International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-5C, May 2019

Measuring the Impact of Fiscal Decentralization on Economic Growth and Income Inequality using the Heuristic Network

Juliansyah Roy, Diana Lestari, Arfiah Busari

Abstract— To achieve regional economic growth, the role of regional budgets is very important. In this regard, the utilization of regional economic and financial resources is an important factor in supporting the implementation of the fiscal decentralization system in the area. The implementation of fiscal decentralization in Indonesia is marked by the process of transferring financial resources to regions in significant amounts. In the last five years (2011-2015), the proportion of balancing funds to total regional income nationally reached an average of 73%. Despite the huge spike in decentralization policies, the implementation of fiscal decentralization in East Kalimantan Province, one of Indonesia's provinces, till now has not been able to bring about improving the welfare of local communities. In reality, there is still income inequality, although still relatively low in East Kalimantan Province. This study performs to measure the impact of fiscal decentralization on economic growth and income inequality in East Kalimantan – Indonesia. The hypothesis in this study is that fiscal decentralization negatively affects income inequality directly or indirectly through economic growth in East Kalimantan – Indonesia. The aim of this study is how to use the heuristic network to prove this hypothesis.

Keywords— fiscal decentralization, economic growth, income inequality, heuristic network

I. INTRODUCTION

Until now, fiscal decentralization and regional autonomy are always interesting topics to discuss. This is because the study of fiscal decentralization is not only an economic aspect, but is closely related to other dimensions such as politics, administrative, and geographical. Moreover, the results of fiscal decentralization studies often do not produce the same conclusions among researchers and enthusiasts of decentralization. There is a clash of opinions with each side having a logical argument and empirically proving it. From a development point of view, decentralization is not only aimed at improving fiscal capacity and efficiency, but also on improving the institutional quality at the local level to support economic growth. This is stated by the study that has been done in [1]. The results of this study confirm that the level of fiscal decentralization is a major determinant of the state's fiscal efficiency. One study of the impact of fiscal decentralization on economic growth that has been done in [2] shows that fiscal decentralization can lead to significant long-term economic growth (especially significant for income decentralization), but in the short run, this causes a decline in economic growth. To achieve regional economic growth, the role of regional budgets is very important. Through local budgets, local governments can allocate a portion of their revenues to improve public services. The budgeting mechanism in this area involves the stakeholders in determining the priority and size of the budget ceilings required in the financing of public services. In this regard, the utilization of regional economic and financial resources is an important factor in supporting the implementation of the fiscal decentralization system in the area. However, the implementation of fiscal decentralization can lead to fiscal disparities and unequal utilization of factors of production (economic resources) that exist in the area. This inequality can lead to uneven fiscal capacity between regions, so that regional financial independence becomes disrupted in supporting the achievement of regional economic growth. This has been studied in [3]. In another study that has been done in (1) shows that fiscal decentralization is increasing when equipped with good institutional structures in terms of low corruption in government institutions, legislation, high bureaucratic quality and democratic accountability. Therefore, decentralization can be an increase in growth if macroeconomic stability and the quality of government institutions exceed the critical levels (economic resources) that exist in the region. This inequality can lead to uneven fiscal capacity between regions, so that regional financial independence is disrupted in supporting the achievement of regional economic growth [4].

The implementation of fiscal decentralization in Indonesia is marked by the process of transferring financial resources to regions in significant amounts. In the last five years (2011-2015), the proportion of balancing funds to total regional income nationally reached an average of 73%. From these figures, it is clear that the regions are still dependent on the balancing funds to carry out their various development programs and activities.

Manuscript published on 30 May 2019.
* Correspondence Author (s)
Juliansyah Roy, Department of Economic Study, Mulawarman University, East Kalimantan, Indonesia. (E-Mail: jlnsyh_roy@yahoo.com)
Diana Lestari, Assistant Professor, Department of Management Studies, KLHBS, Hyderabad, R.R, Telangana, India (E-Mail: diana_lestari82@yaoo.co.id)
Arfiah Busari, Professor, Department of ECE, Sreenidhi Institute of Science & Technology, Hyderabad, India (E-Mail: arfiahbusari@gmail.com)

As it is the largest component in the allocation of transfers to regions, balancing funds have a very important role in regional finance, especially in supporting the implementation of fiscal decentralization and regional autonomy. The government continues to make a continuous improvement on the mechanism of channelling transfers to the regions. There are many studies on the effectiveness of fiscal decentralization policies, one of which is in [5] which measures and determines the effectiveness of fiscal decentralization. Despite the huge spike in decentralization policies, the implementation of fiscal decentralization in East Kalimantan Province, one of Indonesia's provinces, till now has not been able to bring about improving the welfare of local communities. In reality, there is still income inequality, although still relatively low in East Kalimantan Province. The income inequality can be interpreted as the difference in economic prosperity between the rich and the poor. This is reflected in the difference in income. As a result of the difference it will be seen the gap between the rich will get richer and otherwise the poor will get worse. One of study that has been conducted in [6] shows that educational; wealth, and also the employment sector are significant contributors to income inequality in Indonesia. These findings suggest that any policy aimed at reducing unequal access to education and finance is important to improve future income inequality.

