are obtained by using R Software with the forecast and SutteForecastR Package.

4. Results and Discussion

Short-term daily estimates are important for making strategic decisions for the future. In the case of Covid-19, daily forecasting can provide information to decision makers to find a way to prevent Covid-19 from spreading.

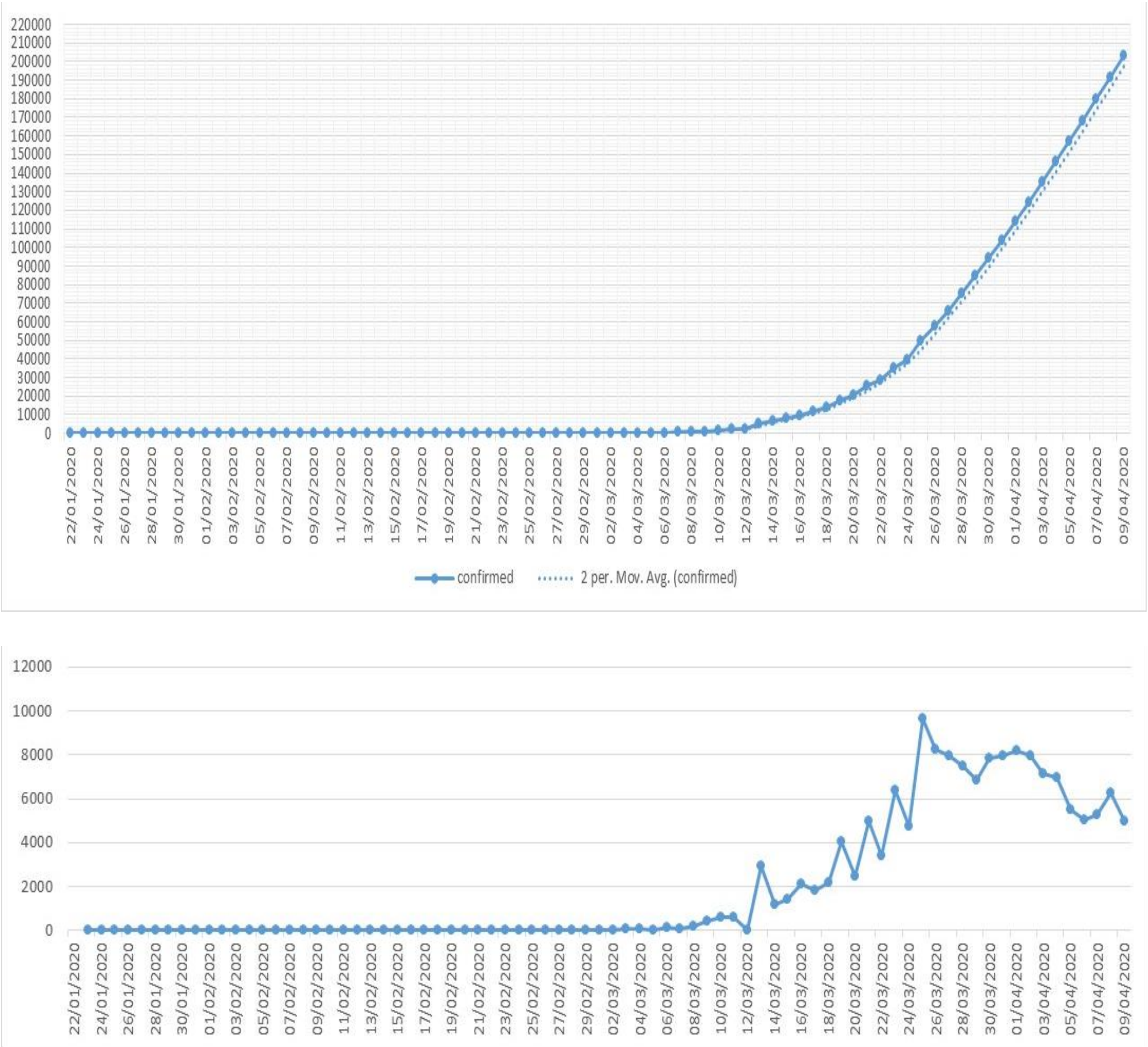

Figure 1 (a) Confirmed Cases of Covid-19 in Spain (12 February 2020 – 09 April 2020) (b) Daily New Cases of Covid-19 in Spain (12 February 2020 – 09 April 2020)

Figure 1 shows that the confirmed cases of Covid-19 in Spain will continue to grow until this curve is sloped. One of the weaknesses of time series forecasting uses previous data experience as predictive data to be data so that predictions that are suitable for the Covid-19 case are short forecasting for 3-5 future periods. Figure 1 also show the addition of confirmed cases of Covid-19 in Spain every day seems to be stabilizing in around 5000 cases.

