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The Linkage Among Economic Growth, Education and Health: Empirical Study in Java Island

Sang Aji Kharismarizky Susilo, Banatul Hayati, Amin Pujiati
Faculty of Economics and Business, Diponegoro University
Corresponding Author: sangajikharismarizky@gmail.com

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Abstract

Java Island accounts for more than half of Indonesia's gross domestic product (GDP), hence it is where the majority of economic activities are concentrated, even though mostly of those major contributions are from certain cities. However, the quality of education and health shown by average years of schooling and life expectancy at birth in Java Island is unevenly distributed when compared with economic growth. This research aims to analyze the causalities and effects of economic growth, education, and health using simultaneous equations models on panel data that consists of 34 cities in Java Island spanning from 2015 to 2019, which are decomposed into three income classifications. Results indicate positive and significant effect from education toward economic growth on every income level. Health instead only brings positive and significant effect toward economic growth in high-income cities. Economic growth affects education positively in upper-middle and lower-middle income cities, and affects health positively only in upper-middle income. Ultimately, the relationship between education and health shows that they have positive and significant effects on each other and are consistent across all income groups.

Keywords: Economic growth; Human capital; Simultaneous equation model
JEL classification: O15; O47; I15; I25; C30

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1. Introduction

Economic growth is a continuous expansion of various production possibilities as measured by the increase in the GDP over a certain period (Parkin, 2011). Todaro & Smith (2015) believed that economic growth also raises a nation's standards of living and brings great benefits in the form of increased consumption in the future. Generally, labor and investment are considered the main contributors to this growth (Bjork, 1999). However, as time went on, more and more researchers came to the conclusion that, in addition to labor and investment, human capital is a significant driver of economic growth (Mankiw et al., 1992; Barro, 2001; Hanushek, 2013; Dhrifi et al., 2021). Human capital, as defined by the modern approach, has a broader definition as now encompasses health factors rather than just the traditional education or skills (Hongyi & Huang, 2009). Eggoh et al. (2015) and Ogundari & Awokuse (2018) supported this by pointing out that investments in both education and health create human capital, which is a crucial component of economic growth and development. Moreover, the concept of human capital should be viewed broadly, taking into account aspects related to health and education.

As of 2019, a significant portion of Indonesia's GDP, 59.03% to be precise, was attributed by Java Island (BPS, 2020). The advantages of

economic growth in Java Island are not without explanation, as it is being the center of industries, business, and trade in Indonesia (Silalahi, 2019). Java Island also has the advantage in terms of demographics, as it is home to more than half of the country's population (BPS, 2021). As a result, it is not surprising that development in Indonesia is heavily concentrated on the island of Java. Although Java Island appears to be superior to the other islands, the high contribution is only due to a few urban areas on the island of Java, especially the metropolitan area and the provincial capital (Maryaningsih et al., 2007).

When looking at the distribution of education and health quality on Java Island, the issue with human capital becomes apparent, particularly when discussing it at the municipal (city) level. At this level, the quality of education and health on Java Island appears to be out of step with economic growth, as will be discussed shortly. Figure 1 and Figure 2 are the Klassen Typology for economic growth (proxied by per capita GRDP), education (by average years of schooling), and health (by life expectancy at birth) in cities on Java Island 2019. Cities with rapid economic growth and strong health/education systems make up Quadrant 1. High economic growth but poor educational/health in Quadrant 2, and the opposite in Quadrant 3. Quadrant 4 denotes an equal low reading for both indicators. A large portion of the city is concentrated below the per capita GRDP figure of IDR 123 billion (average value), so mostly falls into the Quadrant 3, and Quadrant 4, whereas Quadrant 2 has the fewest city, with only one on Figure 1 and two on Figure 2. The horizontal and vertical lines (separators between quadrants) are drawn from the average value of each indicator. The diagonal line is for linearity reference between variables.

The discussion begins with an indication of the unequal distribution between the quality of education and economic growth (Figure 1). Generally, there will be a positive correlation between the distribution of average school years and economic growth (Hanushek & Woessmann, 2010). But in this instance, it scatters erratically instead. Average years of schooling clustered mostly on the range of 10.0 to 11.0 and 8.0 to 9.0. The city with the lowest per capita GRDP is Banjar, but the lowest average years of schooling is held by the city of Tegal, despite having a higher per capita GRDP exceeding other 14 cities. Figure 2 shows the distribution of life expectancy at birth against per capita GRDP which is also spreading irregularly across the chart. Majority of the city clustered on life expectancy at birth value between 71.0 to 75.0. The biggest discrepancy can be found in Cilegon City, which has the lowest life expectancy at birth despite having one of the highest per capita GDPs on Java Island.