Other studies that have been done in [7] have considered how education and globalization affect the income inequality in Asia, with uneven panel data. The results of this study indicate that a higher education levels achieved by people aged 15 and over have improved the distribution of income in Asia, while education inequality, as measured by the Gini education index, has a negative impact on income distribution. The various transmission mechanisms and drivers of increased income inequality are identified and the possibility of a forward-looking development policy to reduce income inequality is given. This has been studied in [8]. The study findings that have been made in [9] show that decentralization initially hampered but ultimately in creased accountability and political and civil freedom, in line with the positive correlation hypothesis between larger fiscal autonomy and inclusive participatory government. The impact of fiscal decentralization on income inequality depends on local government financial resources, i.e. intergovernmental transfers may have a role in equal distribution of income, and provide empirical support for the validity of the Kuznets hypothesis in which there is a nonlinear relationship between the rate of economic development and income inequality [10].

There are so many methods and techniques to measure the impact of a variable on other variables and/or to measure comparative performance in terms of technical efficiency. One of them is descriptive analysis, Pearson correlation test, regression test used to test the correlation of data pattern that has been modelled using multiple linear models [11]. Random effects of GLS (Generalized Least Square) regression and G2SLS (Generalized Two-Stage Least Square) and Kuznets hypothesis have also been used to measure the impact of fiscal decentralization on poverty and income inequality in [12]. Parametric model (using simple OLS (Ordinary Least Square)) and non-parametric model (using DEA (Data Envelopment Analysis)) have also been used to measure comparative performance in terms of technical efficiency [1].

This study proposes the use of Heuristic Networks to measure the impact of fiscal decentralization on economic growth and income inequality in East Kalimantan – Indonesia. The hypothesis in this study is that fiscal decentralization negatively affects income inequality directly or indirectly through economic growth in East Kalimantan – Indonesia. The aim of this study is to prove the hypothesis.

II. METHODS

2.1 Economic Growth and Income Inequality

Economic growth is the process of changing the economic conditions of a country/region on a continuous basis to a better state for a certain period. Economic growth can be interpreted also as a process of increasing the production capacity of an economy which is realized in the form of an increase in national income. The existence of economic growth is an indication of the success of economic development in people's lives. Economists define economic growth as an increase in GDP / GRDP, regardless of whether the increase is greater or less than the rate of population growth, or whether or not a change economic structure. The most important components of economic growth are capital accumulation, population growth, and technological progress. Economic growth is measured by comparing the current GDP / GRDP with the previous year. In relation to regional economic growth, this can be stated as:

$$\mathbf{Growth(t)} = \frac{\mathbf{GRDP(t) - GRDP(t-1)}}{\mathbf{GRDP(t-1)}} \times \mathbf{100} \qquad \textbf{(1)}$$

Where $Growth(t)$, $GRDP(t)$ and $GRDP(t-1)$ are economic growth in current year, GRDP in current year and GRDP in previous year, respectively.

The income inequality is the difference in the amount of income received by society, resulting in greater income disparities among groups within the community. As a result of the difference it will be seen the gap of the rich will get richer and otherwise the poor will get worse. Indicators to determine inequality and income gap can be done with Lorenz curve and GINI coefficients expressed by the following formula [8]:

$$\boldsymbol{GINI(t)} = \frac{\sum_{j=1}^{N}\sum_{k=1}^{N}\left|y_j - y_k\right|P_jP_k}{2\bar{Y}\sum_{i=1}^{N}P_i} \qquad \textbf{(2)}$$

Where y_i is country's i's relevant measure of income and/or consumption (or indicator of interest), and P_i is country's i's population. $\bar{Y}$ is the total average income and/or consumption weighted by population which expressed by:

$$\bar{Y} = \frac{\sum_{i=1}^{N} y_iP_i}{\sum_{i=1}^{N} P_i} \qquad \textbf{(3)}$$

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

The Gini coefficient will give a value between 0 and 1, with 0 denoting the perfect equation and 1 indicating perfect inequality. Fiscal decentralization is a vital issue in the academic discipline of public finance for its effects on the efficiency of public sector and economic growth. Theoretically, fiscal independence at sub-national level leads to higher per capita output and higher rates of growth by enhancing economic efficiency. Fiscal decentralization promotes economic growth by transmitting spending authority to better-equipped local governments to effectively meet country and regional demands. The benefits of fiscal decentralization also have some potential risks that can adversely affect economic growth and development [4]. Conceptually, the form of functional relationships of the effects of fiscal decentralization on economic growth and income inequality is shown in Fig. 1.

