An outlier analysis on the trend of Indonesian propensity to save

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Abstract. Economic cycle is in the interest of researchers as well as governments. Kaldor model of economic cycle is among the existing models. This model is a system consists of two difference equations for discrete model, and two differential equations for continuous model. Two functions of time playing role to the model are capital and production. Saving and investment as functions of capital and production also appear in the model. Often, saving is assumed as a linear function where it is a multiplication of production and a parameter the so-called propensity to save. Hence, it is assumed to be constant. In this paper, Indonesian propensity to save was analyzed. The production is the gross domestic product (GDP). The data of GDP and saving were collected from World Bank. Outlier detection was applied to analyze the data. Neglecting the outlier, the propensity to save was obtained in the form of logarithmic function. The finding is inline with an economic assumption, and it will be important for studying the Indonesian economy.

1. Introduction

Madhani [1] defined the business cycle or economic cycle as the downward and upward movement of gross domestic product (GDP) around its long-term growth trend. Business cycle or economic cycle has attracted tremendous amount of research, among others are [2, 3, 4, 5, 6, 7, 8]. Recent work on business model in discussed in [9, 10]. Understanding economic cycle will be important for governments to manage the national economy, especially to avoid or at least to minimize the impact of an economic crash.

Economic cycle of a nation, in general, is indicated by the Gross Domestic Product (GDP). Although GDP is measured in local currencies, it is usually measured in United States dollar (USD) for international purposes such as recorded by World Bank. In the World Bank record, GDP data is presented in constant year USD and current USD, for example constant 2010 USD. Cahyono et al. [11] reported that GDP data in constant 2010 USD was more sensitive in capturing such cycle than the data in current USD for the case of three countries China, Indonesia and Malaysia.

Kaldor [12] proposed a model of economic cycle based on the variables: production and capital stock, and two other variables: saving and investment. Saving and investment are functions of
production and capital stock. At least one saving or investment must be nonlinear function. This paper focuses on the saving as a function of capital for Indonesian economy, and the need of the function in Kaldor model of economic cycle.

2. Discrete Kaldor model and related variables
Consider discrete Kaldor model of business cycle discussed in [9]:

\[ y_{t+1} = y_t + \alpha(I(y_t, k_t) - S(y_t)), \]

\[ k_{t+1} = (1 - \delta)k_t + \beta I(y_t, k_t), \]

where \( y \) is national income (in this paper it is GDP), \( k \) is capital, \( I(y_t, k_t) \) is (national) investment and \( S(y_t) \) is (national) saving. Investment and saving are assumed in the form

\[ I(y) = \sigma \mu + y \left( \frac{\alpha u}{\delta} - k \right) + \arctan(y - \mu), \]

\[ S(y) = \sigma y, \]

where \( \alpha, \beta, \sigma, \mu, \delta \) are parameters. Equation (3) follows assumption given in [13]. Often, parameter \( \sigma \) is called propensity to save and it is actually a function of production. It will be discussed in the next section.

Applying the model for economic cycle of a country, national income may be represented by the Gross National Product (GDP). There are three ways of determining GDP, i.e. production approach, income approach and expenditure approach. In this paper, however, the focus is not on how GDP measured. Rather, we directly analyze secondary data of GDP and saving of Indonesia which are available online from world bank. Detailed discussion related to GDP and saving may be found in [14].

3. Outlier detection
Outlier is an observation point that is distant from other observations (data). There are two different outliers, i.e. outlier in data and outlier in models. The existing outlier detection method in models is using common Likelihood method. The limitation of this method is the optimal value produced might be not the real optimal values. When research object in the form of data contain outliers, i.e. data which deviates so much from other data, these outliers can influence the resulting model. Hence, they can have an impact on decision making.

Based on the number of variables considered, outliers can be divided into outliers in univariate or multivariate observations and outliers in univariate or multivariate linear models. Outliers in linear models can exist in the predictor (independent) variable, response (dependent) variable, or both at once. It is easier to handle outliers in predictor variables than outliers in both at once. Development of outlier detection method in univariate and multivariate observations have been done by [15,16] which identified an observation that deviate much from other observations.

Outlier detection in univariate linear models have been developed by [17, 18] identified outliers in univariate linear models with Least Trimmed Squares method and Single Linkage Clustering to obtain potential outlier observations. Makkulau et all [19] development of the outlier detection method using the Likelihood Displacement Statistic method(LD) and Likelihood Ratio Statistic for a Mean Shift method (LR), called Likelihood Displacement Statistic-Lagrange (LDL) method and Likelihood Ratio Statistic for a Mean Shift-Lagrange (LRL) method uses Lagrange multipliers.

4. Data and analysis
The data of GDP and propensity to save of Indonesia was collected form world bank which is available online [20]. Figure 1 shows scattered plot of the data from 1967 to 2017. Obviously, the relation of GDP and the propensity to save presented in Figure 1 is not linear. Hence, \( \sigma \) is not constant. Rather, it looks like a logarithmic function.
Assuming that propensity to save is a logarithmic function is inline with economic assumption such as presented in [21]. Let

\[ \sigma = a + b \ln y + \epsilon, \]  

where \( a \) and \( b \) are parameters to be sought by minimizing error \( \epsilon \). The analysis of the error \( \epsilon \) is presented in Figure 2 and Figure 3. Figure 2 show that the errors are normally distributed. It was confirmed by P-value is greater than 0.05. Figure 3 shows that the homogeneity assumption is satisfied, it is because the data are randomly distributed.

The results of outlier analysis are presented in Figure 4 and Figure 5. Figure 4 shows that an outlier does exist in the original data. Moreover, it is the dot in the lowest place of Figure 1. It shows that the propensity to save is negative, it happened during the economic crisis and afterward in 1998, 1999. From economic point of view, it does not reflect the actual trend of the propensity to save. Figure 5 shows that no more outlier after removing the data represented by the lowest dot in Figure 1.
Figure 4. Residual boxplot. Outlier presents.

Figure 5. Residual boxplot after removing outlier.

Propensity to save of Indonesian economy is sought by removing the outlier from the data. After removing the outlier the trend of the propensity to save is a logarithmic function with respect to GDP. Applying a least square method, the propensity to save is in the form

\[ \sigma = -87 + 4.43 \ln y. \]  \hspace{1cm} (6)

Figure 6 shows the propensity to save and its trend with respect of GDP for Indonesian economy.

Figure 6. Logarithmic trend of propensity to save.

5. Conclusion and further research
Kaldor discrete model of economic cycle has been discussed. Some parameters have been included in the model. Applying the model to Indonesian economy, however, adjustments of the parameters are needed, including parameter the so-called propensity to save. Analyzing the data of world bank on Indonesian propensity to save and Gross Domestic Product (GDP) have shown that there have existed outliers. Removing the outlier(s), the trend of propensity to save has been obtained in the form of logarithmic function with respect of GDP. This is in a good agreement with an economic assumption [21].
This finding is important for studying the cycle of Indonesian economy, especially based on Kaldor model. Moreover, understanding the cycle of Indonesian economy is in the need of the government(s) and business players to optimize the growth and minimize the impact of the crash.

Acknowledgments
The research of Edi Cahyono, La Ode Saidi and Makkulau was supported by Kemenristek Dikti of Republik Indonesia for hibah Penelitian Dasar Universitas Halu Oleo 2018 – 2020, [Contract No. 447/UN29.20/PPM/2018 and Contract No. 511b/UN29.20/PPM/2019].

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