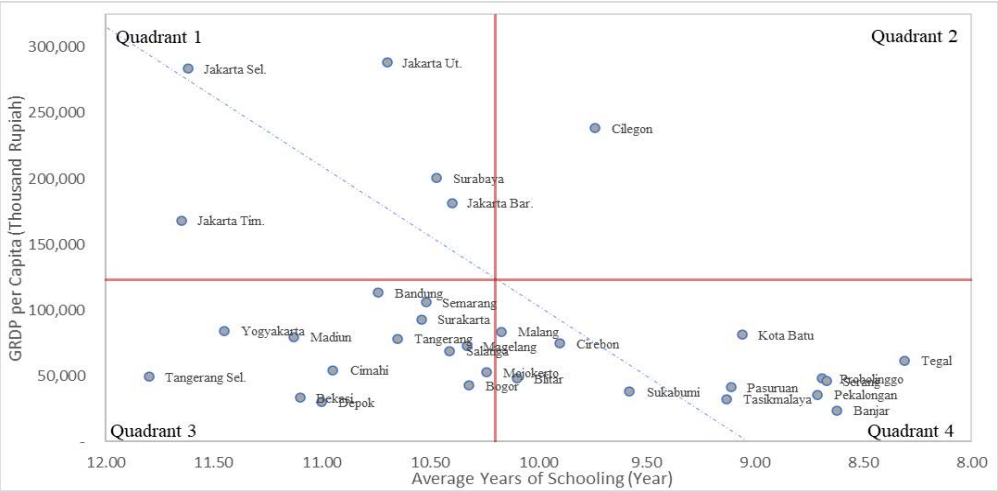

Figure 1. Klassen Typology on GRDP per Capita and Average Years of Schooling
Source: Statistics Indonesia, processed

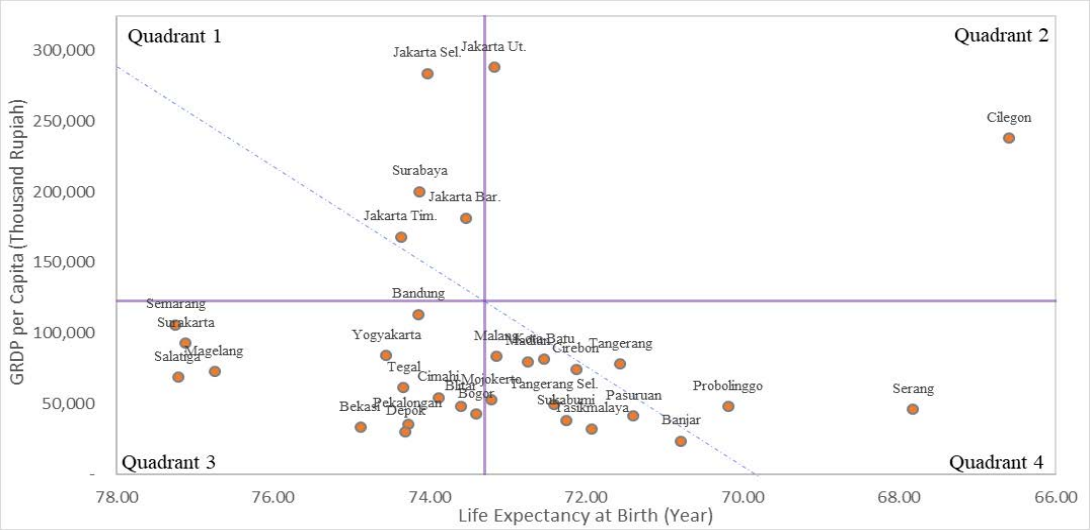

Figure 2. Klassen Typology on GRDP per Capita and Life Expectancy at Birth
Source: Statistics Indonesia, processed

Studies on the multidirectional effects of economic growth, education, and health simultaneously in Java Island are limited. A few known studies about the contribution of human capital to economic growth has been conducted on Java Island, but they are only in a one-way relationship on economic growth. Chotib & Suharto (2019) investigate the impact of human capital on economic growth in East Java, whereas Prasetyo (2020) focuses on Yogyakarta and Central Java, and the (2017) paper by Anwar does take the entirety of Java Island into account. Although health and education would ultimately have an impact on economic growth, it is established that education promotes health and vice versa (Todaro & Smith, 2015). Economic growth, educational, and health attainment have been shown to be correlated with one another in a tripartite relationship by studies by Dhrifi et al. (2021). Henceforth, this study intends to analyze the causalities between economic growth, education, and health in Java Island and presents empirical evidence of its impact using simultaneous equations models (SEM). This is due to the fact that while examining the influence of health on economic growth, the role of education is also taken into account. The use of a basic linear specification does not appear to produce consistent results. Besides economic growth, the two explanatory variables (health and education) must then be described, which produces simultaneity issues, and SEM would be the best method for evaluating the impact of which variables.

2. Research Method

This research aims to test whether aspects of economic growth, education, and health here are factors that influence each other. High income will lead to better education and healthcare; educated individuals typically lead healthier lives and take better care of themselves; healthier people will therefore do better in acquiring education; while worker with high human capital will contribute more towards economic growth (Todaro & Smith, 2015). One indicator that can represent the quality of education is the average years of schooling. Barro (2001) used this metric to measure the degree of human capital, as back then the concept of human capital is primarily refered only to education. Nowadays, health is commonly recognized as a component of human capital that complements education. Acemoglu & Johnson (2007) and Dhrifi et al. (2021) used life expectancy at birth as the proxy for the level

of health. Anwar (2017) used both indicators to proxy human capital in his paper.

