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ECONOMIC GLOBALIZATION, ECONOMIC GROWTH, AND HUMAN CAPITAL : EMPIRICAL EVIDENCE USING THREE STAGE LEAST SQUARE IN INDONESIA

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ABSTRACT

The pace of globalization is increasing rapidly and dynamically as time goes by. Indonesia, located takes advantage of globalization to encourage economic growth. However, over the last decade, from 2000 to 2019, Indonesia's economic globalization index has tended to decline along with the increase in the global economic globalization index. Indonesia's economic growth has been relatively stagnant. Human capital, as the primary input in Indonesia's economic system, is suspected to be suboptimal. In the National Medium-Term Development Plan (RPJMN) for 2020-2024, economic growth and human capital are the main focus in achieving national prosperity. Human capital in this study uses health indicators as a proxy for assessing productivity and educational investment approaches. Data is transformed to meet the stationarity requirements of time series data. The study employs the Three Stage Least Square (3SLS) simultaneous equation method to examine total and direct effects. The estimation results show that changes in globalization growth are directly influenced by changes in economic growth, exchange rate growth, and inflation. Changes in economic growth are directly influenced by changes in exchange rate growth, globalization index growth, and inflation. Human capital is directly influenced by changes in globalization index growth, changes in economic growth, inflation, previous-year inflation, and changes in unemployment rates

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1. INTRODUCTION

Today, the pace of globalization is accelerating and dynamic. The phenomenon of globalization is widely utilized by every country in various fields, including the economic sector. Economic globalization is an interesting phenomenon to continue analyzing in terms of the interconnection between countries [1]. Economic globalization can be observed through the Konjunkturforschungsstelle (KOF) Swiss Economic Institute's globalization index, introduced by [2]. This index is most widely used in academic literature [3] to depict the phenomenon of globalization. The KOF index in describing economic globalization consists of two main components: international trade and foreign investment in a country.

Indonesia is a strategic country located on global trade routes and has tropical abundant natural resources make Indonesia a nation with great economic potential. Economic globalization, reflected in trade liberalization, should ideally bring benefits to the country through production specialization based on comparative advantages [4]. However, as the global economic globalization index increases, Indonesia's economic globalization index has, in fact, experienced a decline. This decline aligns with Indonesia's economic growth, which has stagnated at an average of 5.3 percent throughout the years 2000-2019 [5]. The relatively stagnant economic growth in Indonesia is suspected to have an impact on the quality of human capital [4]. The World Bank's report in 2020 shows that Indonesia's Human Capital Index (HCI) score is much lower when compared to other ASEAN countries [6]. With a less qualified human capital, there is a lack of technological proficiency to leverage the benefits of economic globalization. Therefore, the phenomenon of economic globalization is believed to have a mutually interconnected relationship with economic growth and human capital. These three dimensions are interrelated and influence each other in a two-way system.

In the theory of absolute advantage, comparative advantage, the Heckscher-Ohlin (H-O) theory, and the Product Life Cycle (PLC) theory, it is concluded that the economic conditions of a country, reflected in economic growth, human capital, and labor conditions, influence international trade. The eclectic theory explains that a country's ability to produce goods and services efficiently depends on the magnitude of economic growth and the quality of human capital [7]. [8] explains that international trade is inseparable from supply and demand theory. In this theory, there are price factors reflected in inflation that can affect the supply and demand curves [9]. The Mundell-Fleming theory analyzes the interrelationship between goods and money markets in an open economy. With this theory's approach, a country's economic globalization depends on interest rates and exchange rates. Interest rates in developing countries like Indonesia are determined by world interest rates [9].

The Solow economic growth model and its modifications elucidate the factors influencing economic growth. According to the Solow model and its modifications, a country's economic growth is influenced by capital, labor, and human capital [10]. Foreign investment is a process related to the utilization of economic globalization. Furthermore, international trade activities, reflected in economic globalization, also affect economic growth [2]. The Mundell-Fleming theory indicates that the derivation of the international trade balance curve will affect economic growth through exchange rates. If a country's exchange rate depreciates, it will increase the scale of exports, leading to economic growth. Furthermore, in the classical quantity theory of money, economic growth is influenced by the money supply and inflation. An increase in the money supply in the economy will stimulate demand [9].

In this study, human capital is measured using life expectancy as a proxy for public health. Public health, as reflected in the duration of life, can facilitate the education process, workforce productivity, and has the potential to boost investment in education [11]. In the development of human capital theory, various factors influencing it are analyzed. From several theories, it is concluded that a country's investment in improving the quality of human capital [12][13][14] , economic growth [15], and the labor force [15] will affect the level of human capital. According to [9], both domestic and foreign investments will be used by a country to support development programs. Meanwhile, according to [5], one of the focuses of development programs is the enhancement of human capital.

