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A Case Study: Forecastingthe Total Production of Premium Gasoline in Indonesia

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Abstract:*The increased of price crude oil in the international market affected the total production of premium gasoline in Indonesia, and it shows increased significantly year by year and irregular cycles which bring suitable data series to accurate forecasting. This paper proposes a GM (1,1) forecasting method with time-series data to predict the total production of premium gasoline in Indonesia. After collection, the real data about the total production of premium gasoline in Indonesia from 1996 to 2015, and from the result show that the real data and the forecasting result have a positive correlation, whichfound between the real data and the forecasting outcome from Grey forecasting method. This correlation related to previous research and study about Grey forecasting stated that with the Grey forecasting method suitable for short-term and long-term prediction.*

Keywords: *Forecasting;Gasoline;GM(1,1); Premium; Production; Indonesia*

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I. Introduction

Gasoline is an essential commodity for the community so that fuel price determination affects Indonesian's economy, the size of the budget deficit and welfare of the Indonesian community. The price of fuel oil such as premium, diesel, and kerosene determined by the Indonesia government through PERTAMINAor its official name PT. PERTAMINA (*Persero*) is a government company that manages oil and gas mining in Indonesia, whether subsidized or not. Indonesia has raised the price of subsidized gasoline by nearly 31 percent; this is an indication of the new government's commitment to reforming South-east Asia's largest economy which is on1st April 2016 Indonesia's premium gasoline and diesel fuel costsdebility by IDR 500 approximately USD 0.04 per liter. In January 2015 the Indonesian government scrapped generous subsidies for premium gasoline and stopped the subsidy for diesel fuel at IDR 1,000 per liter. Furthermore, the international crude oil prices recovered since mid-February 2016 from underneath USD 30 per barrel, a 12-year low, to around USD 40 per barrel. Indonesia's fuel prices should be revised upwards as a substitute of downwards. However, there exists a delay in Indonesia's policy-making and developments on the global crude oil market. Therefore, the present-day fuel price cut, effective per 1 April 2016, is based on descending international crude oil prices that occurred in Q4-2015. Additionally, this paper focused on prediction the total production of premium gasoline in Indonesia using Grey forecasting methodology. Finally, the finding might have a contribution and information for the Indonesian government.

II. Research Aims andImplication

The proposed research is noteworthy as not only highlights the total prominence production of premium gasoline in Indonesia for penetration but provides strategies that can be employed to create knowledge in the marketplace more cost-effectively and efficiently. Theory, as well as applied strategies, can be tied to the recommended study using several of case studies with different strategies. The essentialobjectives of the study are mention as follows:

- Highlight a significance the total production of premium gasoline in Indonesia;
- Arrange the total production of premium gasoline in Indonesia;
- Characterize alternative tools in forecasting that can be used more creatively and efficiently to improvethe total production of premium gasoline in Indonesia;
- To give information and suggestion related to the total production of premium gasoline in Indonesia.

III. Research Method

Accurate forecasting is the establishment and precondition of scientific decision making suchGrey information system theory is proposed by Deng 1982, which is characterized by high efficient acquisition of information for a system with imperfect information and uncertain, incomplete structures (Julong, 1989).Theobjective of Grey System andits applications is to bridge the gap existing between social science and naturalscience. Accordingly, the Grey System theory is interdisciplinary, cutting across a variability of specialized fields, and it is apparent that Grey System theory viewpoints the test of time since 1982.Furthermore, Grey System theory aims to provide theory, techniques, notions,and ideas for resolving (analyzing) possible and intricate systems, for example:

- To establish a non-function model instead of regressive analyzing;
- To define and constitute Grey process the stochastic procedure and to discover the real-timetechniques instead of a statistical model to deal with the Grey process, to obtain an approach to modeling withfew data, avoiding searching for data in quantities;
- To turn the disorderly raw data into a more regular series of Grey generatingtechniques for the benefit of modeling instead of modeling withoriginal data;
- To build a differential model-so termed Grey Model (GM) by using theleast 4 data to replace difference modeling in vast quantities of data;
- To advance a novel family of Grey forecasting methods instead of time series and regressive methods-all of these may be referred to as an approachto deal with Grey processes;
- To develop innovational techniques and concepts for decision makingprofessed Grey decision making;
- To develop novel control techniques. For instance, the Grey forecasting controlreplacing classical control which referred to as afterward control, alsorelational control, generating control and programming control;
- To study the mechanism theory, including Grey sequence theory andGrey structure theory;
- To study feeling and emotion functions and fields with whitening functions;
- Based on Grey relations, Grey elements and Grey numbers to be used tostudy Grey mathematics instead of classical mathematics study.

