ISSN No:-2456-2165

Forecasting for Exports and Imports in Indonesia

Eka Novia Rahmaningrum, Nonong Wahyuni, Nour Fitri, Riska Wulandari, Saniyah, Arisman Adnan
[1]Department of Mathematics, Faculty of Mathematics and Natural Science,
University of Riau, Pekanbaru,
Indonesia

Rado Yendra
Department of Mathematics, Faculty of Science and Technology,
UIN Sultan Syarif Kasim Riau, Pekanbaru,
Indonesia

Abstract:- This article discusses export and import forecasting in Indonesia by using the Classical Additive, Classical Multiplicative, Holt-Winter Additive, and Holt-Winter Multiplicative methods. The data used was data on exports and imports in Indonesia in 2014-2020.Export and import data were monthly time-series data. In this research, first, determined the time-series model and the error of each method. The error could be seen as the best method to proceed to forecast. So, the results of this research were forecasting by using the Holt-Winter Additive method for exports and forecasting by using the Holt-Winter Multiplicative method for imports.

Keywords:- *Export, Import, Classical Additive method, Classical Multiplicative, Holt-Additive ,and Holt-Winter Multiplicative.*

I. INTRODUCTION

Indonesia is a developing country with a population of 273.5 million people. Indonesia has abundant natural resources to fulfill the daily needs of the people. These needs are clothing, food ,and shelter. But not all of these needs can be met by the Indonesian state itself, so they must be met by foreign countries. The Indonesian government's policy to meet the needs of its people is to carry out export and import activities.

Export is the activity of selling goods or services to other countries. In Indonesia, exports are divided into two types, namely oil and gas exports and non-oil ,and gas exports. Oil and gas commodities are oil and gas. Non-oil and gas commodities are in the form of agricultural, plantation, forestry, animal husbandry, handicrafts, industrial goods and mineral products from mining products. Export commodities in Indonesia are rubber, palm oil, natural gas, coal, forest products, to grammen and textile producers. Export activities have a positive impact on Indonesia, namely increasing the country's foreign exchange.

Import is an activity to buy goods or services from other countries. In general, the goods purchased are goods that are still minimally produced, or in Indonesia itself, the goods are sold at a higher price. The types of goods imported by Indonesia are consumer goods or finished goods, capital goods, raw materials and additional materials. Import activities have both positive and negative impacts for Indonesia. One of the positive impacts is reducing inflation by getting goods at lower prices. Meanwhile, the negative impact is that it can reduce the country's foreign exchange reserves so that the country's trade balance experiences a deficit. Until now, no country can be independent in meeting the daily needs of its people, so that export and import activities will continue. Each year, export and import activities are budgeted by the Indonesian government. Therefore, there is a need for forecasting exports and imports in Indonesia.

Research on obtaining export forecast values has been carried out in Serbia, where the model that has the smallest error value is the Hol-Winter Multiplicative model with $\alpha = 0{,}7$, $\beta = 0{,}5$and $\gamma = 0{,}2$[1].The same modeling is also applied to imported data in India with the best model being the VAR model [2].In addition, there is a forecasting study using the Holt-Winter method for bank inflows and outflows in Indonesia conducted by [3].In this study, it was found that the model that has the smallest error for bank inflows in Indonesia is the Holt-Winter Additive model and for bank inflows in Indonesia is the Holt-Winter Multiplicative model.So, in this article the author is interested in discussing export and import forecasting in Indonesia using the Classical and Holt-Winter methods.

II. RESEARCH METODOLOGY

A. Classical Method

Classical method is an analytical approach and time series to identify the component factors that affect each data value. Each component is identified separately. The projections of each componentthen can be combined to produce forecasts of future values from time series data [4]. The classical method used is the Additive Classical method, which is the method used to identify future forecasts and add up the projected forecasting results. The equation of this model is as following:

$$y(t) = T + C + S + R$$

where is data in time series, T is trend component, C is cycle component, S is seasonal component and R is residual.Then the Classical Multiplicative method is a method used to identify future forecasts and multiply the projected forecasting results.The equation of this model is:

$$y(t) = T \times C \times S \times R$$

where is data in time series, T is trend component, C is cycle component, S is seasonal component and R is residual.