To create the econometric model, this paper will use a theoretical framework of the macroeconomic production function, which emphasizes the three-way linkages between the three variables. In order to do this, we'll be using an augmented version of Solow's growth model (Mankiw et al., 1992), which takes into account labor, physical capital, and human capital as the independent variables.

$$Y = K^{\alpha} H^{\beta} AL^{1-\alpha-\beta} \quad (1)$$

Economic growth in this study is proxied by per capita GRDP which can be written as (***y***), and human capital can be dissolve into education and health (Dhrifi et al., 2021; Hongyi & Huang, 2009). Then the equation is converted into an econometric model.

$$y_{it} = a_0 + a_1 K_{it} + a_2 L_{it} + a_3 Ed_{it} + a_4 He_{it} + e_{it} \quad (2)$$

This model can be replicated into three structural equations with economic growth (eq 3), education (eq. 4), and health (eq. 5) as the explanatory variables. The initial research hypotheses are as follows: education and health have a positive impact on economic growth; education and health also have an impact on education quality; and finally, education and economic growth have an impact on health quality.

As previously said, this study focuses on the three-way relationship between economic growth, education, and health. In order to analyze it properly, an estimation using SEM will be utilized, rendering economic growth, education, and health as endogenous. Three structural equations will be used, all of which will use the endogenous variables. As the first structural equation can already be derived from eq. (2), the second and third structural equations must be constructed separately, and thus the relevant variables must be identified. Predetermined variables are utilized to supplement the second and third structural equations. Hongyi & Huang (2009) tested the effects of student-teacher ratios in primary and secondary schools on economic growth; this research seeks to be more precise by examining their impact on education quality rather than directly on economic growth. This study also includes the poverty rate as a predetermined variable that affects health, because poverty prevents people from getting the proper healthcares they need (Todaro & Smith, 2015). Finally, food expenditures will be included as a predetermined variables for health's structural equation. The complete structural equations are as follow:

$$lny_{it} = a_0 + a_1 lnK_{it} + a_2 lnL_{it} + a_3 lnEd_{it} + a_4 lnHe_{it} + \mu_{1it} \quad (3)$$

$$lnEd_{it} = \beta_0 + \beta_1 lny_{it} + \beta_2 lnHe_{it} + \beta_3 lnPrSch_{it} + \beta_4 lnSeSch_{it} + \mu_{2it} \quad (4)$$

$$lnHe_{it} = \gamma_0 + \gamma_1 lny_{it} + \gamma_2 lnEd_{it} + \gamma_3 FdExp_{it} + \gamma_4 lnPov_{it} + \mu_{3it} \quad (5)$$

Economic growth proxied by per capita GRDP (***y***), (***K***) is physical capital proxied by gross fixed capital formation, (***L***) is labor, (***Ed***) shows quality of education with average years of schooling as the proxy, (***He***) is health quality proxied by life expectancy at birth. (***PrSch***) and (***SeSch***) are student-teacher ratio for primary and secondary school respectively, higher ratio means higher students per teacher, while lower ratio means more teachers for students. (***FdExp***) is food expenditure per capita, and (***Pov***) is the poverty rate. All data are transformed into natural logarithm (ln), and all of the structural equations are overidentified. This is a panel data regression using secondary data sourced from Central Bureau of Statistics on the span of 5 years (2015-2019) for 34 cities in Java Island. These cities can be further decomposed and compared into three classifications based on income levels derived from "*World Bank Classification by Income Level 2019*" which are "high", "upper-middle", and "lower-middle" incomes.

Table 1. Classification of Income Levels

Classification	US Dollar ($)	Indonesian Rupiah (Rp)
Lower-middle income	$ 1,026 – 3,995	Rp 14,503,536 – 56,473,320
Upper-middle income	$ 3,996 – 12,375	Rp 56,487,456 – 174,933,000
High income	> $ 12,375	[> Rp 174,933,000

F-test is also being used to determine the significance of the simultaneous effect of the independent variables on the dependent variable. The three-stage least squares (3SLS) estimation method was chosen because the usage of ordinary least squares (OLS) in the SEM that have overidentified structural equations, appears unable to offer consistent estimations of model parameters (Gujarati & Porter, 2009). Furthermore, 3SLS outperforms two-stage least squares (TSLS) when considering the potential of correlation between error terms in structural equations (Dhrifi et al., 2021). In terms of classical assumption, all structural equations are normally distributed on every level of income, and don't have any multicollinearity problem. Also in this case, the 3SLS method approach assumes that the structural disturbance in each equation has a zero mean, making it homoscedastic and not serially correlated (Zellner & Theil, 1962). This suggests that heteroscedasticity and autocorrelation testing are unnecessary in this study.

