Available online at
https://journal.rescollacomm.com/index.php/ijqrm/index

International Journal of Quantitative Research and Modeling

e-ISSN 2721-477X
p-ISSN 2722-5046

Vol. 3, No. 2, pp. 72-76, 2022

Mathematical Modeling to Estimate Non-Tax State Revenues

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Abstract

Mathematics is the basic foundation for other sciences. Equation is a mathematical model that can describe real-life problems, one of which is estimating non-tax state revenues in the coming year. Non-State Revenue (PNBP) is the scope of state finances which is equipped with the State Assets and Auction Service Office (KPKNL) which must be reported on the realization of PNBP that will be deposited into the state treasury. Such situation happens because expenditures in each government agency will be available and increase every year by the government. Therefore, *direktorat jenderal keuangan negara* (DJKN) have to be more optimal in the management of the PNBP. This study aims to determine the results of the best estimates and exponential models in estimating non-tax state income at the KPKNL Bandung, Indonesia, in year of 2017 and 2018. This research includes descriptive research using a qualitative approach. The results show that the calculation using the exponential 4^{th} model is the best model for estimating PNBP such that the estimated PNBP results in 2017 is IDR. 574,775,677 and in 2018 is IDR 798,022,691.

Keywords: Mathematical modeling, PNBP estimation, exponential model.

1. Introduction

Mathematics is a form of basic foundation for other sciences. The differential equation is a form of mathematical model that can describe real-life problems (Widowati, Panca Sakti and Sutimin, 2009; Simmons, 2016), one of which is to provide an overview to estimate non-tax state revenues in the coming year (Faozi, Anis, 2016).

Based on Law Number 41 of 2008 concerning the 2009 State Budget, the 2009 State Budget is set. This APBN is determined every year and is intended for the prosperity of the people. The State Revenue and Expenditure Budget (APBN) is the result of all state financial management that is accounted for by the Government in order to regulate state expenditures and revenues in order to realize the achievement of national income, prosperity of economic growth, maintain economic balance, and direct development priorities in general (Kristiantoro, Basuki and Fanani, 2018; Syamsurijal, 2019; Syamsuri and Jamilah, 2020). With the existence of the State Revenue and Expenditure Budget (APBN), the elements contained therein include: tax revenues, non-tax state revenues, grant receipts from within the country and abroad.

Non-Tax State Revenue (PNBP) is the scope of state finances that is accountable to the State Audit Board (BPK) (Putri; 2021; Sinaga et al., 2020; Eddyono et al., 2020; Yamin et al., 2018), which is an independent institution that is also free to analyze the examination of components that affect state revenue, one of which is the Office of the State Assets and Auction Service (KPKNL), which will later be required to report in writing the realization of PNBP will then be deposited into the state treasury, because the budget for each government agency will be available and increase every year therefore DJKN is required to be more optimal in the management of this PNBP (Rosdiana, 2010; Tanjung et al., 2021; Wisudayati et al., 2019; Lubis, 2018).

The PNBP management cycle involves three elements, which include: Revenues from administrative fees for managing state receivables, auction fees for auction officials, and auction fees for pawnshops. In this case, KPKNL has a vital role as a service office that directly deals with stakeholders related to PNBP management (Pramugar and Sinaga, 2021).

With data obtained from KPKNL Bandung in 2012-2016 on Table 1. The results of the realization of PNBP in 2012 amounted to 111,407,517 IDR, in 2013 amounted to 135,376,117 IDR, the results of the realization of income in 2014 amounted to 255,663,561 IDR, and increased in 2015 by 320,380,157 IDR, then the number increased again in 2016 amounting to 413,982,191 IDR. So that the researcher can conclude that the amount of Realized Revenue from

Accounts Receivable is increasing over time. So that the magnitude of this PNBP movement will be a major source of income into the state treasury. This study aims to find out the results of the best estimates and exponential models in estimating non-tax state revenues at KPKNL Bandung in 2017 and 2018 (Sundari and Ariyani, 2021; Tarigan, 2021).