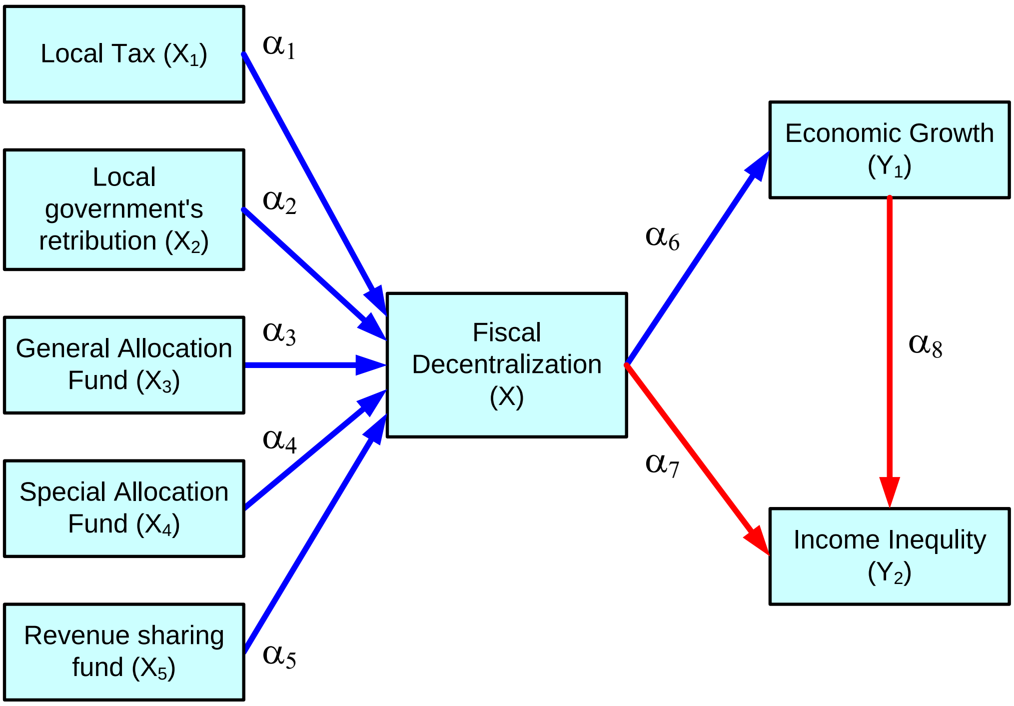

Figure 1. The form of functional relationships of the effects of fiscal decentralization on economic growth and income inequality

Mathematically, the model of the structural equation is expressed by:

$$X = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + e_1 \quad (4)$$

$$Y_1 = \alpha_6 X + e_2 \quad (5)$$

$$Y_2 = \alpha_7 X + \alpha_8 Y_1 + e_3 \quad (6)$$

Where Y_1 and Y_2 are the economic growth and income inequality, respectively, X_1 ... X_5 are the variables of fiscal decentralization, α_1 ... α_8 are partial coefficients of X, and Y, and e_1 ... e_3 are estimated error. Referring to Eq. (5), X is independent variable, whereas Y_1 is dependent variable. Referring to Eq. (6), X and Y_1 are independent variables, whereas Y_2 is dependent variable.

2.2 Heuristic Network

Unlike algorithms, heuristics are problem-solving, learning, or discovery approaches that use practical methods that are not guaranteed to be optimal or perfect, but significant enough to achieve goals [13]. In other words, brought to logical boundaries, heuristic is a *rule of thumb*. The process of heuristic solutions depends on intuitive or empirical rules, which, if applied to the problem, provide one or more solutions [14]. Referring to Eq. (4) – (6), there are many method to obtained all partial coefficients and estimated errors. Some of them are OLS and GARCH (Generalized Auto Regressive Conditional Heterokedasticity). The substitution of Eq. (4) into Eq. (5) is denoted by:

$$Y_1 = \alpha_6(\alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + e_1) + e_2 \quad (7)$$

$$Y_1 = a_1 X_1 + a_2 X_2 + a_3 X_3 + a_4 X_4 + a_5 X_5 + \mu$$

Where a_1 ... a_5 and μ are the new partial coefficients, and estimated error of Y_1, respectively.

If each variable X is considered to contribute an estimated error then Eq. (7) can be expressed by:

$$Y_1 = (a_1 X_1 + \mu_1) + (a_2 X_2 + \mu_2) + (a_3 X_3 + \mu_3) + (a_4 X_4 + \mu_4) + (a_5 X_5 + \mu_5) \quad (8)$$

If the estimated contribution of each variable error X is considered to be derived from the residual correlation between variable X and all other variables, then it can be expressed:

$$\begin{aligned} Y_1 = {} & c_1 f\big(a_{11} X_1 + a_{12}.f(R_1)\big) + c_2.f\big(a_{21} X_2 + a_{22}.f(R_2)\big) + c_3.f\big(a_{31} X_3 + a_{32}.f(R_3)\big) \\ & + c_4.f\big(a_{41} X_4 + a_{42}.f(R_4)\big) + c_5.f\big(a_{51} X_5 + a_{52}.f(R_5)\big) + Z \end{aligned} \quad (9)$$

$$\begin{aligned} R_1 &= w_{12} X_2 + w_{13} X_3 + w_{14} X_4 + w_{15} X_5 \\ R_2 &= w_{21} X_1 + w_{23} X_3 + w_{34} X_4 + w_{35} X_5 \\ R_3 &= w_{31} X_1 + w_{32} X_2 + w_{34} X_4 + w_{35} X_5 \\ R_4 &= w_{41} X_1 + w_{42} X_2 + w_{43} X_3 + w_{45} X_5 \\ R_5 &= w_{51} X_1 + w_{52} X_2 + w_{53} X_3 + w_{54} X_4 \end{aligned} \quad (10)$$

