

PREDICTION OF TIN EXPORTS, POPULATION, POVERTY, AND LABOR FORCE IN THE PROVINCE OF BANGKA BELITUNG ISLANDS

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ABSTRACT

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The COVID-19 virus has also caused shocks to the Bangka Belitung Islands Province in various sectors, especially the economy. To overcome this problem, the government has prepared responsive fiscal and monetary policies to prevent post-COVID-19 risks, especially during the economic recession. To prevent a post-COVID-19 economic recession, a prediction or time series forecast is needed on four variables that influence the economic recession: the number of tin exports, population, poverty, and labor force in the Bangka Belitung Islands Province so that economic growth is maintained. This research aims to predict the four research variables by comparing the Moving Average and Exponential Smoothing methods. This research also uses Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE) as indicators of model accuracy. Based on the results of the accuracy indicators of this model, it was found that the Exponential Smoothing method was better than the Moving Average method. The predicted results for the value of tin exports in 2024 are -3.3645811, with the RMSE value at 42293770, MAE at 29558091, and MAPE at 84.46131. The negative value in the tin export prediction means that the decline in tin exports in 2024 will not have a significant effect because it is still within a reasonable figure. The total labor force in 2024 will be 11057.23, with an RMSE value of 16536.48, an MAE value of 14194.02, and a MAPE of 112.8078. Then, the predicted result for the population is 21241.92 with RMSE of 19537.82, MAE of 11548.41, and MAPE of 37.51894. Then, for the predicted results, the number of poverty is 70.22749 with RMSE, MAE, and MAPE, respectively, of 3992.146, 3205.528, and 139.1129. The alpha value (α) used is 0.0183.



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1. INTRODUCTION

Indonesia has experienced a reasonably large recession in economic history, namely in 1998, which made the Indonesian economy challenging to control. A recession is a condition where real economic growth grows negatively. In other words, there has been a decline in gross domestic product (GDP) for two consecutive quarters in the current year [1]. This can trigger a recession because the GDP variable is an indicator of economic performance [2].

Economic recession, increased unemployment, and decreased income are some aspects that trigger an economic slowdown. In the long term, unemployment and decreasing income will significantly decrease welfare [3]. The significant impact of a prolonged economic recession will result in a decline in health, which reflects a society that faces extreme difficulties in the distribution of welfare [4].

The potential economic recession that occurred in the COVID-19 era started with a health crisis requiring every country to adopt more responsive policies such as regional quarantine and so on. The COVID-19 virus has caused shock worldwide and in various sectors, especially the economy, including the Bangka Belitung Islands Province. Each country has to prepare specific policies, both fiscal and monetary. Of course, each country has different policies that will be adopted [5].

As is known, one of the abundant natural resources that Indonesia has and has the potential to boost the country's economy is tin. As a tin-producing area, the Bangka Belitung Islands Province also contributes to Indonesia's tin commodity export activities. It is also strengthened by the Triple Hit Combo phenomenon, namely the global recession, national recession, and the ban on tin export activities, considering that the Bangka Belitung Islands Province is the largest tin producer in Indonesia. Of course, this will be a major concern for decision-makers when assessing how this impacts the economy in this largest tin-producing province.

Based on the background description above, this quantitative research using time series data will look at the results of predictions or projections between the variables of the number of poor people, total population, labor force, and number of exports of tin commodities in the Bangka Belitung Islands Province. The prediction methods that will be used in this research are the Moving Average and Exponential Smoothing methods. This method is used because the Moving Average method has the advantage of a straightforward calculation process. In contrast, the Exponential Smoothing method is based on the weighting based on the α (alpha) value, which can be determined freely between 0 – 1 [6]. The results of this research can also be part of preventive measures in overcoming economic problems after the COVID-19 pandemic that hit Indonesia, especially in the Bangka Belitung Islands Province in terms of population, number of poor people, number of workforce and number of exports of tin commodities. Become the cause of the economic recession.