2. Materials and Methods

2.1. Materials

Data collection techniques use literature studies by reviewing and analyzing related research topics. Documentation techniques to obtain data on the realization of receivable management income from 2012-2016 aimed at estimating Non-Tax State Revenue (PNBP) at KPKNL Bandung.

2.2. Methods

The exponential model was discovered by Thomas Malthus in 1798, which is used to estimate the revenue of an agency which generally has a constant growth rate in a unit of time. It is known that a state's income at any time forms a function of time by assuming the magnitude of the rate of income will be directly proportional to the increase in time. If it is known that P0 is the amount of income when it is started to be observed and the amount of income at the time unit is Pt. It is assumed that Pt of a function with dP/dt is the rate of change of income which is proportional to the existing amount, then dP/dt=kP or dP/dt-kP=0 where k is the comparison constant.

The shape of this exponential model is derived from the differential equation model as follows:

The decrease in PNBP income at that time is proportional to the constant times PNBP income

$$\frac{dP}{dt} = kP$$

$(t0) = P0$, $k > 0, t0 \leq t \leq t1$, with k comparator constant

$$\frac{dP}{dt} = kP$$

By separating the variables, we get

$$\frac{dP}{P} = k\ dt$$

Then integral to both segments

$$\int \frac{dP}{P} = \int \mathrm{k\ dt}$$

From the above integral calculations, the respective results are obtained as follows:

$$\ln P = kt + c \tag{1}$$

Then,

Sub-trigger $(t0) = P0$, obtained

$$\ln P0 = k\ t0 + c \tag{2}$$

from the equation (2) we get c

$c = \ln P0 - k\ t0$

Then we substitute c into equation (1), we get

$\ln P = kt + \ln P0 - k\ t0$

we move the segment containing the natural logarithm function (ln)

$\ln P - \ln P0 = kt - k\ t0$

we simplify, it becomes

$\ln P - \ln P0 = k(t - t0)$

using the properties of the natural logarithm function (ln), we get

$\ln \frac{P}{P0} k(t - t0)$ with $k = \frac{\ln \frac{P}{P0}}{t - t0}$

because the natural logarithm is the inverse of the exponential, then we make it in the form of exponents

$$e^{\ln \frac{P}{P0}} = e^{k(t-t0)}$$

This results in a simple function

$$\frac{P}{P0} = e^{k(t-t0)}$$

Because at the beginning P = P(t) then the following exponential model is obtained:

$$\mathrm{P}(t) = P0\ e^{k(t-t^0)} \ldots\ldots\text{Exponential Model} \quad (3)$$

Data on Realization of Non-Tax State Revenue (PNBP) KPKNL Bandung.

Table 1. Data on Realization of Non-Tax State Revenue (PNBP) KPKNL Bandung Year 2012-2016

Year	Realization
2012	111.407.517
2013	135.376.117
2014	255.663.561
2015	320.380.157
2016	413.982.191

4. Results and Discussion

The solution using the Exponential Model with Non-Tax State Revenue Data at the KPKNL Bandung is assumed to have t = 0 and P0 = 111.407.517, so that several exponential model solutions are obtained with different intrinsic rates (k values), then the general form of the solution is

$\mathrm{P}(t) = P0\ e^{k(t-t^0)}$

The following is a solution form with the exponential model:

a. Exponential model I, with the following equation form:

$\mathrm{P}(t) = (111.407.517)\ e^{0{,}194862154\ (t-t0)}$

b. Exponential model II, with the following equation form:

$\mathrm{P}(t) = (111.407.517)\ e^{0{,}415333781(t-t0)}$

c. Exponential Model III, with the following equation form:

$\mathrm{P}(t) = (111.407.517)\ e^{0{,}352104493(t-t0)}$

d. Exponential IV model, with the following equation form:

$\mathrm{P}(t) = (111.407.517)\ e^{0{,}328157038(t-t0)}$

Then, we will look for predictions of revenue from administrative costs for managing state receivables in 2017 and 2018 using the Exponential 4 Model.

a. Year 2017

$P(2017) = (111.407.517)\ e^{0{,}328157038(2017-2012)} = 574{,}775{,}767$

b. Year 2018

$P(2018) = (111.407.517)\ e^{0{,}328157038(2018-2012)} = 798{,}022{,}691$

From the two P results, it is found that the prediction of revenue for the administration of state receivables using the Exponential Model IV in 2017 and 2018 is IDR. 574,775,767 and IDR. 798,022,691.

