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Convergence analysis and spatial dependency of economic growth in the districts/municipality in Central Sulawesi Province

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Abstract. This research aims to analyze the economic growth convergence and spatial dependency in the districts/municipality in Central Sulawesi Province 2010-2014 period. The analysis used panel data regression with Fixed Effect Model and Moran Statistics approach. The results show, firstly no σ-convergence of economic growth in the districts/municipality in Central Sulawesi over the period. These result indicated by the standard deviation and coefficient of variation per capita GDRP is increasing. Second, there is β-convergence conducted by absolute convergence and conditional convergence on economic growth in all district/municipality in Central Sulawesi. Third, life expectancy, mean years of schooling and length of good roadway have a significant impact on economic growth in the districts/municipality in Central Sulawesi. Fourth, there is no spatial dependency on economic growth among districts/municipality in Central Sulawesi Province.

1. Introduction

Regional development is an integral part of national development. The development undertaken by the region in addition aims to increase the per capita income and the welfare of the region's people, also aims to catch up and align itself with the already developed areas, in terms of income, productivity, wages and other economic indicators, disparities between regions will be reduced, known as "inter-regional convergence [1].

Research on the reduction of regional disparity (convergence) can be started from the growth model by Solow (1956) and (1957) in [2], which states the convergence of per capita income between countries if non-rival technology can be distributed across countries.

Central Sulawesi has the largest area on Sulawesi Island spread over 13 districts/city with abundant natural resources. By [3], the convergence of economic growth in Central Sulawesi will be achieved if there is a process of convergence of economic growth in the districts /municipality through increasing per capita income growth. Inter-regional convergence is one indicator of success in regional development. However, the successful development of a region cannot be claimed as a success of the region itself.

Interrelated relationships or inter-regional spatial interactions cannot be ignored regarding influencing the success of the development. This study examines the convergence of economic growth between districts/city in Central Sulawesi Province as an indicator of the success of the regional

development. In addition to the convergence issue, the study of spatial linkages between districts/city in Central Sulawesi Province is also interestingly researched as a spatial picture of inter-regional linkages and indicators of development success in the Central Sulawesi region. The formulation of the problems is:

1. What is the convergence and how long will it take to achieve the economic growth convergence of districts/city in Central Sulawesi in the 2010-2014 periods?

2. Do the infrastructure and human capital factors affect the economic growth of districts/city in Central Sulawesi in 2010-2014periods?

3. What is the spatial linkage in the economic growth of districts/municipality in Central Sulawesi in the period 2010-2014?

2. Material and Method

This study examines the convergence of economic growth and spatial linkages in eleven districts/city in Central Sulawesi in 2010-2014 periods. Banggai Laut and North Morowali districts still join their grand districts.

In this study used four independent variables (besides the initial GDRP per capita) that are the length of the good roadway, the government's expenditure on economic function and housing function, Life Expectancy and Mean Year of Schooling in the form of the natural logarithm. The concept of economic growth in the convergence equation constructed in this study is approximated by real GDRP growth per capita. It adopts research conducted by [3] as well as other studies related to convergence such as [1, 4, 5].

2.1. Data Analysis

2.1.1 Sigma-Convergence Analysis. This concept can be measured by the size of dispersion such as standard deviation and or coefficient of variation (CV) which refers to [3],[1] and [6]. Convergence occurs when the dispersion between economies decreases over time.

The formula to calculate the coefficient of variation each year [7].

$$C = \frac{\sqrt{\frac{\sum(Y - \overline{Y})^2}{n}}}{\overline{Y}}$$

In which CV is the coefficient of variation in a given year, Yi represents the per capita real GRDP per districts /city of 2010-2014, and represents the mean of per capita real GDRP for 2010-2014 periods, whereas n is the number of districts and municipality.

2.1.2 Panel Data Regression Analysis. Some estimation techniques used in panel data are:

a. Common Effect Model
The model used [4]:

$$\ln\left(\frac{y_{it}}{y_{it-1}}\right) = s_0 + s_1 \ln y_{it-1} + \sum_{j=2}^{m} s_{ji} X_{it} + u_{it}$$

In this model ignores the regional and time dimensions, and estimates are done by the Ordinary Least Square (OLS) method.

b. Individual Effect Model
Fixed Effect Model (FEM)

$$\ln\left(\frac{y_{it}}{y_{it-1}}\right) = s_{0i} + s_1 \ln y_{it-1} + \sum_{j=2}^{m} s_{ji} X_{it} + u_{it}$$

In this technique, the value of the constant (intercept) of the regression model used by Sufii (2008) may be different for each district/city because each region has special characteristics that are different from other regions.