After more than 30 years of development, Grey forecasting models are becoming increasingly mature (Zeng and Li, 2018). Furthermore, Grey models can construct by using small samples; though, traditional Grey models have the drawback of 'misplaced replacement' during the conversion from a difference equation to a differential equation (Zeng*et al.*, 2018). However, a modified Grey prediction model is employed to accurately forecast China's overall and industrial electricity consumption (Ding, Hipel and Dang, 2018). Meanwhile, according to the estimated result, the average residual error of the Grey forecast model is over 5 percent (Wang and Ghalih, 2017). Also, an expression introducing of rolling modeling data and data of forecast results show their average residual error different from GM(1,1) rolling modeling (Wang and Ghalih, 2017). Besides,a recent study by Chen *et al.* implemented the hybrid Grey wave forecasting model performs well in 15 to 20 step ahead predictions, and it always dominates ARMA and Random Walk in correct direction prediction (Chen *et al.*, 2018).

Similarly, taking the grain production in Henan Province as an example, it verifies this model's validity by comparing with GM(1,1) based on background value optimization and the traditional Grey-Markov forecasting model (Ye, Dang, and Li, 2018). Additionally, a recent study used the essential structures of the Grey forecasting technique are to control data series to acquire approaching prediction number using previous numbers such as, in their study using dataset about the total production and harvested area of paddy in Indonesia since 1996 to 2015 (Ghalih *et al*., 2018).A considerable volume of literature has published on Grey theory, developed by Deng in 1982, is suitable for short-term forecasting, and does not rely on a statistical method. The Grey forecasting method has magnificently applied in many areas of investigation including finance, marketing, and management.

However, in this study, focus on the forecasting method is significantly by applying the single Grey rolling modeling mechanism, and Grey Model (GM) by using the least 4 data to interchange difference modeling in infinite measures of data. This rolling modeling mechanism distributes a means to assuranceinvolvement data are always the furthermost new values. An expression introducing the comparison of rolling modeling data and fundamental data of forecast results show as Figure. The average residual error different rolling modeling GM (1,1) show as Table 2. For example, in Method 1: Choose first four continuous data to predict the 5^{th} of the output value, 2^{nd} to 5^{th} continuous data to predict the 6^{th} output value and later. Besides, in Method 2: forecast the 6^{th} of the production value by adopting first five consecutive data, 2^{nd} to 6th following data to forecast the 7^{th} output value and henceforth. Likewise, the study presents methodologies for prominent the most accurately predicts of the total the total production of premium gasoline in Indonesia by challenging the precision of the Grey forecasting model.

Thoroughconcern by Deng recommended the Grey system theory to construct a Grey model for forecasting.Based on Grey number's appearances, this study uses error combination concept to establish assessment model of prediction accuracy for GM (1,1). This model determines the issue of separation of data accuracy,and fitting accuracy thus closes the gap of Grey prediction inaccuracy evaluation. Accumulated Generation Operation (AGO): Accumulating obtained systematic predictability discrete the time-series data.

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(n)) \quad (1)$$

$x^{(1)}$ is $x^{(0)}$ one-order accumulated generating operation (AGO) arrangement, that is,

$$x^{(1)} = (\sum_{k=1}^{1} x^{(0)}(k), \sum_{k=1}^{2} x^{(0)}(k), ..., \sum_{k=1}^{n} x^{(0)}(k)) \quad (2)$$

Inverse-accumulated generating operation (IAGO): $\hat{x}^{(0)}(k) = x^{(1)}(k) - x^{(1)}(k-1)$.