Where $a_{11} \dots a_{51}$ and $a_{12} \dots a_{52}$ are the partial coefficient of each variable X, and partial coefficient of their residual correlation, respectively, $w_{12} \dots w_{54}$ are the weight of each other variables, $c_1 \dots c_5$ are main coefficients of each variable X, and $f(\ )$ is a logistics function that guarantees the sum of all data multiplications with each weighting within acceptable data ranges. Z is control variable. If all input variables are independent and all data is normalized such that they are in range {0 ... 1} then initial value Z = -1. In compact form can be stated by:

$$\begin{bmatrix} R_1 \\ R_2 \\ R_3 \\ R_4 \\ R_5 \end{bmatrix} = \begin{bmatrix} 0 & w_{12} & w_{13} & w_{14} & w_{15} \\ w_{21} & 0 & w_{23} & w_{24} & w_{25} \\ w_{31} & w_{32} & 0 & w_{34} & w_{35} \\ w_{41} & w_{42} & w_{43} & 0 & w_{45} \\ w_{51} & w_{52} & w_{53} & w_{54} & 0 \end{bmatrix} * \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{bmatrix} \quad (11)$$

$$\begin{bmatrix} Y_{11} \\ Y_{12} \\ Y_{13} \\ Y_{14} \\ Y_{15} \end{bmatrix} = f\left(\begin{bmatrix} a_{11} \\ a_{21} \\ a_{31} \\ a_{41} \\ a_{51} \end{bmatrix} .* \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{bmatrix} + \begin{bmatrix} a_{12} \\ a_{22} \\ a_{32} \\ a_{42} \\ a_{52} \end{bmatrix} .* f\left(\begin{bmatrix} R_1 \\ R_2 \\ R_3 \\ R_4 \\ R_5 \end{bmatrix} \right) \right) \quad (12)$$

$$Y_1 = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \end{bmatrix} .* \begin{bmatrix} Y_{11} \\ Y_{12} \\ Y_{13} \\ Y_{14} \\ Y_{15} \end{bmatrix} + Z \quad (13)$$

Eq. (11) - (13) can be described by using heuristic network as shown in Fig. 2. If actual value denoted by Y_1 and output heuristic network denoted by $\bar{Y}_1$ then the error network expressed by:

$$e = Y_1 - \bar{Y}_1 \quad (14)$$

The error function used is SSE (Sum Squared Error) which is expressed by:

$$SSE = \frac{1}{2}\sum_{i=1}^{K}\left(Y_1(i) - \bar{Y}_1(i)\right)^2 = \frac{1}{2}\sum_{i=1}^{K}\left(e(i)\right)^2 \quad (15)$$

Where K is the number of train data.

The Heuristic Network is built to optimize all network weights in such a way so that $SSE \to 0$ through training process.