3. Results and Discussion

Three-stage least squares (3SLS) is used to estimate the above eq. (3), eq. (4), and eq. (5) over in order to analyze the three-way relationship between economic growth, health, and education. The estimation is conducted into cities that are decomposed into three income classes, in total there are nine separate estimation regressions.

The Hausman test of endogeneity is used to determine whether a structural equation has simultaneity problems and whether the dependent variable is in fact endogenous (Gujarati & Porter, 2009). According to Table 2, all structural equations do have simultaneity problems, and the variables ***y***, ***Ed***, and ***He*** can be confirmed as endogenous variables. Thus, the SEM regression using the 3SLS method can be carried out.

The key findings of this study, as shown in Tables 3, 4, and 5 above, suggest that economic growth, education, and health significantly correlate each other, albeit the impacts may differ, supporting the three-way linkages. ***Ed*** has a positive and significant impact on ***y*** across all income levels. On high income cities, ***Ed*** has a positive effect on ***y*** with a coefficient of 3.236; coefficient of 1.7991 on upper-middle income; and coefficient of 2.4487 on lower-middle income. High-income cities appear to be having the highest coefficient, meaning that cities with higher GRDP per capita also tend to have better quality education, and thus policies and actions to improve education quality will remarkably aid economic growth in these places. This may be consistent with the study by Dhrifi et al. (2021), which found that education have a more favorable and significant impact on an economy with higher income. What is intriguing is that ***y*** has no significant impact on ***Ed*** in high income cities, as opposed to upper medium and lower-middle income cities, the former which have the highest significant coefficient of 0.2967. This could eventually lead to the assumption that education in higher-income economies is not caused by the high income itself, whereas education in lower-income cities would benefit greatly from economic growth.

He only influences ***y*** positively in high-income cities with the coefficient of 7.634 and adversely on the rest, with the greatest negative coefficient in low-middle-income cities with the coefficient of -14.441. Although this result is against the earlier hypothesis, the situation is comparable to that of Iskandar's (2017) study, which found that employing a human capital indicator would actually have a negative impact on economic growth instead. According to him, this is due to inefficient allocation and the

significant disparity between districts and cities. Research by Acemoglu & Johnson (2007) also found that health represented using life expectancy tends to have a negative effect on GDP per capita. This can be explained by the fact that, as shows on Figure 2, cities with lower GRDP per capita tend to have higher health quality compared to those with higher GRDP per capita, thus making the correlation being negative, confirming the issues explained in the introduction. This could also imply that good quality of health does not necessarily have an impact on the high productivity of an economy and vice versa.

Table 2. Hausman Test of Endogeneity

Structural Eq.	Endogenous Variables	*Residual*	*t-statistic*	*Probability*
Eq. (3)	***y = Ed, He***	*yResid*	7.1509	0.0000***
Eq. (4)	***Ed = y, He***	*EdResid*	17.3975	0.0000***
Eq. (5)	***He = y, Ed***	*HeResid*	30.2361	0.0000***

Note: ***) significant at α 1%; **) α 5%; *) α 10%.

Table 3. Estimation Coefficient on High Income Cities

Variables	Economic Growth Eq. (3)		Education Eq. (4)		Health Eq. (5)	
y	-		0.0128		-0.0242	***
K	0.4814	***	-		-	
L	-0.9770	***	-		-	
Ed	3.2357	**	-		0.9132	***
He	7.6336	***	0.6800	***	-	
PrSch	-		0.1521		-	
SeSch	-		0.1405	**	-	
FdExp	-		-		-0.0404	*
Pov	-		-		-0.0723	***
Obs	35		35		35	
R^2	0.89		0.40		0.63	

Table 4. Estimation Coefficient on Upper-middle Income Cities

Variables	Economic Growth Eq. (3)		Education Eq. (4)		Health Eq. (5)	
y	-		0.2132	***	0.1660	***
K	0.7351	***	-		-	
L	-0.7889	***	-		-	
Ed	1.7991	***	-		0.2515	***
He	-9.5452	***	1.1663	**	-	
PrSch	-		0.2928	*	-	
SeSch	-		-0.3036	***	-	
FdExp	-		-		-0.0950	***
Pov	-		-		-0.0351	***
Obs	65		65		65	
R^2	0.78		0.30		0.50	

Table 5. Estimation Coefficient on Lower-middle Income Cities

Variables	Economic Growth Eq. (3)		Education Eq. (4)		Health Eq. (5)	
y	-		0.2967	***	-0.0507	***
K	0.1141	*	-		-	
L	-0.2018	**	-		-	
Ed	2.4487	***	-		0.0557	*
He	-14.441	***	6.6489	***	-	
PrSch	-		0.2242	**	-	
SeSch	-		-0.0912		-	
FdExp	-		-		0.0083	
Pov	-		-		-0.0112	**
Obs	70		70		70	
R^2	0.62		0.54		0.12	

Note: ***) significant at α 1%; **) α 5%; *) α 10%.

