Predicted Economic Growth Rate using Linear Regression Method

(Case study : Bandung City)

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***Abstract*—The result of this paper the model to predict the economic growth rate of Bandung city base on economic growth rate data since year 2001 to 2015. The approximation value of economic growth rate can use to projection or estimate revenue for development planning next years.**

Keywords: economic growth, bandung city, linear regression

I. INTRODUCTION

The level of welfare is one of the important indicators that must archieved in the development of a region. The level of welfare of the population in a region can be seen from the economic growth. The higher the economic growth, The level of welfare will be better. The economic growth problem is cover economic problem in the long term, industrial development, infrastructure development, increase number of school, increase production in serivces sector, increase production of capital goods[9].

The economic growth rate can calculate from Gross Regional Domestic Revenue this year and last year. Bandung city is one of capital city in Indonesia and also is creative city with the top ten economic growth in Indonesia, about 7.63 in 2015[6].

Based on the last year economic growth rate, we can use for predict the next year economic growth rate, as a projection or predict regional revenue for development planning. There fore, in this paper we discuss about model to predict the economic growth rate Bandung city using linear regression method.

The reminder of this paper is organized as follows. Section 2 describes about the economic growth and economic growth in Bandung City. Section 3 describes about linear regression method to the value approximation of economic growth rate. Section 4 describes about build model for predict the economic growth rate. Section 5 describes experiment and result using model, and Section 6 conslution of paper.

II. ECONOMIC GROWTH

The economic growth can be defined as a long term increase in the ability of a country to provied various types of economic goods to its population. This ability growth according to technological avances, institutional adjusments and idelogois are used[8]. Based on that definition, the economic growth have 3 component, (1) the economic growth in a region can be seen from the continous increase fo inventories; (2) advance technology is factor in economic growth that determine the degree of growth of ability in the provision of various goods to the population; (3) the widespread and efficient use of technology requires an adjusment in the institutional and ideological field so that the innovations generated by the people's science can be exploited appropriately[7].

The economic growth can use for measure result of development in a region. Income per capita can use for measure the level of welfare of population, because the higher income per capita with constant work that can make the higher of the level of welface of population and its productivity. Moreover, the economic growth rate can use to projection or estimate revenue in a region for development planning next years, and can use for make business approximation, especially sales for the company to make the preparation of product planning and the development of labor and capital resources.

factor that impact to the economic growth, as follow.

a. Factor of manpower resources;
b. Factor of natural resources;
c. Factor of science and technology;
d. Factor of culture;
e. Factor of capital resources.

Formula for calulate the economic growth rate, as follow.

$$R(t-1,t) = \frac{(PDRB_t - PDRB_{t-1}) * 100}{PDB_{t-1}} \qquad (1)$$

Where:

R is a level of the economic growth (%)

$PDRB_t$ is income in the year t

$PDRB_{t-1}$ is income in the year t – 1

A. *Economic Growth of Bandung City*

Bandung city is a creative city with have level of economic growth rate (EGR) that high and the top ten economic growth rate in Indonesia. The following is the economic growth rate of Bandung city in year 2001 to 2015 [1-6].

TABLE 1 The economic growth rate of Bandung city in 2001-2015

Year	EGR (%)
2001	7.54
2002	7.13
2003	7.34
2004	7.49
2005	7.53
2006	7.83
2007	8.24
2008	8.17
2009	8.34
2010	8.45
2011	7.91
2012	8.53
2013	7.84
2014	7.71
2015	7.63

III. REGRESSION

Regression is a curve experiment techniques for data that low accuracy. Low accuracy data usually get from observation result, laboratory experiment result, and statistics data. Data from measurement result generally have meaningful noise. So curve that matching with data coordinate is not necessary through all coordinate, enough with the approximation function to the coordinates. The point of view which used is determine the curve that has trend to the data coordinate, i.e. the curve follows the pattern as a group (FIGURE 1). That curve was made to increase the difference between the data coordinat and approximation coordinate on the curve as small as possible. The least squares regression method.

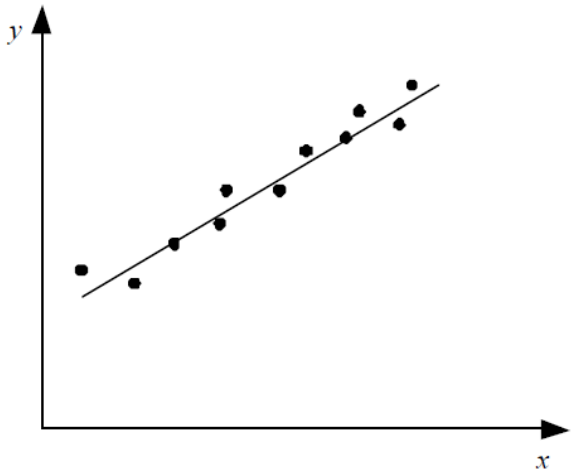

FIGURE 1 Regression

A. *Linear Regression*

Linear regression is a curve matching for data that has a linear relationship between the independent variable and its dependent variable. For example the coordinate (x_i, y_i) is the measured data, then the straight line is made approaching the data coordinate. The straight line is made in such a way that the error is as small as possible with the data coordinates. The analysis to know the direction of the relationship between independent variable and dependent variable whether positive or negative and to predict the value of the dependent variable if the value of the independent variable increased or decreased.