B. Holt-Winter method

The Holt-Winter method is a development of the simple exponential smoothing method that uses three smoothing constants, namely the constant for smoothing the whole level, trend smoothing, and seasonal smoothing.The Holt-Winter method uses two approaches, namely the Multiplicative Holt-Winter Method and the Additive Holt-Winter Method [5].

The equations of the two models can be seen in the following table:

	Holt- Winter Multiplicative	**Holt- Winter Additive**
Level	$\bar{L}_t = \alpha \frac{Y_t}{\hat{S}_{t-s}} + (1-\alpha)\left(\bar{L}t-1+\hat{B}t-1\right)$	$\bar{L}_t = \alpha\left(Y_t - \hat{S}_{t-s}\right) + (1-\alpha)\left(\bar{L}_t-1+\hat{B}_t-1\right)$
Trend	$\hat{B}_t = \beta\left(\bar{L}_t - \bar{L}_{t-1}\right) + (1-\beta)\hat{B}_{t-1}$	$\hat{B}_t = \beta\left(\bar{L}_t - \bar{L}_{t-1}\right) + (1-\beta)\hat{B}_{t-1}$
Seasonal	$\hat{S}_t = \gamma\left(\frac{Y_t}{L_t}\right) + (1-\gamma)\hat{S}_{t-s}$	$\hat{S}_t = \gamma(Y_t - L_t) + (1-\gamma)\hat{S}_{t-s}$
Forecast	$F_{t+m} = \left(\bar{L}_t + \hat{B}_t\, m\right)\hat{S}_{t-s+m}$	$F_{t+m} = \left(\bar{L}_t + \hat{B}_t\, m\right)\hat{S}_{t-s+m}$

Tabel 1: Multiplicative Holt-Winter and Additive Holt-Winter Method Equations

In table 1, $\bar{L}_t$ is the level, $\hat{B}_t$ is the trend component, $\hat{S}_t$ is the seasonal component, F_{t+m} is the forecast for period m, Y_t is the observed value and α, β and γ is the exponential parameter of level, trend and seasonal, respectively. Furthermore, the value of the parameter α, β and γ determined through a linear program with the aim of minimizing MAE (Mean Absolute Error), this can be done using R software.

After several forecasting models are obtained, then a comparison is made to choose a better model. The comparison is done by looking at the results of the measurement of the model's error rate. The measurement of model error in this study uses MAE, which is expected to be very small and can represent the data. The MAE value is obtained from the following equation:

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|e_i|$$

where $e_i = Y_i - F_i$.

III. RESULTS AND DISCUSSION

In this journal, the data used was Indonesian Export and Import data per month in 2014-2020 [6].Based on this data, the Indonesia's exports graph for the last 7 years is as following:

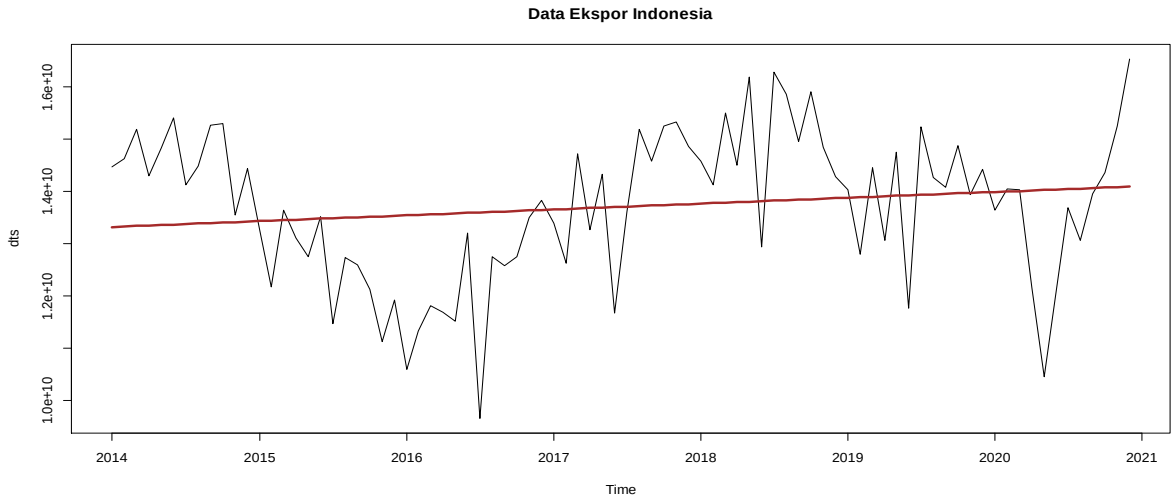

Fig. 1: Indonesian Export Data

ISSN No:-2456-2165

Based on Figure 1, it can be seen that exports from Indonesia from January 2014 to December 2020 fluctuated with the lowest export value of USD 9,649.503,975.97 in July 2016 and the highest export value of USD 16,539.555,059.63 in December 2020. It is also seen that the dataexports from Indonesia have a trend, namely an upward trend.The following is a graph of imports to Indonesia for the last 7 years.

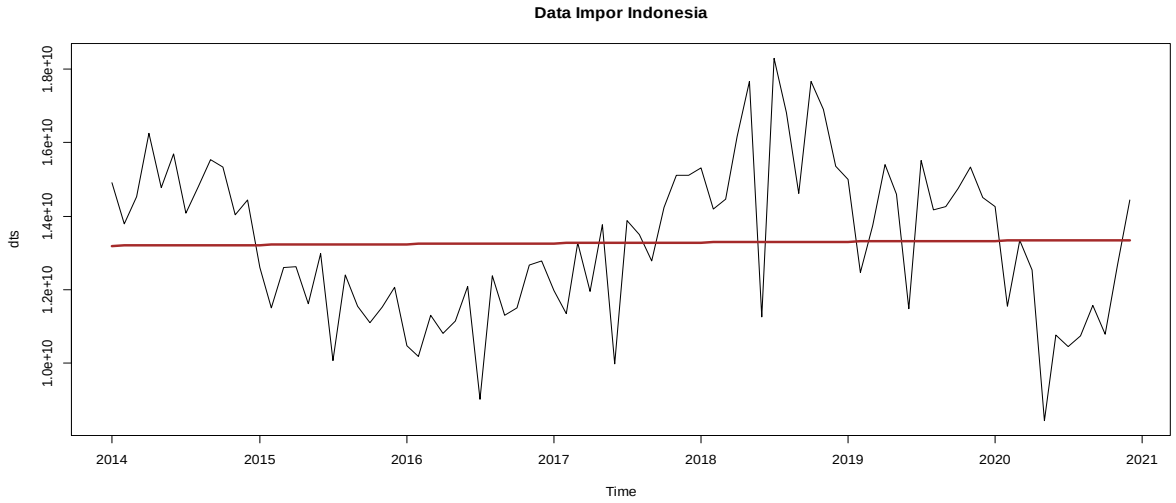

Fig. 2: Indonesian Import Data

Based on Figure 2, it can be seen that imports to Indonesia from January 2014 to December 2020 fluctuated with the lowest import value of USD 8,438,627,383.00 in May 2020 and the highest import value of USD 17,662,888,974.00 in May 2018.The above also shows that import data to Indonesia has a trend, namely an upward trend.Because the export and import data have an upward trend, the data can be estimated using the classical method and the Holt-Winter method.The following is a graph of the estimated data for Indonesia's exports and imports.