However, both ***He*** and ***Ed*** do correlate positively to each other on all income levels, this is in line with the findings of Dhrifi et al. (2021). ***He*** affects ***Ed*** positively and significantly with the coefficient of 0.680 on high income cities; 1.166 on upper-middle income; and 6.649 on lower-middle income, the former of which have the greatest impact. On the other hand, ***Ed*** has significant and positive impact on ***He*** with high income cities having coefficient of 0.9132 on; upper-middle income having 0.2515; and lower-middle income having 0.0557. Based on the respective coefficients, policies and initiatives to improve education quality would benefit healthcare the most in places with higher growth, on the other hand, cities with lower growth would see the greatest improvement in education quality as a result of increased healthcare. It is this positive and varied correlation that shows the need to balance human development priorities between education and health between cities with high and low incomes. This effort can be fulfilled by raising the budget of education and healthcare, enhancing the quality of buildings and infrastructure, and ensuring equal access to education and health. Another effort is to eradicate poverty and improve people's living standards so that they are able to get opportunities for education and better health.

Secondary findings in this study are focused towards the predetermined variables, they show that ***K*** positively and significantly affects ***y*** on every income level, with upper-middle income cities having the largest coefficient of 0.7351, implying that investment should have the biggest impact on cities with upper-middle income, as cities in this classification also have growing industries. ***L*** has negative and significant impact toward ***y*** on all income levels. This implies that cities with lower per capita GRDP would require more labor to create the same amount of output than cities with greater per capita GRDP, which is inefficient. Based on Solow model, the use of more efficient labor means the rate of technological development is also advanced (Mankiw & Scarth, 2010), therefore this unfavorable result of ***L*** appears to confirm that cities are more technologically advanced the higher their income. ***PrSch*** has positive and significant correlation to ***Ed*** only on upper-and-lower-middle income with similar coefficient of 0.293 and 0.224 respectively. As the nature of this ratio, positive correlation means that increase in average years of schooling would likely be affected by increase in student quantity, in this case is the primary school. Meanwhile ***SeSch*** correlates ***Ed*** positively only on high income cities with coefficient of 0.141 and negatively on upper-middle income cities with -0.304 coefficient, this means increase in average years of schooling would likely be affected by increase in student quantity on high income cities, and by increase of teacher in upper-middle income cities. ***FdExp*** correlates ***He*** negatively

on high income and upper-middle income cities, meaning increased food consumption is inversely connected to health. ***Pov*** negatively affects ***He*** on every income level with highest coefficient is on high income cities with coefficient of -0.072. This indicates that poverty will have a greater impact on health when the economy has a higher standard of living.

4. Conclusions

This study investigates causal linkages and impacts among economic growth, education, and health in Java Island by using simultaneous equations models. Of all the above, it can be concluded that economic growth, education, and health have substantial correlations, albeit the effects may differ. In line with what is disclosed in the introduction, the primary findings indicate that there are indeed issues on human capital distribution, specifically health, in Java Island indicated by the life expectancy at birth indicator that negatively correlates with per capita GRDP. Between education and health, on the other hand, are favorably associated. This study also finds unusual results regarding the economic growth that is negatively impacted by labor, but the plausible explanation is that this was caused by inefficient worker on cities with lower per capita GRDP.

Empirical findings in this study have important implications that could be made into consideration. Based on what have been discussed, special emphasis should be placed on improving health outcomes and life expectancy in these cities. This can be accomplished by broadening access to healthcare, establishing health insurance programs, and creating a physically and mentally healthy work environment. Regarding the education quality, there must be government policies and programs in place to ensure that students may complete their education until they all graduate from high school, and more chances for tertiary education must be made available. Another aspect that is considered to be able to support the improvement of the quality of human capital is efforts to alleviate poverty and improve the welfare of the population. As with the improvement of human capital quality in Java, the aforementioned findings that showed the unusual negative correlation between labor and economic growth should also be resolved.

4.1 Limitation

The limitation of this study is that the use of indicator in this study, specifically on labor variables represented by the number of Work Force, and health variables represented by the Life Expectancy at Birth, in this case (34 Cities in Java Island 2015 - 2019). They naturally tend to show a negative correlation in cross-section, even though the value shows a steady increase in time series, this is most probably caused by the high disparity on these cities. As a result, the estimation results of those two variables had a negative effect on Economic Growth, resulting in contradictory estimation results with earlier studies and the possible formation of new research gaps.

4.2 Future Scope

Due to the limitations encountered in completing this investigation, further study is still required to pursue more conclusive results. There are various recommendations that future studies should consider if they want to continue their research in this area. One suggestion is to use more various indicator of education and health, might be an improvised index of many factors combined that could reflect the actual quality of both aspects closest to reality. Besides this, the sample of cities needs to be increased to yield more accurate results considering the topic itself is very cross-section intensive.