This research aligns with the results of Natasya and Putu Mahardika's 2023 [7] research entitled "Analysis of the Effect of Inflation, Exports and Unemployment on Economic Growth." The results of this research state that exports positively and significantly influenced economic growth in 5 ASEAN countries, one of which is Indonesia, from 1991-2020. Economic power is oriented towards export activities, which are used as the most important source for the country to obtain foreign exchange in international trade. Apart from that, there is also another research conducted by Cut Nova Rianda in 2023 [8] entitled "Analysis of the Impact of the Economic Recession on Society," with the results of the research stating that the recession hurts society, which results in a gap between poor and rich, the number of unemployment increases, government spending the bigger and more companies lay off their employees. Based on this, the stability of the export value and the reduction in unemployment greatly influence economic growth. Another research by Sudibyo, Iswardani, Septyanto, and Wicaksono in 2020 [9] used moving average, Single-exponential smoothing, and double-exponential smoothing to forecast inflation in Indonesia between January 2015 and May 2020. It was found that Single Exponential Smoothing provided the best forecasting results based on its accuracy criteria. MAPE, MAD, and MSD indicate higher accuracy in the data context compared to other methods.

The goals and objectives of the RPJMD for the Bangka Belitung Islands Province are to increase economic growth and government and community income by reducing unemployment and poverty rates and controlling the rate of population growth and production in the mining sector. We hope that the results of this research can provide an overview for policymakers regarding future predictions, especially the issue of population, number of poor people, number of the labor force, and number of exports of tin commodities in the Bangka Belitung Islands Province after the Covid-19 pandemic so that preventive policies can be adopted. To prevent undesirable things so that economic growth will be maintained.

2. RESEARCH METHODS

2.1 Data Collection and Presentation

This research uses quantitative research using time series data. This research uses secondary data from the official website of the Central Statistics Agency (BPS) of Bangka Belitung Islands Province, precisely from the website <https://babel.bps.go.id/> [10]. The data used a time series data analysis technique, which is data that is arranged based on time sequence and collected over time, which can be in the form of weeks, months, and years [11]. The time series data used in this research is data on the export value of tin commodities, the labor force, the number of residents, and the number of poor people in the Bangka Belitung Islands Province from 2010 to 2023.

Table 1. Research data from 2010 to 2023

No	Year	Tin Export Value (Thousand US\$)	Number Of Workforce	Total Population	Number Of Poverty
1.	2010	126382776.17	628095	1230227	67750
2.	2011	181968164.17	611698	1258234	65550
⋮	⋮	⋮	⋮	⋮	⋮
13.	2022	133386646.64	778185	1494621	66780
14.	2023	140850278.03	795488	1506533	68690

Data Source: BPS Bangka Belitung Islands Province website

2.2 Moving Average Method

Forecasting in this research uses the Moving Average forecasting method, namely a moving average, carried out by taking a group of observation values and looking for the average value as a prediction for the coming period [12]. The Moving Average method has special characteristics, namely:

- To determine forecasts for future periods requires historical data over a certain period. For example, forecasting with a 3-month Moving Average, the 5th month forecast will only be made after the 4th month is complete or ends.
- The longer the Moving Average period, the more visible the smoothing effect is in the forecast or produces a smoother Moving Average. In general, the Moving Average method can be formulated as follows:

$$S_{t+1} = \frac{X_t + X_{t-1} + \dots + X_{t-n+1}}{n} \quad (1)$$

Information:

- S_{t+1} : Forecast for period $t + 1$
 X_t : Data for period t
 n : Moving average timeframe

2.3 Exponential Smoothing Method

This research also uses the exponential smoothing forecasting method, which is a forecasting method for moving average time series data analysis. It is carried out by weighting exponentially decreasing values in new data [13]. In this case, we gave the greater weight to the latest data. The characteristics of this method include that the data used is given a weight symbolized by the smoothing constant alpha (α), which ranges from 0 to 1 and is determined freely by trial and error [14]. This method can assume that the data fluctuates around a fixed mean value, without any trend, without following a pattern or trend [15].