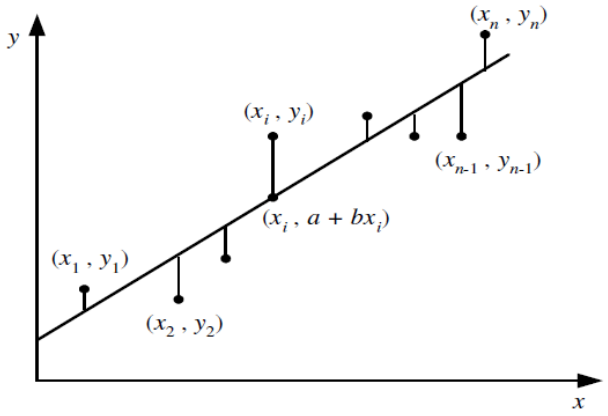

FIGURE 2 Regression of Data

Since the data contains errors, so the actual data value of $g(x_i)$ can be written as follows.

$$g(x_i) = y_i + e_i \; i = 1, 2, \dots, n \qquad (2)$$

Where e_i is a error each data. The desired linear function in accordance with linear regression is as follows.

$$f(x) = a + bx \qquad (3)$$

That equation matches the data so that its deviation is minimum. The equation as follows.

$$r_i = y_i - f(x_i) = y_i - (a + bx_i) \qquad (4)$$

The total squared deviation equation is as follows. Equations (4).

$$R = \sum_{i=1}^{n} r_i^2 = \sum_{i=1}^{n} (y_i - a - bx_i)^2 \qquad (5)$$

For a minimum R, the equation (4) is derivated as follows.

$$\frac{\partial R}{\partial a} = -2 \sum (y_i - a - bx_i) = 0$$

$$\frac{\partial R}{\partial b} = -2 \sum x_i \, (y_i - a - bx_i) = 0$$

Each segment of the two equations divided by 2 becomes as follows.

$$\sum (y_i - a - bx_i) = 0 \quad \Rightarrow \sum y_i - \sum a - \sum bx_i = 0$$

$$\sum x_i (y_i - a - bx_i) = 0 \Rightarrow \sum x_i y_i - \sum a x_i - \sum b x_i^2 = 0$$

Hereafter becomes as follows.

$$\sum a + \sum bx_i = \sum y_i$$

$$\sum a\, x_i + \sum bx_i^2 = \sum x_i y_i$$

Or be as follows.

$$na + b \sum x_i = \sum y_i$$

$$a \sum x_i + b \sum x_i^2 = \sum x_i y_i$$

These two last equations are named as normal equations, and can be written in terms of the following matrix equations.

$$\begin{bmatrix} n & \sum x_i \\ \sum x_i & \sum x_i^2 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum x_i y_i \end{bmatrix}$$

Solutions (values a and b) can be searched by the garuss elimination method. In addition, it can also be searched by the following formula.

$$b = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2} \qquad (6)$$

$$a = \bar{y} - b\bar{x} \qquad (7)$$

IV. BUILD EQUATION FOR ECONOMIC GROWTH

In this section create a model to predict the economic growth rate based on data from 2001 to 2015 with the regression method. The data of economic growth rate of Bandung city in 2001 to 2015, as follows.

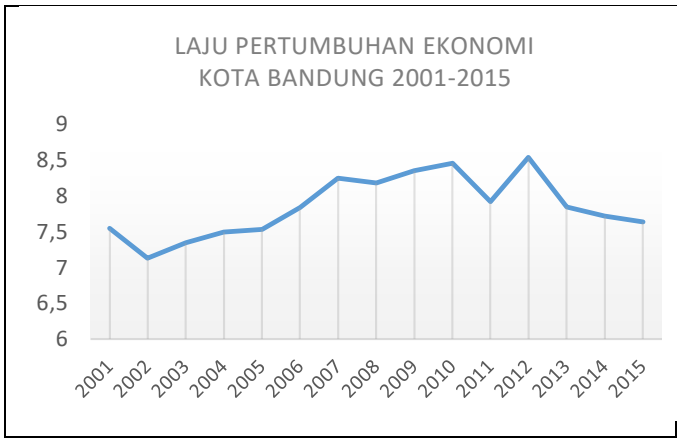

FIGURE 3 Graph of Economic Growth Rate of Bandung City 2001-2015

To calculate the regression, the year data becomes x and the economic growth rate becomes y. The first stage should be calculated first value x^2 and $x.y$. Then calculated values $\sum x_i y_i$, $\sum x_i, \sum y_i$ dan $\sum x_i^2$.

$$x^2 = 2001^2 = 4.004.001$$

$$x.y = 2001 * 7{,}54 = 15.087{,}54$$

The calculations are all shown in TABEL 2.