Since Covid-19 is established as a pandemic by WHO and the existence of lockdown or social restrictions will affect the economic development of a country. One thing that is influential is the stock market because with the existence of this pandemic, investors are starting to panic buying, so selling stock has resulted in a drop in stock prices. Moreover, based on WHO data on 9 April 2020, Spain became the second highest country with a confirmed cases of Covid-19 in the world.

Figure 2 Closing Price of IBEX Stock Spain (12 February 2020 – 09 April 2020)

Figure 2 shows that the closing price of the IBEX stock market has decreased from the beginning of Covid-19 in Spain (12 February 2020) and began to stabilize on 24 March 2020 around 6900 per share.

Based on the description, the process of forecasting the data is done using the ARIMA and SutteARIMA Methods. The results are presented in table 1 for confirmed cases of Covid-19 in Spain and table 2 for IBEX Stock.

Table 1 Results of Fitting Confirmed Cases of Covid-19 in Spain

Date	**Actual**	**ARIMA(2,2,1)**	**APE**	**SutteARIMA**	**APE**
03/04/2020	119199	120424	0,0103	120425	0,0103
04/04/2020	126168	128740	0,0800	127990	0,0738
05/04/2020	131646	137307	0,1519	135531	0,1370
06/04/2020	136675	145917	0,2241	142134	0,1924
07/04/2020	141942	154699	0,2978	148668	0,2472
08/04/2020	148220	163557	0,3721	155430	0,3040
09/04/2020	153222	172545	0,4475	163200	0,3691
		MAPE	**0,2263**	**MAPE**	**0,1905**

Table 1 shows that the SutteARIMA method is most appropriate for predicting the confirmed cases of Covid-19 in Spain with MAPE value of 0.1905 (smaller than 0.04 compared to MAP E value of ARIMA). So, the SutteARIMA method will be used to predict Confirmed Cases of Covid-19 from 10 April to 12 April 2020 (table 2).

Table 2. Forecast for Confirmed Case of Covid-19 in Spain from 10 April to 12 April 2020

Date	**Forecast**	**Lower 99%**	**Higher 99%**
10/04/2020	158925	157336	160498
11/04/2020	164390	162746	166017
12/04/2020	169969	168269	171651

Table 3 Results of Fitting Data of IBEX Stock

Date	**Actual**	**ARIMA(0,1,0) with drift**	**APE**	**SutteARIMA**	**APE**

Date	Actual	ARIMA(0,1,0) with drift	APE	SutteARIMA	APE
03/04/2020	6579,4	6692,606	0,017206	6698,858	0,018156
04/04/2020	6574,1	6599,812	0,003102	6557,42	0,003341
05/04/2020	6581,6	6507,018	0,011001	6526,984	0,007967
06/04/2020	6844,3	6414,223	0,025105	6464,475	0,017467
07/04/2020	7002,0	6321,429	0,039209	6627,872	0,007367
08/04/2020	6951,8	6228,635	0,053313	6687,791	0,016474
09/04/2020	7070,6	6135,841	0,067416	6606,707	0,00415
		MAPE	**0,030908**	**MAPE**	**0,010703**

Based on Table 3, As the SutteARIMA method is the most appropriate method for this time series, we use it to forecast the IBEX Stock from 10 April 2020 to 12 April 2020 (table 4).

Table 4: Forecast for Closing Price of IBEX from 10 April to 12 April 2020

Date	Forecast	Lower 99%	Higher 99%
14/04/2020	7000,61	6930,60	7069,91
15/04/2020	6930,61	6861,30	6999,22
16/04/2020	6860,62	6792,01	6928,54

Based on forecasting results, we can conclude that: SutteARIMA method is the most suitable forecasting method to forecast confirmed cases of Covid-19 in Spain and Closing Price of IBEX. This can be verified by the value of forecasting accuracy measures (MAPE), the best SutteARIMA method for all data.

5. Conclusion and Further Research

Forecasting of Covid-19 and IBEX Stock in Spain can give an idea of the policy maker to make decision for future. In fitting data Covid-19 and IBEX Stock in Spain from 03 April 2020 to 09 April 2020, the SutteARIMA method is more suitable than ARIMA method. The confimed cases of Covid-19 of Spain on 12 April 2020 that is 169969 with interval value 168269-171651 cases and the closing price of IBEX Stock on 16 April 2020 that is 6860,62 with interval value 6792,01 – 6928,54. Based on the forecast, the policy maker can using to make a policy for future. For further research, this method can comparison with other methods, for example with Neural Network.

References

Ahmar, A.S., 2019. Reliability Test of SutteARIMA to Forecasting Artificial Data. https://doi.org/10.31219/osf.io/9zn7v

Ahmar, A.S., 2018. A Comparison of α-Sutte Indicator and ARIMA Methods in Renewable Energy Forecasting in Indonesia. Int. J. Eng. Technol. 7, 20–22.