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6. Appendices

Appendix 1

Sample decomposition based on "*World Bank Classification by Income Level 2019*" with the Rupiah exchange rate against the US Dollar based on the 2019 average exchange rate of US $ 1 = Rp 14,136:

a. Lower-middle income : $ 1,026 – 3,995 [Rp 14,503,536 – 56,473,320]
b. Upper-middle income : $ 3,996 – 12,375 [Rp 56,487,456 – 174,933,000]
c. High income : > $ 12,375 [> Rp 174,933,000]

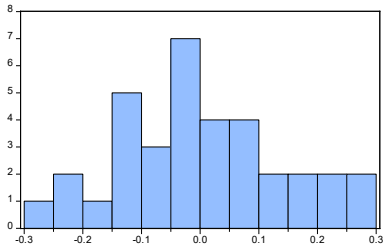
Cities	Per capita GRDP ($)	Cities	Per capita GRDP ($)	Cities	Per capita GRDP ($)
High Income		Kota Surakarta	6,568	Kota Depok	2,129
Kota Jakarta Selatan	20,093	Kota Salatiga	4,873	Kota Cimahi	3,839
Kota Jakarta Pusat	54,485	Kota Semarang	7,494	Kota Tasikmalaya	2,279
Kota Jakarta Barat	12,849	Kota Tegal	4,349	Kota Banjar	1,662
Kota Jakarta Utara	20,416	Kota Yogyakarta	5,961	Kota Pekalongan	2,518
Kota Kediri	34,238	Kota Malang	5,909	Kota Blitar	3,384
Kota Surabaya	14,174	Kota Madiun	5,635	Kota Probolinggo	3,382
Kota Cilegon	16,860	Kota Batu	5,763	Kota Pasuruan	2,923
Upper Middle Income		Kota Tangerang	5,532	Kota Mojokerto	3,716
Kota Jakarta Timur	11,895	**Lower Middle Income**		Kota Serang	3,253
Kota Bandung	8,006	Kota Bogor	3,001	Kota Tangerang Sel	3,492
Kota Cirebon	5,266	Kota Sukabumi	2,682		
Kota Magelang	5,127	Kota Bekasi	2,358		

Appendix 2

Normality and multicollinearity test results

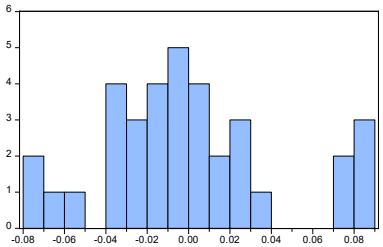
High Income Cities

Eq. (3)



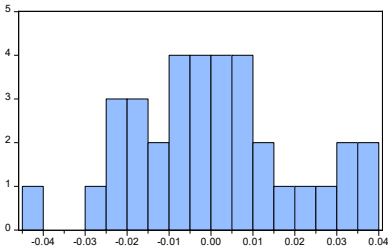
Jarque-Bera: 0.9168 (0.6322)

Eq. (4)



Jarque-Bera: 1.1761 (0.5554)

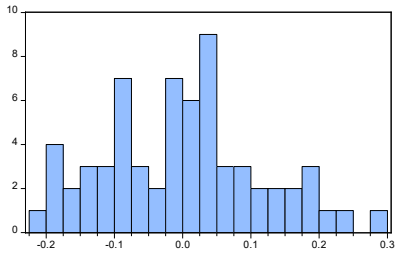
Eq. (5)



Jarque-Bera: 0.6136 (0.7357)

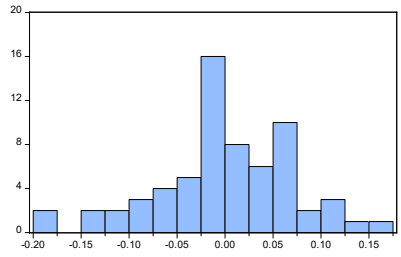
Upper-middle Income Cities

Eq. (3)



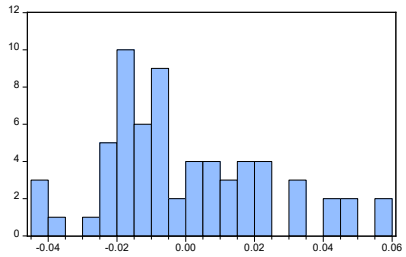
Jarque-Bera: 1.1310 (0.5680)

Eq. (4)



Jarque-Bera: 2.1664 (0.3384)

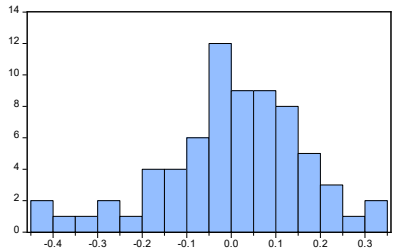
Eq. (5)



Jarque-Bera: 3.6802 (0.1587)

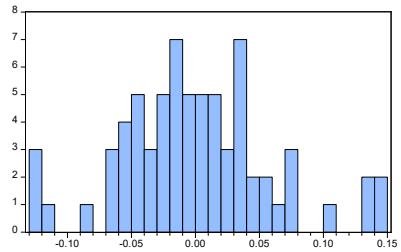
Lower-middle Income Cities

Eq. (3)