Random effect or Error Component Model (ECM)

In the model used [4]:

$$\ln\left(\frac{y_{it}}{y_{it-1}}\right) = s_0 + s_1 \ln y_{it-1} + \sum_{j=2}^{m} s_{ji} X_{it} + w_{it}$$

Where $w_{it} = {}_i + u_{it}$,

${}_i$ = the error component of the cross section

u_{it} = component error from cross-section and time series.

The intercept value in Error Correction Model (ECM) for each unit is random and represents a larger population with a constant mean value. To choose which model is right between common effect or individual effect is applied Chow test Arief in [4]:

The specified hypothesis is:

$$H_0: s_{01} = s_{02} = ... = s_{0n} \quad (cc \qquad e \qquad)$$

$$H_1: s_{01} \neq s_{02} \neq ... \neq s_{0n} \quad (i1 \qquad e \qquad)$$

Statistical test :

$$F_t = \frac{SSE_1 - SSE_2 /(n-1)}{SSE_2 /(nt-n-k)}$$

Where:

SSE1　　　　= Quadratic sum of equations of common effect model

SSE2　　　　= Quadratic sum of the remaining models of the individual effect

N　　　　　 = number of districts / city

T　　　　　 = number of time series

K　　　　　 = number of independent variables

c. Estimation of Panel Data Regression Model

The equation function of the panel data regression model is expressed as follows:

Absolute Convergence Model:

$$\ln\left(\frac{y_{it}}{y_{it-1}}\right) = s_0 + s_1 \ln y_{it-1} + u_{it}$$

Where:

s_0　 : Constant/intercept

s_1　 : Convergence coefficient

y_{it} :Gross Domestic Regional Product Percapita of district and municipality i in year t

y_{it-1} : Gross Domestic Regional Product Percapita of district and municipality i in year t-1

u_{it}　 : *error term*

i　　 : *cross-section*(11 districts and 1 city)

t　　 : *time series* (2010-2014 periods respectively)

Model Conditional Convergence:

$$\ln\left(\frac{y_{it}}{y_{it-1}}\right) = s_0 + s_1 \ln y_{it-1} + s_2 JLN_{it} + s_3 EKONPER_{it}$$

$$+ s_4 AHH_{it} + s_5 RLS_{it} + u_{it}$$

s_0 : Constant/intercept

s_1 : Coefficient convergence

y_{it} : GDRP Percapita at constant price 2000 of districts and municipality i at year t

y_{it-1} : GDRP Percapita at constant price 2000 of districts and municipality i at year t-1

JLN_{it} : Natural logarithm of length of good and the length roadway in districts and municipality
           i in year t

$EKONPER_{it}$: Natural logarithm of local government expenditure on economic and housing function in
           districts/municipality i year t

AHH_{it} : Natural logarithm of life expectancy index in districts/municipality i year t

RLS_{it} : Natural logarithm of mean length schooling in districts/municipality i year y

u_{it} : *error term*

i   : *cross-section*(11 districts/municipality)

t   : *time series*(2010-2014periods)

3. Results and discussion

3.1. σ-convergence analysis

The gamma (σ) convergence was analyzed by measuring the GDRP per capita dispersion level by calculating the standard deviation and coefficient of variation from the real GDRP per capita value. The existence of the results of the calculation of the two measures of dispersion is presented in the following table.

Table 1. Dispersion Measures of Real GDRP percapita Districts / Municipality in Central Sulawesi, 2010-2014 Period

Year	Deviation Standard of Logarithm GDRB Real per capita	Variation Coefficient of Logarithm GDRP Real per capita
2010	0.12212	0.01809
2011	0.12679	0.01869
2012	0.13113	0.01925
2013	0.13366	0.01953
2014	0.13180	0.01920

Source: BPS, data was be calculated by authors.

The results obtained from the calculation of the coefficient of variation and standard deviation above shows that the dispersion of logarithm value of GDRP per capita of 11 districts/city in Central Sulawesi is relatively increased in the observation period. This relatively high rate of dispersion shows that there has been an increasing disparity of per capita GRDP among districts/city in Central Sulawesi Province. Therefore, in general, the condition of sigma convergence does not occur in per capita GDRP per districts /city in Central Sulawesi Province.