Ahmar, A.S., Rahman, A., Mulbar, U., 2018. α- Sutte Indicator: a new method for time series forecasting. J. Phys. Conf. Ser. 1040, 012018.

Anokye, R., Acheampong, E., Owusu, I., Isaac Obeng, E., 2018. Time series analysis of malaria in Kumasi: Using ARIMA models to forecast future incidence. Cogent Soc. Sci. 4. https://doi.org/10.1080/23311886.2018.1461544

Benvenuto, D., Giovanetti, M., Vassallo, L., Angeletti, S., Ciccozzi, M., 2020. Application of the ARIMA model on the COVID-2019 epidemic dataset. Data Br. 29, 105340. https://doi.org/10.1016/j.dib.2020.105340

Brockwel, P.J., Davis, R.A., 2006. Time series : Theory and Methods, 2nd ed. Springer-

Verlag, New York, NY.
Brockwell, P.J., Davis, R.A., 2016. Introduction to time series and forecasting, 2nd ed. Springer, New York.
Fanelli, D., Piazza, F., 2020. Analysis and forecast of COVID-19 spreading in China, Italy and France. Chaos, Solitons & Fractals 134, 109761. https://doi.org/10.1016/j.chaos.2020.109761
France24, 2020. Spain announces lockdown after reporting 1,500 new coronavirus cases in a day [WWW Document]. URL https://www.france24.com/en/20200314-spain-to-announce-lockdown-after-reporting-1-500-new-coronavirus-cases-in-a-day (accessed 4.9.20).
IMF, 2018. World Economic Outlook (WEO) World Economic Outlook, April 2018 Cyclical Upswing, Structural Change. IMF.
Kim, S., Kim, H., 2016. A new metric of absolute percentage error for intermittent demand forecasts. Int. J. Forecast. 32, 669–679. https://doi.org/10.1016/j.ijforecast.2015.12.003
Koczkodaj, W.W., Mansournia, M.A., Pedrycz, W., Wolny-Dominiak, A., Zabrodskii, P.F., Strzaška, D., Armstrong, T., Zolfaghari, A.H., Debski, M., Mazurek, J., 2020. 1,000,000 cases of COVID-19 outside of China: The date predicted by a simple heuristic. Glob. Epidemiol. 100023. https://doi.org/10.1016/j.gloepi.2020.100023
Liu, Q., Liu, X., Jiang, B., Yang, W., 2011. Forecasting incidence of hemorrhagic fever with renal syndrome in China using ARIMA model. BMC Infect. Dis. 11, 218. https://doi.org/10.1186/1471-2334-11-218
McMurtry, A., 2020. COVID-19: Spain unveils lifeline amid stock market bust [WWW Document]. URL https://www.aa.com.tr/en/latest-on-coronavirus-outbreak/covid-19-spain-unveils-lifeline-amid-stock-market-bust/1764097 (accessed 4.9.20).
Molina, L.L., Angón, E., García, A., Moralejo, R.H., Caballero-Villalobos, J., Perea, J., 2018.

Time series analysis of bovine venereal diseases in La Pampa, Argentina. PLoS One 13, e0201739. https://doi.org/10.1371/journal.pone.0201739

Montgomery, D.C., Jennings, C.L., Kulahci, M., 2015. Introduction to time series analysis and forecasting. John Wiley & Sons, New Jersey.

Roosa, K., Lee, Y., Luo, R., Kirpich, A., Rothenberg, R., Hyman, J.M., Yan, P., Chowell, G., 2020. Real-time forecasts of the COVID-19 epidemic in China from February 5th to February 24th, 2020. Infect. Dis. Model. 5, 256–263. https://doi.org/10.1016/j.idm.2020.02.002

Wang, Y., Shen, Z., Jiang, Y., 2018. Comparison of ARIMA and GM(1,1) models for prediction of hepatitis B in China. PLoS One 13, e0201987. https://doi.org/10.1371/journal.pone.0201987

Wei, W.W.S., 1994. Time Series Analysis: Univariate and Multivariate Methods. Addison-Wesley Publishing Company, New York.

WHO, 2020. Situation report - 77 Coronavirus disease 2019 (COVID-19 [WWW Document]. URL https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/ (accessed 4.7.20).

Worldometer, 2020. Spain Coronavirus [WWW Document]. URL https://www.worldometers.info/coronavirus/country/spain/ (accessed 4.8.20).

Yang, Y., Peng, F., Wang, R., Guan, K., Jiang, T., Xu, G., Sun, J., Chang, C., 2020. The deadly coronaviruses: The 2003 SARS pandemic and the 2020 novel coronavirus epidemic in China. J. Autoimmun. 102434. https://doi.org/10.1016/j.jaut.2020.102434

Zhang, X., Zhang, T., Young, A.A., Li, X., 2014. Applications and Comparisons of Four Time Series Models in Epidemiological Surveillance Data. PLoS One 9, e88075. https://doi.org/10.1371/journal.pone.0088075