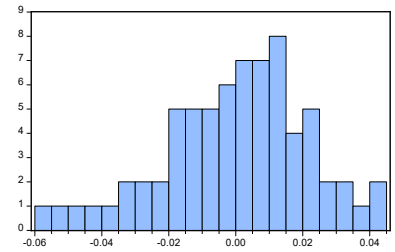
Jarque-Bera: 5.4907 (0.0642)

Eq. (4)



Jarque-Bera: 1.7871 (0.4091)

Eq. (5)



Jarque-Bera: 2.4827 (0.2889)

High Income Cities				
Eq. (3)	K	L	Ed	He
K	1			
L	0.5333	1		
Ed	0.7627	0.4602	1	
He	0.2016	0.3705	0.6435	1
Eq. (4)	y	He	PrSch	Sesch
y	1			
He	0.2335	1		
PrSch	-0.1751	-0.0619	1	
Sesch	0.1039	0.4696	0.2916	1
Eq. (5)	y	Ed	FdExp	Pov
y	1			
Ed	0.2815	1		
FdExp	-0.0947	0.5345	1	
Pov	0.2021	-0.3457	-0.5664	1
Upper-middle Income Cities				
Eq. (3)	K	L	Ed	He
K	1			
L	0.7472	1		

Upper-middle Income Cities				
Ed	0.4137	0.4006	1	
He	0.2180	-0.0676	0.2129	1
Eq. (4)	y	He	PrSch	Sesch
y	1			
He	0.2023	1		
PrSch	0.5398	-0.2805	1	
Sesch	0.3428	-0.3086	0.7777	1
Eq. (5)	y	Ed	FdExp	Pov
y	1			
Ed	0.6666	1		
FdExp	0.6691	0.5501	1	
Pov	-0.5973	-0.3063	-0.5895	1
Lower-middle Income Cities				
Eq. (3)	K	L	Ed	He
K	1			
L	0.7174	1		
Ed	0.6484	0.5246	1	
He	0.4480	0.3937	0.5887	1
Eq. (4)	y	He	PrSch	Sesch
Y	1			
He	-0.0771	1		
PrSch	0.1606	0.2005	1	
Sesch	-0.0445	0.3597	0.7720	1
Eq. (5)	y	Ed	FdExp	Pov
y	1			
Ed	0.2861	1		
FdExp	0.2404	0.7461	1	
Pov	-0.2394	-0.6729	-0.7447	1

Appendix 3

Estimation Results on High Income Cities

System: UNTITLED

Estimation Method: Three-Stage Least Squares

Date: 08/11/22 Time: 19:10

Sample: 2015 2019

Included observations: 35

Total system (balanced) observations 105

Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-20.42047	3.910712	-5.221677	0.0000
C(2)	0.481442	0.115464	4.169612	0.0001
C(3)	-0.977022	0.080463	-12.14257	0.0000
C(4)	3.235717	1.401849	2.308179	0.0233
C(5)	7.633551	1.072127	7.120005	0.0000
C(6)	-1.565094	0.955183	-1.638527	0.1048
C(7)	0.012840	0.017030	0.754006	0.4528
C(8)	0.680009	0.247245	2.750348	0.0072
C(9)	0.152137	0.115082	1.321996	0.1895
C(10)	0.140489	0.064308	2.184634	0.0315
C(11)	2.879637	0.339908	8.471820	0.0000
C(12)	-0.024184	0.008744	-2.765783	0.0069
C(13)	0.913180	0.099526	9.175319	0.0000
C(14)	-0.040409	0.025316	-1.796225	0.0943
C(15)	-0.072260	0.013259	-5.449784	0.0000
Determinant residual covariance		6.10E-09		

Equation: Y=C(1)+C(2)*K+C(3)*L+C(4)*ED+C(5)*HE

Instruments: K L PRSCH SESCH FDEXP POV C

Observations: 35

R-squared	0.897569	Mean dependent var	12.47913
Adjusted R-squared	0.883911	S.D. dependent var	0.483459
S.E. of regression	0.164723	Sum squared resid	0.814011
Durbin-Watson stat	0.400169		

Equation: ED=C(6)+C(7)*Y+C(8)*HE+C(9)*PRSCH+C(10)*SESCH

Instruments: K L PRSCH SESCH FDEXP POV C

Observations: 35

R-squared	0.401498	Mean dependent var	2.347668
Adjusted R-squared	0.321698	S.D. dependent var	0.056418
S.E. of regression	0.046465	Sum squared resid	0.064771
Durbin-Watson stat	0.257954		

Equation: HE=C(11)+C(12)*Y+C(13)*ED+C(14)*FDEXP+C(15)*POV
Instruments: K L PRSCH SESCH FDEXP POV C
Observations: 35

R-squared	0.630548	Mean dependent var	4.284294
Adjusted R-squared	0.581288	S.D. dependent var	0.037293
S.E. of regression	0.024131	Sum squared resid	0.017470
Durbin-Watson stat	0.444455		