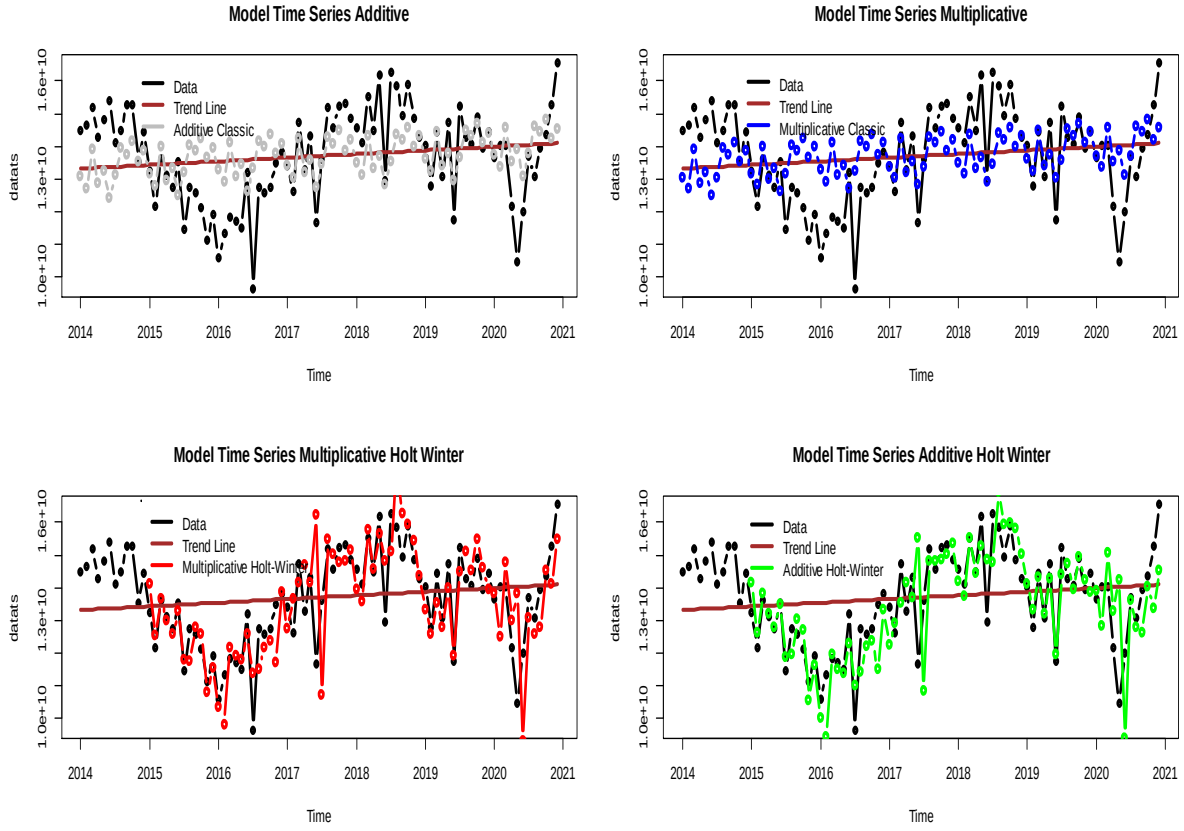

Fig. 3: Time Series Data Export Model

ISSN No:-2456-2165

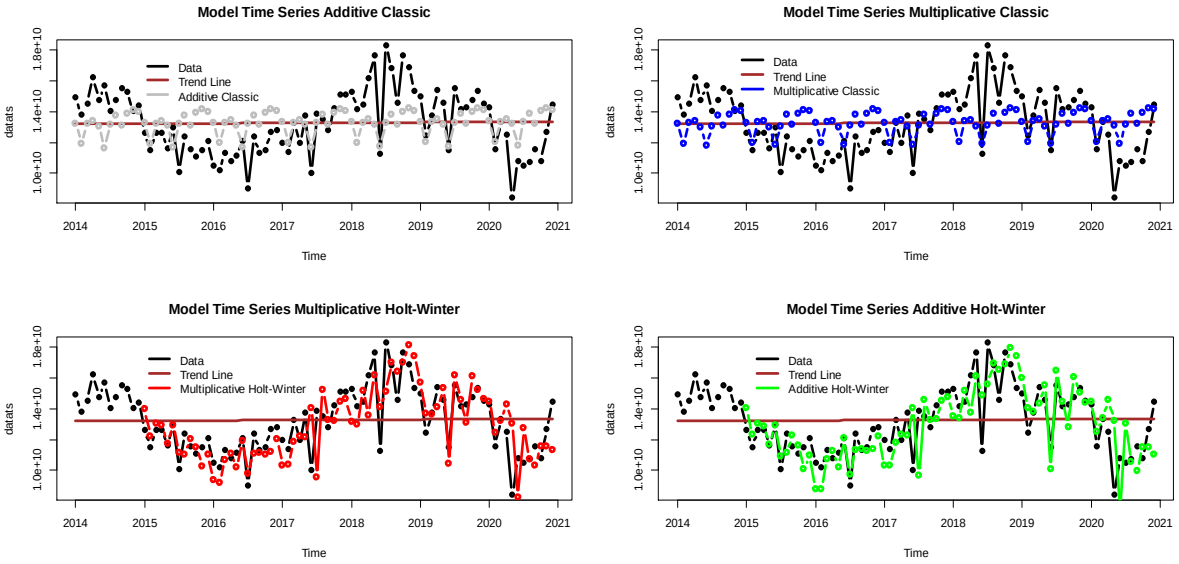

Fig. 4: Time Series Model of Imported Data

From Figure 3 and Figure 4 it can be seen that the comparison of the estimated value with the actual data uses the classical method and the Holt-Winter method, where theestimated value that is close to the actual data for exports and imports is the Holt-Winter method. Furthermore, to find out a better method, the smallest error check is carried out with the MAE formula. So that the following results are obtained:

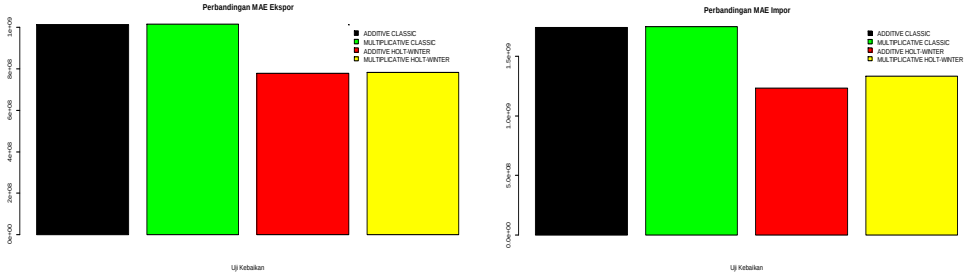

Fig. 5: MAE Export and Import

Based on Figure 5, it can be seen that the smallest error for export data is in the additive Holt-Winter method and for import data is the multiplicative Holt-Winter method .So, the appropriate forecasting method for Indonesia's export and import data for the next three years is the additive Holt-Winter method for exports and the multiplicative Holt-Winter method for imports.Here are the results of the forecasting of both.

Year / Month	2021		2022		2023	
	Exports	**Imports**	**Exports**	**Imports**	**Exports**	**Imports**
January	14941289145	15790264542	16494501645	22023016870	18047714145	28255769199
February	14928858911	16123179328	16482071411	22284667672	18035283911	28446156017
March	15492722221	16879326949	17045934721	23130697236	18599147221	29382067522
April	14287764380	15528652147	15840976880	21107607512	17394189380	26686562876
May	14507148150	15533264760	16060360650	20951655860	17613573150	26370046960
June	15193426407	17240312854	16746638907	23084287955	18299851407	28928263056
July	17077544695	20029022710	18630757195	26631778846	20183969695	33234534982
August	16552431639	19391525163	18105644139	25613204617	19658856639	31834884072
September	17050883221	20423425920	18604095721	26805546429	20157308221	33187666937
October	17472109330	21337697728	19025321830	27836290341	20578534330	34334882955
November	17653077297	22138701340	19206289797	28714357269	20759402297	35290013198
December	18092767560	23290117427	19645980059	30040679795	21199192559	36791242162

Tabel 2*:* Forecasting Indonesian Exports and Imports in USD

The graphs of forecasting exports and imports in Indonesia are shown in Figure 6 and Figure 7 below.