3.2. Analysis of β-convergence

Selection of the Best Panel Regression Model was conducted by analize Absolute Convergence Regression Model. After processing with Eviews 7, the following results are obtained:

Table 2. Output Model Absolute Convergence

Variables	Common Effect Model		Fixed Effect Model		Random Effect Model	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Constant	-0.09	0.55	0.90	0.01	0.24	0.29
ln y_{it-1}	0.01	0.32	-0.05	0.02	-0.01	0.44
R^2	0.02		0.56		0.01	
Adjusted R^2	-0.00		0.47		-0.01	
F-Statistic	0.99		5.34		0.56	
Prob (F-Stat)	0.32		0.00		0.46	
Cross Section F	5.68		Chow Test			
Prob (Cross Section F)	0.00					
Chi-Sq. Stat			6.29		Hausman Test	
Prob (Chi-Sq. Stat)			0.01			

Source : [8] data calculated by authors

The first step of determining the right regression model is to test the significance of the model with the Chow Test. Based on the above table the value of Cross Section F (F_{test}) of 5.68. The F_{table} value with α = 5 percent and degrees of freedom (10.43) of 2.06. When compared, the value $F_{test} > F_{table}$ value so that the decision taken is rejected H_0 and the right model is the Fixed Effect Model.

The advanced test of the regression model is the Hausman Test using test statistic χ2. Based on table 2 the value of χ2 is 6.29. The value of χ2 table with α = 5 percent and degrees of freedom (df) = 1 of 3.84. When compared, the value of χ2 test> value χ2table so that the decision taken is rejected H0 and the right model is Fixed Effect Model.

Based on the previous test, the model used for the estimation of absolute convergence is the Fixed Effect Model as follows:

$$ln\left(\frac{y_{ti}}{y_{ti-1}}\right) = 0.90 - 0.05\, ln\ y_{ti-1} + U_{ti}$$

3.3. Conditional Convergence Regression Model

Based on the results of processing using Eviews 7, obtained the results presented in the following table 3:

Table 3. Conditional Convergence Model Processing Results

Variables	Common Effect Model		FixedEffect Model		RandomEffect Model	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Constant	-0.709	0.124	-12.835	0.049	-0.662	0.376
ln y_{it-1}	0.013	0.296	-0.131	0.002	-0.017	0.379
JLN	0.014	0.119	-0.017	0.075	-0.008	0.453
EKONPER	-0.013	0.244	0.007	0.379	-0.002	0.788
AHH	0.220	0.043	3.438	0.037	0.285	0.117
RLS	-0.056	0.091	0.212	0.056	-0.040	0.431
R^2	0.176		0.765		0.074	
Adjusted R^2	0.092		0.674		-0.020	
F-Statistic	2.090		8.453		0.785	
Prob (F-Stat)	0.082		0.000		0.565	
Cross Section F	7.127		Chow Test			
Prob (Cross Section F)	0.000					
Chi-Sq. Stat			24.067		Hausman Test	
Prob (Chi-Sq. Stat)			0.000			

Source : BPS, data to be calculated by authors.

Based on the Chow test from table 3, Cross Section F_{test} value is 7,127. The F_{table} value with $\quad$ = 5 percent and degrees of freedom (10.39) of 2.08. When compared, the value $F_{test} > F_{table}$ value so that the decision taken is rejected H_0 and the right model is the Fixed Effect Model. The advanced test of the regression model is the Hausman Test. Based on table 3 the value of $\quad$2 is 24.067. The value of $\quad$2table with $\quad$ = 5 percent and degrees of freedom (df) = 5 of 11,071. When compared, the value of $\quad$2 test> value $\quad$2table so that the decision taken is rejected H_0 and the right model is the Fixed Effect Model. The model used to predict conditional convergence is the Fixed Effect Model as follows:

$$Ii\left(\frac{y_{Ii}}{y_{Ii-1}}\right) = -12.83 - 0.13\ Ii\ y_{Ii-1} - 0.02\ Jl + 0.01\ E + 3.44\ A + 0.21\ R + u_{Ii}$$

3.4. Classical Assumption Test
Multicollinearity Test

Table 4. Correlation Matrix

	GDRPKAP	JLN	EKONPER	AHH	RLS
GDRPKAP	1				
JLN	-0.18	1			
EKONPER	0.24	0.32	1		
AHH	0.42	-0.06	-0.08	1	
RLS	0.38	-0.25	-0.20	0.65	1

Source : Statistical Result

Table 4 shows that the correlation value between the independent variables is less than 0.80 so it can be concluded that the regression is free from multicollinearity effect.