In general, the Exponential Smoothing method can be formulated as follows [16]:

$$S_t = \alpha X_t + (1 - \alpha)S_{t-1} \quad (2)$$

Information:

- S : Forecasting the t -th period
 α : Smoothing parameter with constant $0 \leq \alpha \leq 1$

S_{t-1} : Forecasting in previous periods
 X_t : Actual data in the t-th period

2.4 Model Accuracy Indicator

In the forecasting process, the forecasting results obtained by each method are generally different because they contain an element of degree of uncertainty [17]. The accuracy of a method shows how far the forecasting model can project actual known data. The standard statistical measure uses an error factor obtained from the difference between the actual data and the forecast results for the t period or can be expressed as $E_t = X_t - S_t$, for $t = 1, 2, \dots, n$. [18]. A smaller error value indicates that the method is suitable to use. To measure the error of a model in this research, what is used is to measure the Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE) values. To calculate the value of the Root Mean Square Error (RMSE), use the equation:

$$RMSE = \sqrt{\frac{\sum (X_t - S_t)^2}{n}} \quad (3)$$

Information:

X_t : Actual data in the t-th period
 S_t : Forecasting value
 n : Lots of observations

To calculate the value of Mean Absolute Error (MAE) use the equation:

$$MAE = \frac{\sum |X_t - S_t|}{n} \quad (4)$$

Information:

X_t : Actual data in the t-th period
 S_t : Forecasting value
 n : Lots of observations

To calculate the value of Mean Absolute Percentage Error (MAPE) use the equation:

$$MAPE = \frac{1}{n} \sum_{i=1}^n \frac{|X_t - S_t|}{X_t} \quad (5)$$

Information:

X_t : Actual data in the t-th period
 S_t : Forecasting value
 n : Lots of observations

2.5 Research Flow

Researchers use Rstudio and Microsoft Excel software to support the data analysis process. In general, the flow in this study is as follows:

1. Begin.
In this case, the researcher begins to prepare the research concept and everything needed in the research process
2. Data Collection.
In this process, the researcher collected secondary data on the export value of tin commodities, labor force, residents, and poor people in the Bangka Belitung Islands Province from 2010 to 2023. This data is used to make predictions for the next period.
3. Data Analysis Process.
This process uses two prediction methods: the Moving Average Method and the Exponential Smoothing Method in the Moving Average Method using the 3-period Moving Average and the 5-period Moving Average. As for Exponential Smoothing, the data must be stationary, so it is necessary to carry out a stationary data process.

4. Calculation Accuracy with RMSE, MAE, and MAPE.

This accuracy calculation process determines the best methods for moving average and exponential smoothing. However, for accuracy calculations, we also use the Moving Average method to choose the best method for comparing the 3-period Moving Average and the 5-period Moving Average. After that, the accuracy of the best Moving Average method and the Exponential Smoothing method is calculated to produce the best method.

5. Prediction Results and Accuracy.

This process explains the prediction results and accuracy of the best method obtained.

6. Finish.

3. RESULTS AND DISCUSSION

Based on **Table 1**, a time series plot of actual data will be created to see the data patterns used to identify data stationarity.