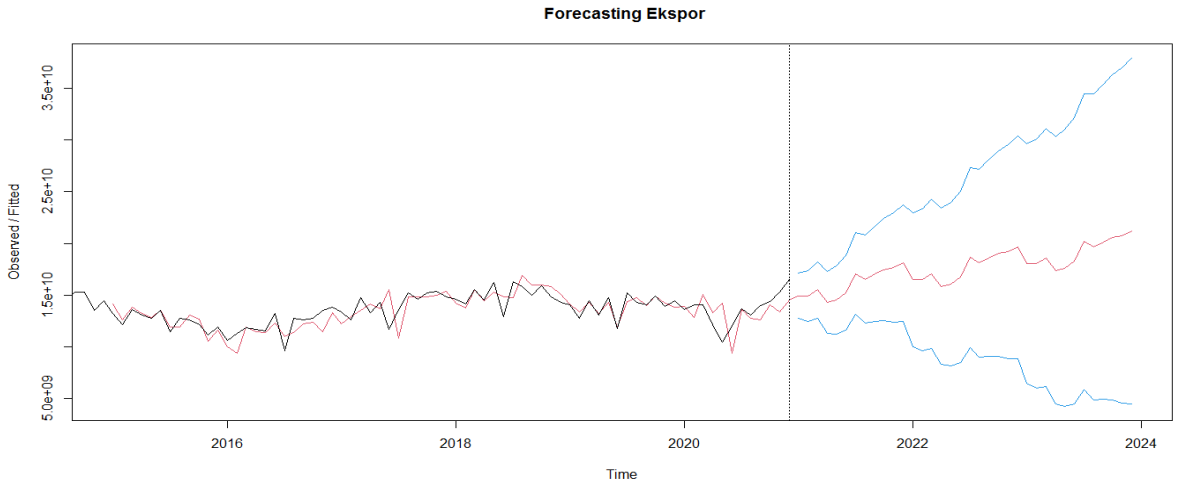

Fig. 6: Export Forecasting

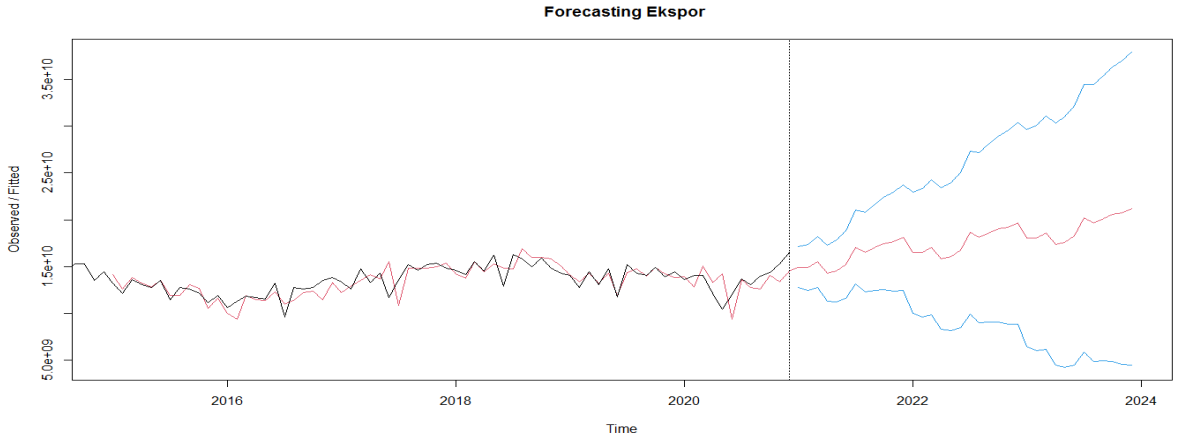

Fig. 7: Import Forecasting

IV. CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that forecasting export data by using the classical method (additive and multiplicative) and the Holt-Winter method (additive and multiplicative). The best estimate value is using the additive Holt-Winter method, this is due to constant seasonal variations. Then after forecasting, the number of errors obtained is 779234124. While forecasting imported data in Indonesia uses the classical method (additive and multiplicative) and the Holt-Winter method (additive and multiplicative). The best estimate value is using the multiplicative Holt-Winter method, this is due to seasonal variations which are not constant. Then after forecasting, the number of errors obtained is 1168016653.

REFERENCES

[1.] J. Mladenovic, V. Lepojevic dan V. Jankovic-Milic, "MODELLING AND PROGNOSIS OF THE EXPORT OF HOLT-WINTERS AND ARIMA METHOD," *EKONOMSKE TEME*, vol. 54, pp. 233-260, 2016.

[2.] T. Khan, "Identifying an Appropriate Forecasting Model for Forecasting Total Import of Bangladesh," *International Journal of Trade, Economics and Finance*, vol. 12, no. 1, pp. 242-246, 2011.

[3.] Rahman, D. A. S. Al-adawiyyah, S. V. Rivika, Muliana, A. Adnan and R. Yendra, "Holt-Winter Forecasting Method for Inflow and Outflow of Bank Indonesia in Riau," *International Journal of Economics and Management Studies*, vol. 8, no. 7, pp. 71-76, 2021.

[4.] J. Hanke and D. Wichern, Bussines Forecasting Ninth Edition, New Jersey: Pearson Education, 2009.

[5.] R. Hyndman and G. Athanasopoulos, "Forecasting: principles and practice," OTexts.com/fpp2, Melbourne, Australia, 2018.

[6.] Badan Pusat Statistik, "Badan Pusat Statistik," BPS-Statistics Indonesia, 2021. [Online]. Available: https://www.bps.go.id/exim/. [Accessed 9 Desember 2021].