Normality Test

Table 5. One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		55
Normal	Mean	.0000000
Parameters[a,b]	Std. Deviation	.02089955
Most Extreme	Absolute	.127
Differences	Positive	.112
	Negative	-.127
Kolmogorov-Smirnov Z		.941
Asymp. Sig. (2-tailed)		.339

a. Test distribution is Normal.
b. Calculated from data.

From the output of SPSS, it shows that the probability (P) of 0.339 is more than α = 5 percent (P> 0.05), there is no significant difference between the data tested and the normal standard data, meaning that the data is normally distributed.

Heteroscedasticity Test and Autocorrelation Test
The panel regression model used in the estimation of β-convergence is Fixed Effect Model with Generalized Least Square (GLS) method. Therefore, testing the assumption of heteroscedasticity and autocorrelation of the regression model is not necessary, since the violation of such assumptions in the GLS method has been anticipated [9].
Analysis and Interpretation of Estimated Results β-Convergence
The following table presents the results of the β-Convergence test.

Table 6. *-Convergence* Test Result of 11 Districts/Municipality inCentral Sulawesi In 2010-2014 Periods

Independent Variables	Dependent Variablesis $\ln\left(\dfrac{y_{it}}{y_{it-1}}\right)$					
	Absolute Convergence			*Conditional Convergence*		
	Coefficient	*t-stat.*	Prob.	Coefficient	*t-stat.*	Prob.
$\ln y_{it-1}$	-0.05	-2.42	0.02	-0.13	-3.31	0.00
JLN				-0.02	-1.83	0.08
EKONPER				0.01	0.89	0.38
AHH				3.44	2.16	0.04
RLS				0.21	1.97	0.06
R^2	0.56			0.77		
Adj R^2	0.47			0.67		
F-Stat	5.34			8.45		
Prob (F-Stat)	0.00			0.00		
Speed of convergence (persen)	5.45			14.04		
The half life of convergence (year)	13			5		

3.4.1 Absolute Convergence. Based on the estimation result using the Fixed Effect Model in Table 6, the value of the initial GDRP per capita coefficient (ln) for the absolute convergence model has a negative and significant direction. When viewed probability value < (0,05), so that decision taken is rejected H_0 which mean GDRP per capita early influence significant to economic growth.

The results of statistic testing with Fixed Effect Model show evidence that there is an absolute convergence of economic growth of districts/city in Central Sulawesi in 2010-2014 periods with a confidence level of 95 percent. Convergence speed or catch-up rate of 5.45 percent per year. While the value of the half life of the convergence model of absolute convergence shows a value of 13 years. This figure shows that the time required by the districts / city in Central Sulawesi to reduce half of the economic growth gap in of about 13 years

3.4.2 Conditional Convergence. From table 6, the adjusted value of R2 in the conditional convergence model to 67.4 percent. This indicates that infrastructure variables (Length of Good and Bad Roadway, Government Expenditures on Economic Function and Housing Function) and human capital (Life Expectancy Rate, Average Length School) can explain economic growth quite well.

Based on the estimation using Fixed Effect Model (FEM) with GLS method, as presented in Table 6, the value of the initial per capita GDRP coefficient (ln) for the conditional convergence model has a negative and significant direction with a 95 percent confidence level. Based on the results of statistical tests, it can be concluded that there is a conditional convergence of economic growth of districts/city in Central Sulawesi in 2010-2014 periods with a confidence level of 95 percent. The addition of infrastructure and human capital variables in conditional convergence increased the rate of convergence of districts/city economic growth in Central Sulawesi to 14.04 percent per year. The impact is the half-life of convergence or the time required by the districts/city in Central Sulawesi to close half of the initial gap to be shorter, ie 5 years.