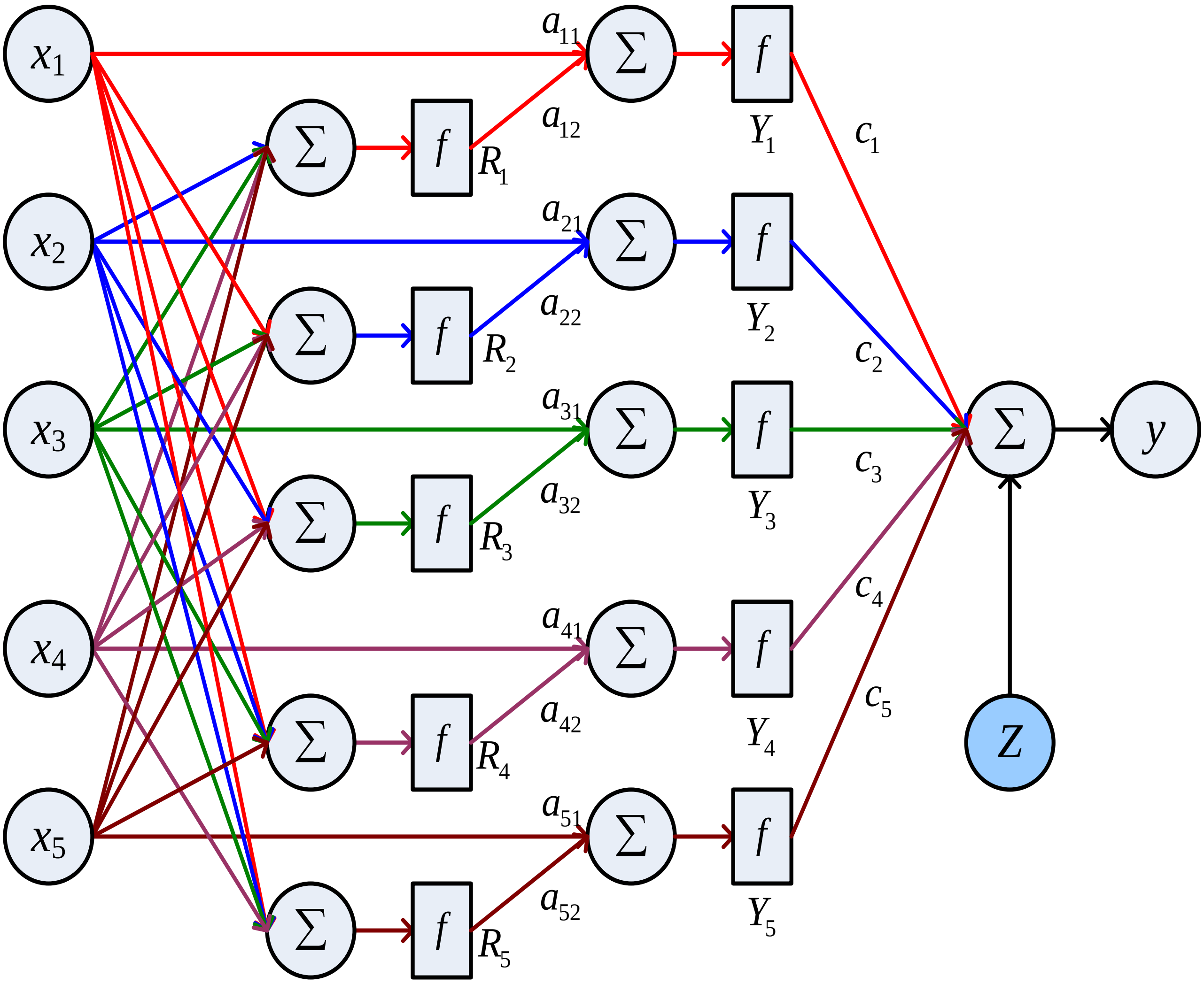

Figure 2. Heuristic Network

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Weighted adjustment is done by dividing network error based on the weighting proportion. Referring to Fig. 2, then the division of network error is expressed by:

$$dc_i = E.*\frac{Y_{1i}}{\sum_{i=1}^{5} Y_{1i} + Z} \qquad dZ = E.*\frac{Y_{1i}}{\sum_{i=1}^{5} Y_{1i} + Z} \qquad (16)$$

$$da_{i1} = dc_i.*\frac{X_i}{X_i + R_i} \qquad da_{i2} = dc_i.*\frac{R_i}{X_i + R_i} \qquad (17)$$

$$dw_{ij} = da_{i2}.*\frac{w_{ij}}{\sum_{j=1}^{5} w_{ij}} \qquad (18)$$

Weighted adjustment is expressed by:

$$w_{ij(new)} = w_{ij(old)} + dw_{ij} * alpha$$
$$a_{i1(new)} = a_{i1(old)} + da_{i1} * alpha \quad a_{i2(new)} = a_{i2(old)} + da_{i2} * alpha \qquad (19)$$
$$c_{i(new)} = c_{i(old)} + dc_i * alpha \quad Z_{(new)} = Z_{(old)} + dZ * alpha$$

Where *alpha* is the learning parameter.

To stop the iteration process during training, it is necessary to use the target error that is set close to zero. The training process is terminated if $SSE < SSE_{target}$. The logistic function used is tangent-sigmoid expressed by:

$$f(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}} \qquad (20)$$

2.3 Datasets

This study is using datasets as shown in Table 1 and 2. To measure the effect of all the independent variables to the dependent variable, the Eq. (5) and (6) are need to be modified as follows:

$$Y_1(t+1) = \alpha_6 X(t) + e_2 \qquad (21)$$
$$Y_2(t+1) = \alpha_7 X(t) + \alpha_8 Y_1(t) + e_3 \qquad (22)$$

The heuristic network training process is done using programs created using MATLAB tool software.

Table 1. Datasets of the fiscal decentralization in East Kalimantan – Indonesia Period 2010-2015

No.	District/City	YEAR (*t*)	Local Government's Tax (X1)	Local Government's Retribution (X2)	General Allocation Fund (X3)	Special Allocation Fund (X4)	Revenue Sharing Fund (X5)
1	SAMARINDA	2010	24.15786	24.04357	26.16978	23.16826	27.15548
2		2011	24.28756	23.98326	26.30201	23.56492	26.97937
3		2012	24.49037	24.29586	26.37104	22.82276	27.31873
4		2013	24.62133	24.51462	26.31591	23.66977	27.19514
5		2014	24.80343	24.66025	25.92076	19.52209	27.35946
6		2015	24.96541	24.88043	25.79507	20.04883	27.27198
7	BALIKPAPAN	2010	24.54454	23.85961	25.62922	23.03780	27.20808
8		2011	24.61855	23.94650	25.91328	23.18826	27.05967
9		2012	24.90071	23.99134	25.88456	22.75155	27.38264
10		2013	25.05676	24.04519	25.89856	24.26689	27.11592
11		2014	25.20562	24.09345	25.06692	22.59390	27.35797
12		2015	25.27710	24.19754	24.93795	23.32116	27.43544
13	BONTANG	2010	23.37710	21.46658	25.13032	23.34931	27.14527
14		2011	23.40628	21.65932	24.96327	22.39596	26.95162
15		2012	23.53099	21.90351	24.61365	22.72339	27.28438
16		2013	23.49626	22.02800	23.52183	22.76019	27.01582
17		2014	23.43968	21.77487	22.63894	22.67053	27.33459
18		2015	23.53415	21.96583	22.86829	22.76019	27.19326
19	KUKAR	2010	22.78497	23.29575	26.49978	24.61006	28.93262
20		2011	21.79480	22.91828	26.33272	21.85163	28.55909
21		2012	23.52165	23.82061	25.16929	21.76784	28.93070
22		2013	23.33257	23.95647	25.03344	24.37067	28.63534