Table 2. Data on the Estimation of Non-Tax State Revenue (PNBP) KPKNL Bandung using the exponential model IV

Year	Estimation
2012	111.407.517
2013	135.376.117
2014	255.663.561
2015	320.380.157
2016	413.982.191
2017	574.775.767
2018	798.022.691

On the other hand, here are the MAPE errors for each exponential model:

Exponential Model I

$\mathrm{P}(t) = (111.407.517)\ e^{0{,}194862154\ (t-t0)}$

MAPE = 23 %

Exponential Model II

$P(t) = (111.407.517)\ e^{0,415333781(t-t0)}$
MAPE = 17.45 %
Exponential Model III
$P(t) = (111.407.517)\ e^{0,352104493(t-t0)}$
MAPE = 7.79 %
Exponential Model IV
$P(t) = (111.407.517)\ e^{0,328157038(t-t0)}$
MAPE = 7.43 %

Table 3. Data MAPE errors for each Exponential Model

Model Type	Average Error
Exponential Model I	23 %
Exponential Model II	17.45 %
Exponential Model III	7.79 %
Exponential Model IV	7.43 %

Based on the table of error calculations above, it can be concluded that the best exponential model is the IV exponential model. The general form of the model is $(t) = (111.407.517)\ e^{0,328157038(t-t^0)}$. With errors of 7.44% per year. For more details, the results of the estimate can be seen in Figure 1.

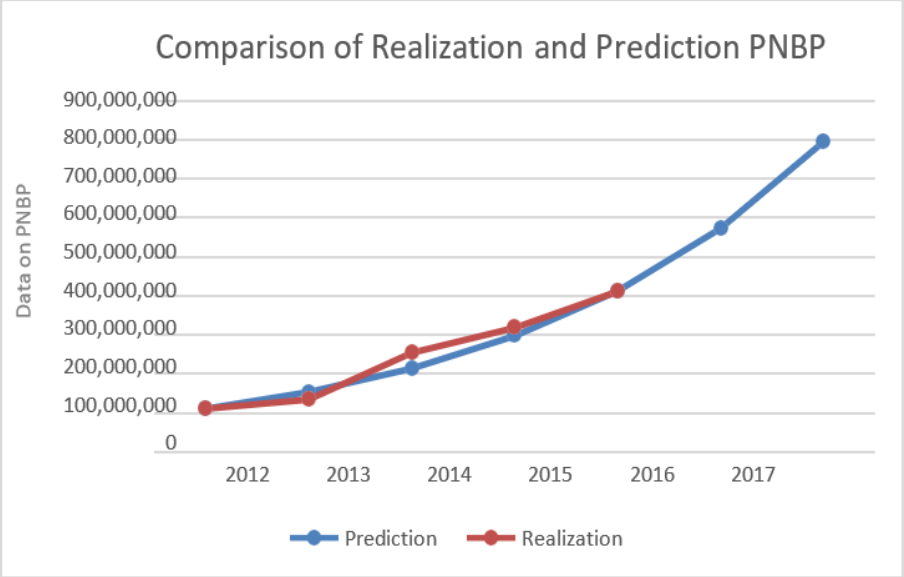

Figure 1. Realization Comparison Graph with PNBP Estimate at KPKNL Bandung using exponential model IV

5. Conclusion

Based on the discussion that has been carried out above, it can be concluded that the exponential model IV with the model form $(t) = (111.407.517)\ e^{0,328157038(t-t^0)}$) can be used to estimate the calculation of Non-Tax State Revenue (PNBP). namely Revenue from administrative costs for managing state receivables, the prediction results obtained from revenue administration fees for managing state receivables in 2017 was as much as IDR. 574,775,767 and in 2018 as much as IDR. 798,022,691.

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