TABLE 2 The calculations result

x	y	x_i^2	$x_i . y_i$
2001	7.54	4,004,001	15,087.54
2002	7.13	4,008,004	14,274.26
2003	7.34	4,012,009	14,702.02
2004	7.49	4,016,016	15,009.96
2005	7.53	4,020,025	15,097.65
2006	7.83	4,024,036	15,706.98
2007	8.24	4,028,049	16,537.68
2008	8.17	4,032,064	16,405.36
2009	8.34	4,036,081	16,755.06

2010	8.45	4,040,100	16,984.50
2011	7.91	4,044,121	15,907.01
2012	8.53	4,048,144	17,162.36
2013	7.84	4,052,169	15,781.92
2014	7.71	4,056,196	15,527.94
2015	7.63	4,060,225	15,374.45
$\sum x_i =$ 30,120	$\sum y_i =$ 117.68	$\sum x_i^2 =$ 60,481,240	$\sum x_i.y_i =$ 236,314.69

Then count a and b by equation (6) to satisfy the linear regression equation $f(x) = a + bx$.

$$b = \frac{15(236{,}314.69) - (30{,}120)(117.68)}{n(60{,}481{,}240) - \quad 907{,}214{,}400}$$
$$b = 0.047321429$$

To calculate the value of a using the equation (7) below.

$$a = \frac{\sum x_i}{n} - 0.047321429 \left(\frac{\sum y_i}{n}\right)$$
$$a = \frac{30{,}120}{15} - 0.047321429 \left(\frac{117.68}{5}\right)$$
$$a = -87.17609524$$

After obtaining the values of a and b, then it can be input to equation (3) to get the prediction model of economic growth rate. Here is the equation model.

$$f(x) = -87.17609524 + 0.047321429x$$

V. EXPERIMENT AND RESULT

The experiment was conducted by calculating the economic growth rate for 2016, 2017, 2018 and others. Here's the calculation to get the economic growth rate for 2016, 2017 and 2018.

Estimated rate of economic growth in 2016.

$$f(2016) = -87.17609524 + 0.047321429x$$
$$f(2016) = -87.17609524 + 0.047321429 * 2016$$
$$f(2016) = 8.22$$

Estimates of the rate of economic growth in 2016, 2017, 2018 and so on are shown in TABLE 3.

TABLE 3 Experiment Results

x	y
2016	8.22
2017	8.27
2018	8.32
2019	8.37
2020	8.41
2021	8.46
2022	8.51
2023	8.56
2024	8.60
2025	8.65
2026	8.70
2027	8.74
2028	8.79
2029	8.84
2030	8.89

Based on TABLE 3, shows that the rate of economic growth is increasing. Using the economic growth rate can estimate its GRDP. To calculate the PDRB estimate using equation (1) which is changed to the following.

$$PDRB_t = PDRB_{t-1} + \left(\frac{PDRB_{t-1} * R}{100}\right) \quad (8)$$

Using equation (8) to obtain GRDP, here are the results.

TABLE 4 Estimated GRDP

x	y	**PDRB (Juta)**
2015	-	149,566,785.03
2016	8.22	161,867,016.27
2017	8.27	175,255,404.71
2018	8.32	189,834,110.52
2019	8.37	205,715,385.26
2020	8.41	223,022,614.23
2021	8.46	241,891,470.99
2022	8.51	262,471,196.28
2023	8.56	284,926,015.60
2024	8.60	309,436,710.71
2025	8.65	336,202,362.63
2026	8.70	365,442,285.26
2027	8.74	397,398,171.54
2028	8.79	432,336,476.04
2029	8.84	470,551,061.19
2030	8.89	512,366,137.18

VI. CONLUSION

From this experiment, it can be concluded that linear regression calculation to predict the value of economic growth rate of Bandung city based on data of economic growth rate from 2001 to 2015 get good result. From the results of the prediction, obtained the rate of economic development for the year 2016 of

8.22, the year 2017 of 8.27 and the year 2018 of 8.32. From 2016-2018 cendenrung mengalamai increase. This predicts that the city of Bandung has a good economy rate.

VII. Future Work

To obtain more accurate results, it is necessary to experiment using the extrapolation method.

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PERNYATAAN

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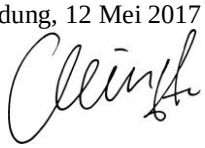
Bandung, 12 Mei 2017



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