Retrieval Number: E11440585C19/2019©BEIESP
DOI:10.35940/ijeat.E1144.0585C19
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

23		**2014**	23.00496	22.90807	22.61169	22.23821	29.03424
24		**2015**	22.69140	22.53174	22.36924	22.14578	29.32423
25	**KUTAI TIMUR**	**2010**	20.95051	21.73793	25.91727	23.04044	27.52285
26		**2011**	21.55935	22.39926	26.24782	25.61523	27.49903
27		**2012**	22.21076	22.98926	26.40076	26.89158	27.81246
28		**2013**	22.76182	22.97356	25.94206	24.75106	27.79700
29		**2014**	22.28603	22.75724	24.97457	24.61213	27.91272
30		**2015**	22.76182	22.15643	24.69029	24.53168	27.80394
31	**KUTAI BARAT**	**2010**	21.36931	22.06838	26.35143	24.60198	27.14488
32		**2011**	22.02696	22.26167	26.52832	23.67750	27.12758
33		**2012**	22.47229	22.89008	26.63591	24.72612	27.31646
34		**2013**	22.00540	22.33456	26.55190	23.37103	27.25226
35		**2014**	22.78041	22.54632	26.25367	24.52929	27.45791
36		**2015**	22.26835	22.79182	26.35143	24.60198	27.29969
37	**PASER**	**2010**	20.85587	22.87078	25.48188	24.00175	27.04934
38		**2011**	20.92516	23.34098	25.87753	22.62697	26.90788
39		**2012**	21.46868	23.47457	25.93641	22.83155	27.29343
40		**2013**	21.39596	23.31125	25.56481	22.74574	27.12964
41		**2014**	21.99669	23.36984	23.95235	22.21922	27.35873
42		**2015**	20.59704	23.11490	23.76304	23.68646	27.19226
43	**BERAU**	**2010**	22.35371	22.45341	26.08848	24.87772	27.03770
44		**2011**	22.54633	22.97917	26.41352	22.80424	26.91673
45		**2012**	22.57314	22.48448	26.43967	23.15222	27.26344
46		**2013**	22.85764	23.47669	26.26200	23.77020	27.01658
47		**2014**	22.27624	23.20982	25.80043	23.52105	27.30024
48		**2015**	22.11490	23.08183	25.65005	24.22573	27.35289
49	**PPU**	**2010**	20.42262	22.11804	24.18806	24.19040	27.13457
50		**2011**	19.71231	21.73920	24.68659	23.86684	26.90869
51		**2012**	20.00681	22.29042	24.22256	22.28737	27.23590
52		**2013**	20.05336	22.18996	23.84604	23.07009	26.94106
53		**2014**	20.46895	21.75195	23.62464	22.29973	27.31196
54		**2015**	20.53977	21.82996	24.40796	22.22502	27.50184

Retrieval Number: E11440585C19/2019©BEIESP
DOI:10.35940/ijeat.E1144.0585C19
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Table 2. Datasets of the economic growth and income inequality in East Kalimantan – Indonesia Period 2010-2015

NO.	District/City	Year (*t*)	Economic Growth (Y1)	Income Inequality (Y2)	Year (*t*+1)	Y1(*t*+1)	Y2(*t*+1)
1	SAMARINDA	2010	5.90	0.250	2011	3.11	0.249
2		2011	3.11	0.249	2012	4.82	0.189
3		2012	4.82	0.189	2013	4.49	0.151
4		2013	4.49	0.151	2014	6.30	0.110
5		2014	6.30	0.110	2015	6.60	0.131
6		2015	6.60	0.131	2010	3.26	0.270
7	BALIKPAPAN	2010	3.26	0.270	2011	2.08	0.186
8		2011	2.08	0.186	2012	12.37	0.150
9		2012	12.37	0.150	2013	1.70	0.135
10		2013	1.70	0.135	2014	5.13	0.140
11		2014	5.13	0.140	2015	7.22	0.138
12		2015	7.22	0.138	2010	(2.94)	0.206
13	BONTANG	2010	(2.94)	0.206	2011	(3.97)	0.280
14		2011	(3.97)	0.280	2012	0.53	0.175
15		2012	0.53	0.175	2013	(3.03)	0.194
16		2013	(3.03)	0.194	2014	(3.44)	0.174
17		2014	(3.44)	0.174	2015	(7.98)	0.184
18		2015	(7.98)	0.184	2010	(2.53)	0.240
19	KUKAR	2010	(2.53)	0.240	2011	(4.02)	0.211
20		2011	(4.02)	0.211	2012	4.67	0.249
21		2012	4.67	0.249	2013	2.08	0.222
22		2013	2.08	0.222	2014	3.88	0.222
23		2014	3.88	0.222	2015	0.25	0.222
24		2015	0.25	0.222	2010	22.39	0.221
25	KUTAI TIMUR	2010	22.39	0.221	2011	8.08	0.230
26		2011	8.08	0.230	2012	(0.86)	0.204
27		2012	(0.86)	0.204	2013	5.60	0.235
28		2013	5.60	0.235	2014	9.28	0.215
29		2014	9.28	0.215	2015	11.43	0.225
30		2015	11.43	0.225	2010	6.11	0.254
31	KUTAI BARAT	2010	6.11	0.254	2011	6.45	0.227
32		2011	6.45	0.227	2012	6.83	0.283
33		2012	6.83	0.283	2013	6.89	0.266
34		2013	6.89	0.266	2014	6.10	0.242
35		2014	6.10	0.242	2015	7.85	0.254