3.5 Factors Affecting Economic Growth

The result of the Fixed Effect Model estimation with the GLS method shows the coefficient of determination (R^2) model which is formed equal to 0,765. This result implies that the model can explain the economic growth variation of districts/ city in Central Sulawesi at 76.5 percent. The remaining 23.5 percent is explained by other variables outside the model. The simultaneous significance test of the conditional convergence model with F-Test shows that Per capita GRDP, Length of Good or Bad Roadway, Government Expenditure on Economic Function and Housing Function, Life Expectancy and Length of Schooling Average are significantly influencing the economic growth of districts/city in Sulawesi Central 2010-2014 periods with a confidence level of 95 percent (table 7).

The results of the t-test can explain the independent variables (other than the initial GDRP per capita) affecting the economic growth of the districts/city in Central Sulawesi in the 2010-2014 period, as presented in the following table.

Table 7. t-test result

Variables	Coefficients	t-stat	Probability	Remarks
JLN	-0.017	-1.831	0.075	Significant (= 10 %)
EKONPER	0.007	0.889	0.379	No Significant
AHH	3.438	2.161	0.037	Significant (= 5 %)
RLS	0.212	1.973	0.056	Significant (= 10 %)

Based on the results of the t-test in table 7, it can be concluded that the variable Life Expectancy (AHH) has a positive and significant impact on the economic growth of districts/city in Central Sulawesi 2010-2014 periods with a confidence level of 95 percent.

Based on the results presented in table 7, Average of Length Schooling as one indicator of the quality of human capital in education, also positively and significantly influence the economic growth of districts/ city in Central Sulawesi with 90 percent confidence level.

The variable of length good and bad roadway also has a significant influence on the economic growth of districts/city in Central Sulawesi 2010-2014 period with 90 percent confidence level. However, the relationship between the two variables is the opposite. Policies related to the handling of quality and quantities of length roadway in Central Sulawesi are still limited. Based on BPS-Statistics of Transportation data, the growth of length good and bad roadway in the 2010-2014 period is only 1.52 percent, while the total growth of total roadway in the same period is smaller that is 0.33 percent. Funding related to ineffective highway infrastructure policies could be a burden for the region itself, triggering a slowdown in economic growth.

Another variable related to infrastructure is government spending by economic and housing functions. The results of the t-test in table 7 show that these variables do not significantly affect the economic growth of the districts/city in Central Sulawesi in 2010-2014periods. Inadequate allocation of local government spending related to infrastructure causes the independent variables no significant effect on economic growth.

3.6 Spatial Linkage Analysis

The following results are presented in the Moran's I of economic growth variable of districts / city in Central Sulawesi in 2010-2014 periods respectively.

Table 8. *Moran's Index Statistical Result*

Year	Moran'sI Stat	E(I)	V(I)	z-value	p-value
2010	0.049	-0.10	0.03	0.809	0.218
2011	0.117	-0.10	0.03	1.217	0.115
2012	0.037	-0.10	0.03	0.762	0.228
2013	-0.022	-0.10	0.03	0.491	0.316
2014	-0.180	-0.10	0.03	-0.464	0.349

Based on the data presented in the table above, the index value of Moran's I during the 2010-2013 period shows that the value of I> E (I). This indicates a positive autocorrelation, and there is a clustered pattern of areas with similar characteristics. While the value of index Moran's I in 2014 shows the opposite of the value of I <E (I), which means the data has a negative autocorrelation and shows the pattern spread.

To test the significance of inter-regional linkages is done by statistical testing. Based on table 8, in the period 2010-2014 the value of Z <Z table (Z table for   = 5 percent of 1.96). The conclusion obtained is the accept H_0 which means there is no link between economic growth between districts/city in Central Sulawesi in the 2010-2014 period.

4. Conclusion

From the results of the discussion and analysis that has been done can be concluded several the things as follows:

1. The σ-convergence analysis shows that there is no sigma convergence in districts / city economic growth in Central Sulawesi Province in 2010-2014periods.
2. The result of β-convergence analysis using Fixed Effect Model with Generalized Least Square technique shows the existence of Absolute Convergence and Conditional Convergence in economic growth of districts / city in Central Sulawesi with 95 percent confidence level.
3. Life Expectancy, Average of Length Schooling and length and quality road have a significant effect on economic growth. This proves that the factor of infrastructure and human capital have a significant effect on the economic growth of districts/city in Central Sulawesi in the 2010-2014 period.
4. There is no spatial correlation in districts/city economic growth in Central Sulawesi Province 2010-2014.

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