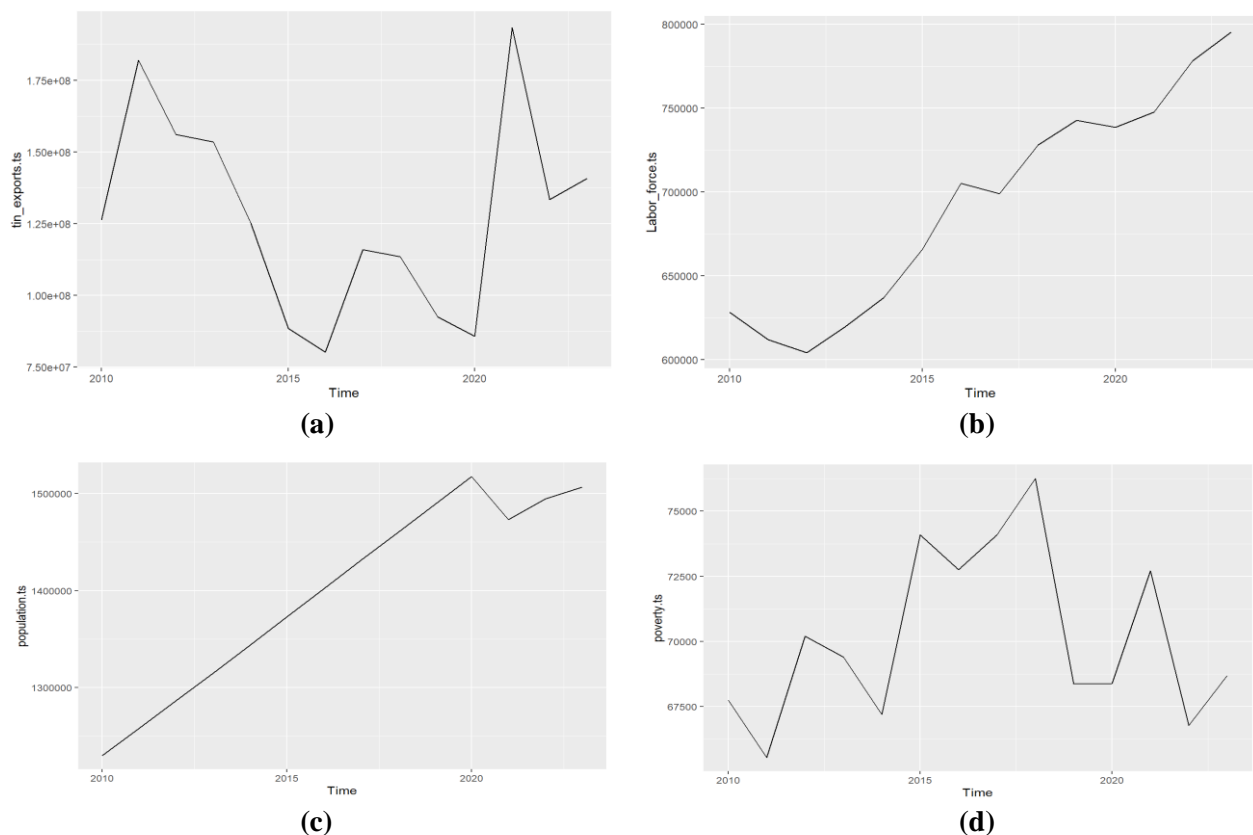


Figure 1. The plot of Research Data From 2010 to 2023, (a) Tin export value, (b) Number of the labor force, (c) Total population, (d) Number of the poverty

Figure 1 shows that the data plot for all research variables is not stationary. Meanwhile, stationary data is required to make predictions using the exponential smoothing method. Therefore, steps are needed to make the data stationary with the help of Rstudio.

3.1 Period and 5 Period Moving Average Predictions

In predicting using the moving average method, this research uses 3 years and 5 years because the data used is annual data. The moving average method with 3 years is carried out by adding the actual data values for the three previous periods and then dividing by three. Meanwhile, for 5 years, this is done by adding up the actual data values for the last five periods and then dividing by five [19]. Then, after obtaining the prediction data, we will see which method has the smallest error rate using the RMSE, MAE, and MAPE indicators. Using the help of RStudio, each method's prediction values and accuracy levels were obtained.