36		2015	7.85	0.254	2010	1.94	0.330
37	**PASER**	2010	11.94	0.330	2011	12.92	0.319
38		2011	12.92	0.319	2012	7.10	0.283
39		2012	7.10	0.283	2013	7.74	0.266
40		2013	7.74	0.266	2014	17.31	0.242
41		2014	17.31	0.242	2015	10.85	0.254
42		2015	10.85	0.254	2010	5.08	0.260
43	**BERAU**	2010	5.08	0.260	2011	5.70	0.247
44		2011	5.70	0.247	2012	4.97	0.219
45		2012	4.97	0.219	2013	10.57	0.186
46		2013	10.57	0.186	2014	8.03	0.180
47		2014	8.03	0.180	2015	7.93	0.183
48		2015	7.93	0.183	2010	1.63	0.246
49	**PPU**	2010	1.63	0.246	2011	3.79	0.284
50		2011	3.79	0.284	2012	4.99	0.245
51		2012	4.99	0.245	2013	3.51	0.229
52		2013	3.51	0.229	2014	7.28	0.225
53		2014	7.28	0.225	2015	11.68	0.227
54		2015	11.68	0.227			

III. RESULT AND DISCUSSION

There are two heuristic networks to be trained based on Eq. (21) and (22) by using all the data in Table 1 and 2. The SSE target used in the training process is 0.001, learning parameter used is alpha = 0.5, and all the weight initialization are set to 0.0001. The performances of training errors during the training process are shown in Fig. 3 and 4. All the final weights of heuristic network are shown in Table 3 and 4.

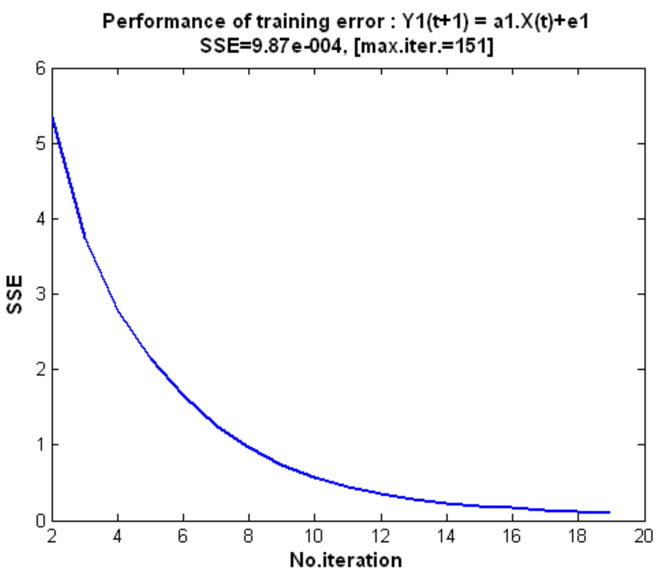

Figure 3. Training error performance of Heuristic Network 1 (Eq. (21))

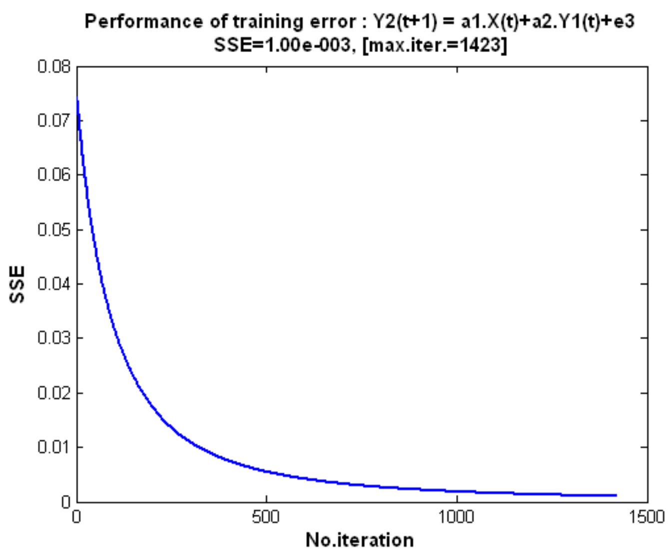

Figure 4. Training error performance of Heuristic Network 1 (Eq. (22))