Gray Derivatives:

$$z^{(1)} = 0.5x^{(1)}(k) + 0.5x^{(1)}(k-1) \quad (3)$$

The vital order differential equation of GM (1,1) model is $dx / dt + ax = b$, where t symbolizes the independent variables in the system, a represents the developed coefficient; b is the Grey measured variable. Additionally,a and$b$ denoted the considerations demanding perseverance in the model. When a model is assembled, the differential equation is $x^0(k) + az^{(1)}(k) = b$, including $k = 2,3,…,n$, where a and b denoted replacement substantial number, this differential equation $x^{(0)}(k) + az^{(1)}(k) = b$ is called as GM (1,1) model.

$$Y_N = BA,\ B^T Y_N = B^T BA,\ A = (B^T B)^{-1} B^T Y_N$$

Furthermore, accrued matrix a and b are as below magnify equations:

$$a = \frac{\sum_{k=2}^{n} z^{(1)}(k) \sum_{k=2}^{n} x^{(0)}(k) - (n-1) \sum_{k=2}^{n} z^{(1)}(k) x^{(0)}(k)}{(n-1) \sum_{k=2}^{n} \left[z^{(1)}(k) \right]^2 - \left[\sum_{k=2}^{n} z^{(1)}(k) \right]^2} \quad (4)$$

$$b = \frac{\sum_{k=2}^{n} [z^{(1)}(k)]^2 \sum_{k=2}^{n} x^{(0)}(k) - \sum_{k=2}^{n} z^{(1)}(k) \sum_{k=2}^{n} z^{(1)}(k) x^{(0)}(k)}{(n-1) \sum_{k=2}^{n} [z^{(1)}(k)]^2 - [\sum_{k=2}^{n} z^{(1)}(k)]^2} \quad (5)$$

Whitening Equation:

$$x^{(1)}(k) = \left[x^{(1)}(1) - \frac{b}{a} \right] e^a e^{-ak} + \frac{b}{a} = \left[x^{(1)}(1) - \frac{b}{a} \right] e^{-a(k-1)} + \frac{b}{a}$$

$$x^{(1)}(k+1) = \left[x^{(0)}(1) - \frac{b}{a} \right] e^{-ak} + \frac{b}{a}$$, where $x^{(1)}(1) = x^{(0)}(1)$.

Utilize Inverse-accumulated generating operation (IAGO) equation as below:

$$\hat{x}^{(0)}(k+1) = x^{(1)}(k+1) - x^{(1)}(k) = (1 - e^a) \left[x^{(0)}(1) - \frac{b}{a} \right] e^{-ak} \quad (6)$$

Focus on the process of modeling, known thatthesimulation and prediction accuracy depends on the parameters of a, b and initial value, but a and$b$ values depend on Equation (1) and Equation (2), whether the matchtype. Therefore, the background value of the structure and initial value selection is significant, its impact on the simulation and prediction accuracy.

IV. Research Finding And Discussion

Data collected from *BadanPusatStatistik* (Statistics Indonesia) used to forecast the total production of premium gasoline in Indonesia. This study generated results that corroborate the findings of several previous studies in this field. What is noteworthy in Table 1 and Table 2, Table 1 is that the raw data of the total production of premium gasoline in Indonesia from 1996 to 2015. Likewise, Table 2is the average residual error from the Grey forecasting until 12 years prediction. Relating the two results, it could see that the result from Grey forecasting to predict the total production of premium gasoline in Indonesia have a low error.Interestingly, on an average residual error, only one has a more significant error which is in 4 years prediction about 4.70 % error. An optimum number to forecast of the total production of premium gasoline in Indonesia has established with $\alpha = 0.4$, data series length $m = 4$, and data series step $\triangle = 1$. Marginally poorer prediction results obtained with α = 0.4, *m* = 4 and △= 12, that is with the prediction from the previous years. Such as, in this study, used data on GM (1,1) prediction of the total production of premium gasoline in Indonesia from Table 1 given in Table 2. Also, there are the results for a four years period the total error ranges start from 4.70 %.

Table 1

Year	*Real Data*	*Year*	*Real Data*
1996	60815	**2006**	71822
1997	63373	**2007**	71337
1998	59403	**2008**	72404
1999	62450	**2009**	72799
2000	69244	**2010**	66820
2001	66534	**2011**	64460
2002	68975	**2012**	67684
2003	64368	**2013**	67819
2004	70260	**2014**	70828
2005	71013	**2015**	71733