Table 2. RMSE, MAE, and MAPE Values

Method	Variable	RMSE	MAE	MAPE
Moving Average 3 periods	Tin Export Value (US\$)	16987485	15099976	12.06828
	Number of Labor Force	9633.402	8555.199	1.260913
	Total Population	7977.417	4215.577	0.2982263
	Number of Poverty	1182.425	977.7275	1.368703
Moving Average 5 periods	Tin Export Value (US\$)	13276416	10644394	8.612989
	Number of Labor Force	4714.979	4190.994	0.6077554
	Total Population	5260.285	2949.442	0.2081654
	Number of Poverty	1422.257	1209.78	1.725585

Based on **Table 2**, the method with the lowest error rate is the 5-year moving average method, which is used as the best method for forecasting moving averages in this research.

Table 3 . 5 Year Moving Average Prediction

Metode	Year	Tin Export Value	Number of Labor Force	Total population	Number of Poverty
Moving Average 5 periods	2024	129177802	7822772.9	1505473	6899015
	2025	129177802	798748.3	1514805	6899015
	2026	129177802	815223.7	1524137	6899015

Based on **Table 3**, predictions for the labor force and population will increase over the next 3 years. Meanwhile, the predicted value of tin exports and the number of people living in poverty have a cash prediction value for the next 3 years.

In determining the smoothing value for Exponential Smoothing, a smoothing parameter is used, namely the alpha parameter (α) [20]. The value of this smoothing constant can be determined freely to reduce the error value. In predictions using the Exponential Smoothing method, this research uses the alpha value (α) obtained automatically via Rstudio.

Table 4. Alpha Constant Value (α)

Variable	Alpha (α)	RMSE	MAE	MAPE
Tin Export Value	0.0183	42293770	29558091	84.46131
Number of Labor Force	0.0183	16536.48	14194.02	112.8078
Total Population	0.0183	19537.82	11548.41	37.51894
Number of Poverty	0.0183	3992.146	3205.528	139.1129

Based on **Table 4**, each variable's alpha constant value (α) for each variable is the same, 0.0183, which is used in making predictions. The RMSE, MAE, and MAPE values obtained were smaller than those RMSE, MAE, and MAPE values in the 5 year Moving Average method. So, it can be concluded that the best forecasting method in this research is the Exponential Smoothing method because the error value is smaller than the moving average method.

Table 5 . Exponential Smoothing Prediction

Year	Tin Export Value	Number of Labor Force	Total population	Number of Poverty
2024	-33645811	11057.23	21241.92	7022749
2025	-33645811	11057.23	21241.92	7022749
2026	-33645811	11057.23	21241.92	7022749

Based on **Table 5**, the predicted value of tin exports, the number of workers, the number of residents, and the number of poor people have constant predicted values for the next 3 years. This is because making predictions for 2025 requires actual data in 2024, so forecasting should only be done for one period in the future, namely 2024. Apart from that, exponential smoothing is a simple method because it can only be predicted within a short period, usually predicting one period in the future [21]. The prediction results graph can be seen in the following image.