Table 3. Final weight of Heuristic Network 1

Variables	Partial coefficient $a_{11} \dots a_{51}$	Coefficient of residual correlation $a_{12} \dots a_{52}$	Main coefficient $c_1 \dots c_5$
$X1$	0.53251	0.000433	0.53284
$X2$	0.53254	0.000403	0.53284
$X3$	0.53258	0.000366	0.53284
$X4$	0.53255	0.000391	0.53284
$X5$	0.53263	0.000311	0.53284

Table 4. Final weight of Heuristic Network 2

Variables	Partial coefficient $a_{11} \dots a_{51}$	Coefficient of residual correlation $a_{12} \dots a_{52}$	Main coefficient $c_1 \dots c_5$
$X1$	-0.00042	9.98E-05	-0.00042
$X2$	-0.00042	9.98E-05	-0.00042
$X3$	-0.00042	9.98E-05	-0.00042
$X4$	-0.00042	9.98E-05	-0.00042
$X5$	-0.00042	9.98E-05	-0.00042
$Y1$	-0.00034	9.98E-05	-0.00034

From Table 3 and 4 it can be found that all coefficients of residual correlation are small enough so that it can be said that all input variables are proved independent. Because all the main coefficients from Table 3 are positive so that it can be said that fiscal decentralization (X) gives a direct influence on economic growth ($Y1$) by the average of 0.53. While all the main coefficients from Table 4 are negative both X and $Y1$. It can be said that the fiscal decentralization directly gives a negative influence on income inequality by the average of -0.00042, and indirectly gives a negative influence through economic growth on the average of -0.00034. With the value of the main coefficient is small enough it can be concluded that fiscal decentralization does not give any effect to income inequality.

CONCLUSION

In this paper, the heuristic network has been used to measure the impact of fiscal decentralization on economic growth and income inequality. After the training process, all residual correlation coefficients are obtained quite small. This proves that all input variables are independent. The analysis of all main coefficients concludes that fiscal decentralization does not give any effect on income inequality. In this case, the hypothesis that has been made is proven. To prove the accuracy of the conclusions that have been made, the future work is how to measure the impact of income inequality on economic growth and fiscal decentralization.

ACKNOWLEDGMENTS

The authors would like to express their heartfelt thanks to The Modern Computing Research Center, Department of Information Technology, State Polytechnic of Samarinda for providing all their support.

REFERENCES

1. D. Tirtosuharto, Does fiscal decentralization help Indonesia avoid the middle-income trap ?, ADBI Working Paper 729. Tokyo:Asian Development Bank Institute, Japan, 2017.
2. M. Miri, E. H. Taacha, and M. A. Benatia, “Fiscal Decentralization and Economic Growth in Morocco: A Panel Cointegration Analysis,” International Journal of Economics and Financial Issues, vol. 7, no. 6, pp. 192-201, 2017.
3. T. H. Simanjuntak, and I. Mukhlis, “The Relation of Fiscal Decentralization, Regional Finance and Social Justice for the Local Development of Indonesia,” Applied Economics and Finance, vol. 4, no. 1, 2016.
4. U. Arif, and E. Ahmad, “Growth Effects of Fiscal Decentralization: The Role of Macroeconomic Stability and Governance Institutions,” FWU Journal of Social Sciences, vol. 11, no. 1, pp. 276-289, 2017.
5. A. Fye, “Significance of fiscal decentralisation: The Gambia at a glance,” Net Journal of Business Management, vol. 5, no. 1, pp. 6-18, 2017.
6. E. Wicaksono, H. Amir, and A. Nugroho, “The sources of income inequality in Indonesia: A Regression-based inequality decomposition,” ADBI Working Paper 667. Tokyo: Asian Development Bank Institute, 2017.
7. K. H. Park, Education, globalization, and income inequality in Asia, ADBI Working Paper 732. Tokyo: Asian Development Bank Institute. , Japan, 2017.
8. S. R. Basu, “Do data show divergence ? Revisiting global income inequalitiy trends,” Asia-Pacific Development Journal, vol. 24, no. 1, pp. 23-53, 2017.
9. A. Bojanic, “The Impact of Fiscal Decentralization on Accountability, Economic Freedom, and Political and Civil Liberties in the Americas,” Economies, vol. 6, no. 1, pp. 8, 2018.
10. S. Makreshanska, and G. Petrevski, Decentralization, scal transfers and income inequality in Central and Eastern European countries, Skopje, 2016.
11. R. Islam, A. B. A. Ghani, r. Z. Abidin et al., “Impact on poverty and income inequality in Malaysia’s economic growth,” Problems and Perspectives in Management, vol. 15, no. 1, pp. 55-62, 2017.
12. C. F. Sepulveda, and J. Martinez-Vasquez, “The consequences of fiscal decentralization on poverty and income equality,” Environmental and Planning C: Government and Policy, vol. 29, pp. 321-343, 2011.
13. L. Magnani, Heuristic Reasoning: Springer International Publishing Switzerland, 2015.
14. M. B. Ridha, “The Role of Heuristic Methods as a Decision-Making Tool in Aggregate Production Planning,” International Journal of Business Administration, vol. 6, no. 2, 2015.