Estimation Results on Upper-middle Income Cities

System: UNTITLED
Estimation Method: Three-Stage Least Squares
Date: 08/11/22 Time: 20:47
Sample: 2015 2019
Included observations: 65
Total system (balanced) observations 195
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	50.96779	11.97200	4.257251	0.0000
C(2)	0.735133	0.150152	4.895924	0.0000
C(3)	-0.788922	0.190653	-4.138007	0.0001
C(4)	1.799101	0.280474	6.414504	0.0000
C(5)	-9.545177	2.611790	-3.654649	0.0003
C(6)	4.931631	2.190878	2.250984	0.0256
C(7)	0.213210	0.062964	3.386202	0.0009
C(8)	1.166319	0.545433	2.138335	0.0338
C(9)	0.292782	0.172666	1.695657	0.0917
C(10)	-0.303557	0.107550	-2.822461	0.0053
C(11)	4.228329	0.301846	14.00825	0.0000
C(12)	0.166015	0.029411	5.644723	0.0000
C(13)	0.251532	0.073217	3.435419	0.0007
C(14)	-0.095034	0.024824	-3.828377	0.0002
C(15)	-0.035063	0.013119	-2.672702	0.0082
Determinant residual covariance		3.06E-08		

Equation: Y=C(1)+C(2)*K+C(3)*L+C(4)*ED+C(5)*HE
Instruments: K L PRSCH SESCH FDEXP POV C
Observations: 65

R-squared	0.781912	Mean dependent var	11.21805
Adjusted R-squared	0.767372	S.D. dependent var	0.270131
S.E. of regression	0.130288	Sum squared resid	1.018498
Durbin-Watson stat	0.712692		

Equation: ED=C(6)+C(7)*Y+C(8)*HE+C(9)*PRSCH+C(10)*SESCH
Instruments: K L PRSCH SESCH FDEXP POV C
Observations: 65

R-squared	0.298037	Mean dependent var	2.323536
Adjusted R-squared	0.251239	S.D. dependent var	0.093852
S.E. of regression	0.081211	Sum squared resid	0.395716
Durbin-Watson stat	0.678443		

Equation: HE=C(11)+C(12)*Y+C(13)*ED+C(14)*FDEXP+C(15)*POV
Instruments: K L PRSCH SESCH FDEXP POV C
Observations: 65

R-squared	-0.499499	Mean dependent var	4.307540
Adjusted R-squared	-0.599466	S.D. dependent var	0.027234
S.E. of regression	0.034443	Sum squared resid	0.071180
Durbin-Watson stat	0.466791		

Estimation Results on Lower-middle Income Cities

System: UNTITLED
Estimation Method: Three-Stage Least Squares
Date: 08/11/22 Time: 21:34
Sample: 2015 2019
Included observations: 70
Total system (balanced) observations 210
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	68.21245	8.005386	8.520821	0.0000
C(2)	0.114140	0.059880	1.906140	0.0581
C(3)	-0.201793	0.079265	-2.545816	0.0117
C(4)	2.448716	0.356810	6.862802	0.0000
C(5)	-14.44132	1.885114	-7.660717	0.0000
C(6)	-29.70091	3.623361	-8.197061	0.0000
C(7)	0.296686	0.051012	5.815957	0.0000
C(8)	6.648857	0.802388	8.286336	0.0000
C(9)	0.224150	0.086820	2.581771	0.0106
C(10)	-0.091160	0.060010	-1.519086	0.1304
C(11)	4.591610	0.123090	37.30299	0.0000
C(12)	-0.050718	0.010844	-4.677213	0.0000
C(13)	0.055749	0.069903	1.797514	0.0961
C(14)	0.008326	0.013877	0.599973	0.5492
C(15)	-0.011220	0.005882	-1.957449	0.0479
Determinant residual covariance		1.26E-09		

Equation: Y=C(1)+C(2)*K+C(3)*L+C(4)*ED+C(5)*HE			
Instruments: K L PRSCH SESCH FDEXP POV C			
Observations: 70			
R-squared	-0.622601	Mean dependent var	10.44630
Adjusted R-squared	-0.722453	S.D. dependent var	0.247527
S.E. of regression	0.324861	Sum squared resid	6.859740
Durbin-Watson stat	0.624337		

Equation: ED=C(6)+C(7)*Y+C(8)*HE+C(9)*PRSCH+C(10)*SESCH			
Instruments: K L PRSCH SESCH FDEXP POV C			
Observations: 70			
R-squared	-0.548316	Mean dependent var	2.267425
Adjusted R-squared	-0.643597	S.D. dependent var	0.109366
S.E. of regression	0.140210	Sum squared resid	1.277832
Durbin-Watson stat	0.558247		

Equation: HE=C(11)+C(12)*Y+C(13)*ED+C(14)*FDEXP+C(15)*POV			
Instruments: K L PRSCH SESCH FDEXP POV C			
Observations: 70			
R-squared	0.119436	Mean dependent var	4.279132
Adjusted R-squared	0.065247	S.D. dependent var	0.026910
S.E. of regression	0.026017	Sum squared resid	0.043998
Durbin-Watson stat	0.546533		

Appendix 4

Formulas on System Equation using 3SLS, [EViews]