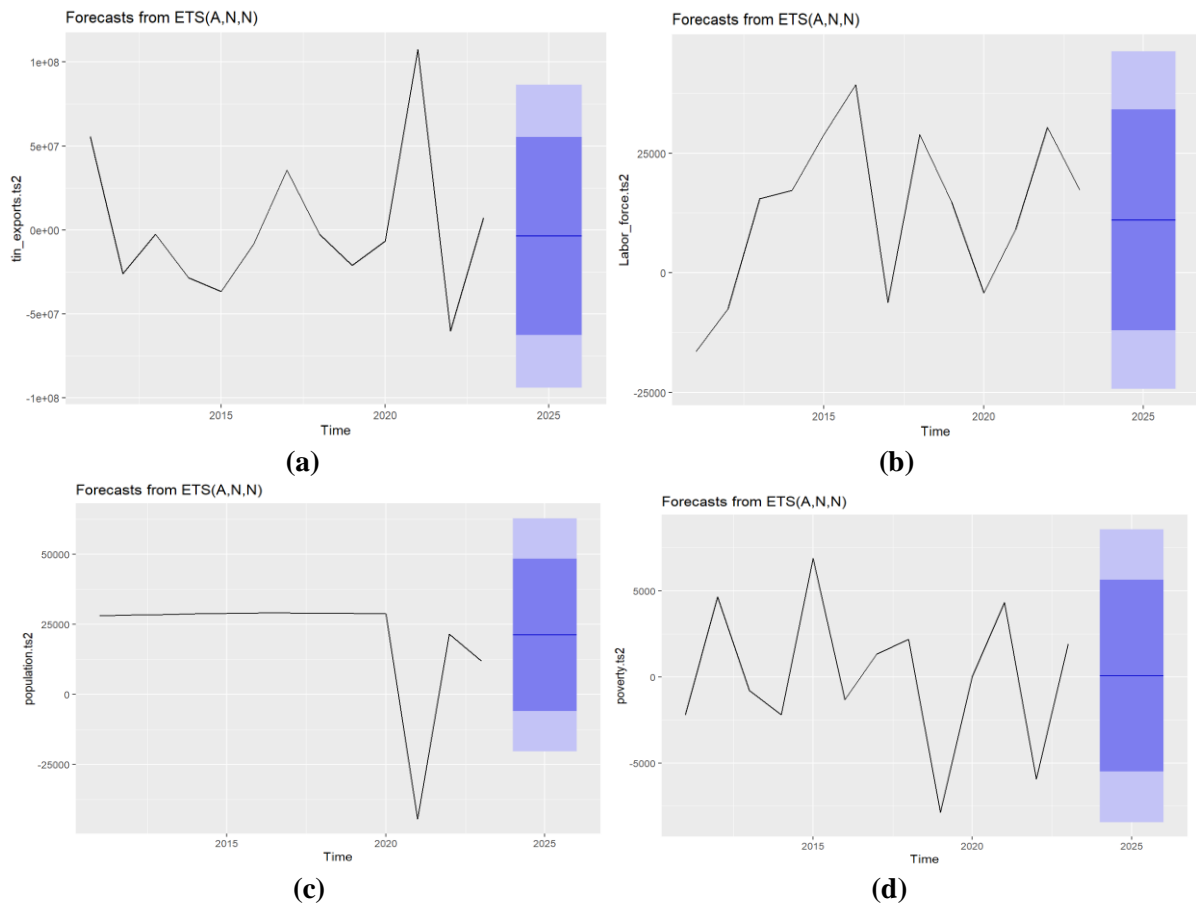


Figure Source: RStudio Software

Figure 2. Prediction data plot, (a) Tin export value, (b) Number of labor force, (c) Total population, (d) Number of the poverty

Based on **Figure 2**, the prediction results for each variable are calculated using stationary data. It is found that the predicted results for the value of tin exports, the number of the labor force, and the number of the poverty will decrease in 2024. Meanwhile, the expected results for the population will increase in 2024.

4. CONCLUSIONS

Based on the explanation of the research results above regarding predictions of the number of tin exports, population, poverty, and the labor force in preventing a post-COVID-19 economic recession in the Bangka Belitung Islands Province, it can be concluded that the best method for making predictions is the Exponential Smoothing method. The prediction results are carried out for the next period, namely 2024 because the actual data available is only up to 2023. Meanwhile, to predict 2025, actual data is needed in 2024. The predicted results for the value of tin exports in 2024 are -3.3645811, with the RMSE value at 42293770, MAE at 29558091, and MAPE at 84.46131. The negative value in the tin export prediction means that the decline in tin exports in 2024 will have a minor effect because it is still within a reasonable figure. The total labor force in 2024 will be 11057.23, with an RMSE value of 16536.48, an MAE value of 14194.02, and a MAPE value of 112.8078. Then, the predicted result for the population is 21241.92 with RMSE of 19537.82, MAE of 11548.41, and MAPE of 37.51894. Then, for the predicted results, the poverty rate is 70.22749 with RMSE, MAE, and MAPE, respectively, of 3992.146, 3205.528, and 139.1129. The alpha value (α) used is 0.0183.

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