Furthermore, the lower error is 3.93 % for the eight years. In contrast to the average residual error the total production of premium gasoline in Indonesia in Table 2 relatively lower for continues years. The most remarkable consequence of emerging from the data is that from the Grey forecasting result from 1996 to 2005 can be used to predict the value in 2006. The further analysis presented that the average error 3.93 % is the lowest error in 8 years prediction. The single most striking observation to emerge after comparing the data could see in Figure.Overall, the average error in the total production of premium gasoline in Indonesia measures that Grey forecasting accurately observed. Turning now to the Table 1 and Table 2 presents the results obtained from preliminary real data compare with out of sample data from 2006 to 2015. The correlation between real data and out of sample data is remarkable because those data have a small average error which is only 4.70 % error. Comparatively, the highest average error in 12 years forecasting is about 5.07 %. As a result of Grey forecasting, the correlation between the real data and the predictive value from the production of premium gasoline in Indonesia slightly different. Precisely, on 2006-2008 and 2012-2014 the real data is virtually equal to the predicted value. It means that the result of Grey forecasting in this circumstance is worthy because based on the theory the more precise the results of raw data with forecasting value thanthe better the results. From the results of the total error of four years (4.70%), eight years (3.93%), and 12 years (5.07%) described in Table 2.

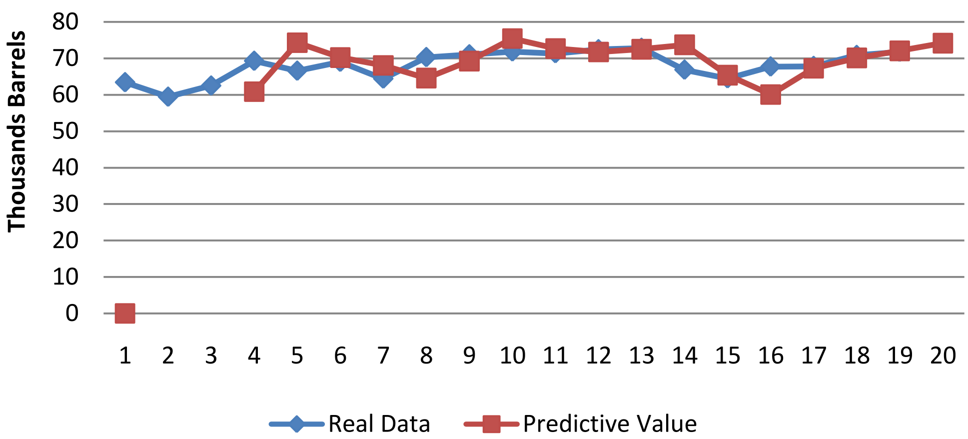

Table 2

Year	*Grey Forecasting*	*Average Error (%)*	*Year*	*Grey Forecasting*	*Average Error (%)*
1996	-	-	**2006**	75361	0.0492
1997	-	-	**2007**	72607	0.0178
1998	-	-	**2008**	71714	0.0095
1999	-	-	**2009**	72440	0.0049
2000	60806	0.1218	**2010**	73651	0.1022
2001	74252	0.1160	**2011**	65342	0.0136
2002	70160	0.0171	**2012**	60019	0.1132
2003	67979	0.0560	**2013**	67202	0.0090
2004	64524	0.0816	**2014**	70053	0.0109
2005	69196	0.0255	**2015**	72000	0.0037

V. Conclusion

The essential structures of the Grey forecasting technique are to determine data series to acquire upcoming prediction numeral using previous numbers such as, in this study using dataset about the total production of premium gasoline in Indonesia since 1996 to 2015. In this paper, the Grey system modeling based on the experimental results for forecasting the total production of premium gasoline Indonesia were examined and showed the number about 4.70 % total error to predict range one until four years. Interestingly, in five years the total error is relatively small about 4.62 %. That indicates the Grey forecasting method not permanently have a real total error in the range fourth years but in another range of the year might have the small total error. Likewise, the total production of premium gasoline in Indonesia illustrates small residual average error. Researcher of the study has found few pre-research limitations. It is logical that conducting research period should be considered as one limitation of the study because of this research data and duration. No researcher can cover the wholedata as a sample because of the scope of doing such thing is impossible, and this study used secondary data. Therefore, researchers can choose a selectednumber of the total selection data to get a sample of the study,butthere is a fact that a large number of sample size, which presents much better results than a small number of a samplesize of the study. The information of average error is another noteworthy limitation of the study. It means there is apossibility to get few or incomplete information, which might create data error or gap ofthe study. This research shows the test that conducted the total production of premium gasoline in Indonesia increased year by year according to the real data and the Grey forecast method. However, according to the mathematical theory, the prediction is an extrapolation model.In summary, it implies that Indonesia government should make the action plan for the future to develop oil sectors.

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