Existing empirical studies have been limited to one-way analyses, and there has been no study that addresses the simultaneous relationship between economic globalization, economic growth, and human capital in Indonesia. For example, in the study by [16], the study explored the short-term and long-term relationships between technological innovation, globalization, natural resources, human capital, economic growth, financial development, and ecological footprint in 73 developing countries. Study on economic

globalization and economic growth was also conducted by [1] in Nigeria, using a one-way analysis with Autoregressive Distributed Lag (ARDL). The study by [17] examined the simultaneous relationship between trade policy, export expansion, and human capital using 3SLS but was limited to the period up to 1985 and did not incorporate the KOF economic globalization index variable. Furthermore, the study by [18] investigated the simultaneous relationship between foreign direct investment (a globalization approach), technological innovation (a human capital approach), and economic growth using the 3SLS method, but it did not consider the components of free trade that could be included in the KOF economic globalization index. Moreover, this study did not include health components, which are seen as an approach to productivity and the scale of returns on education investment [11].

Based on these issues, it is important to examine the relationship between economic globalization, economic growth, and human capital in Indonesia for the period 2000-2019, as well as the factors influencing these three variables. This study employs a Simultaneous Equation Model. Simultaneous equations are typically estimated using Two Stage Least Square (2SLS). However, the 2SLS method has limitations, such as not utilizing information from other variables in the system and not providing different weights to residual error variations. Consequently, when there is a correlation among errors, 2SLS estimations may lack efficiency [19]. This limitation can be addressed by using 3SLS. The 3SLS method is applied to estimate precisely identified simultaneous equations and over-identified equations. In 3SLS estimation, the basis for estimating parameter systems uses the variance-covariance matrix of the residuals from the 2SLS estimation. The weightings of this variance-covariance matrix are used to account for heteroskedasticity among the equation residuals. Parameter estimation is conducted using Generalized Least Square (GLS). GLS provides higher weightings to observations with low variance, making them contribute more to the regression parameter estimation. This results in more efficient and consistent estimations [19]. Therefore, in this study, the 3SLS estimation method is required.

2. RESEARCH METHODS

This study examines the simultaneous relationship between economic globalization, economic growth, and human capital in Indonesia for the period from 2000 to 2020. The data used in this study are secondary data, consisting of time series data with an annual frequency covering the years from 2000 to 2019. The simultaneous equation analysis method is a form of statistical inference to answer study objectives. The simultaneous equation analysis method is used to answer the simultaneous relationship between economic globalization, economic growth and Indonesian human capital from 2000 to 2019. Simultaneous equation analysis aims to see the influence of exogenous and endogenous variables simultaneously. This research builds a simultaneous equation model with Three Stage Least Square (3SLS) estimation because the regression results are more efficient [19].

Table 1. Variable in the Study

Notation	Variable	Unit	Source
G	Economic Globalization Index de facto	Index	KOF Swiss Economic Institute
PE	Economic growth	%	World Bank
AHH	Life expectancy	Year	World Bank
INF	General Inflation	%	Statistics Indonesia (BPS)
IR	BI rate	%	Bank Indonesia
Kurs	Exchange Rate	USD/Rp	World Bank
LF	Labor Force	People	World Bank
UNEM	Unemployment rate	%	World Bank
M2	Broad money as a percentage of GDP	%	World bank

The analysis methods used in this study are graphical method and simultaneous equation method. The flowchart is depicted on Figure 1.

2.1 Graphical Analysis

Graphical analysis is a form of descriptive analysis that depicts the characteristics of study variables. The graphical analysis used in this study consists of line charts and scatter plot matrices.

2.2 Stationary

Analysis with time series data assumes that the data must be stationary [20]. Neglecting stationarity can lead to issues like spurious regression or non-meaningful regression results [21]. Stationarity is required to ensure that the data behavior in the study variable doesn't exhibit excessive variation and tends to approach its mean value. The stationarity test used is the augmented Dickey-Fuller test (ADF Test). ADF test construct the variable Y_t on regression $\Delta Y_t = \delta Y_{t-1} + \omega_t$. Then test the significance of δ regarding whether there is a unit root or not. The test statistic τ is stated $\tau = \frac{\hat{\delta}}{se(\hat{\delta})}$, where se is standard error. The variable Y_t stationary when $\tau >$ Mackinnon's τ table.

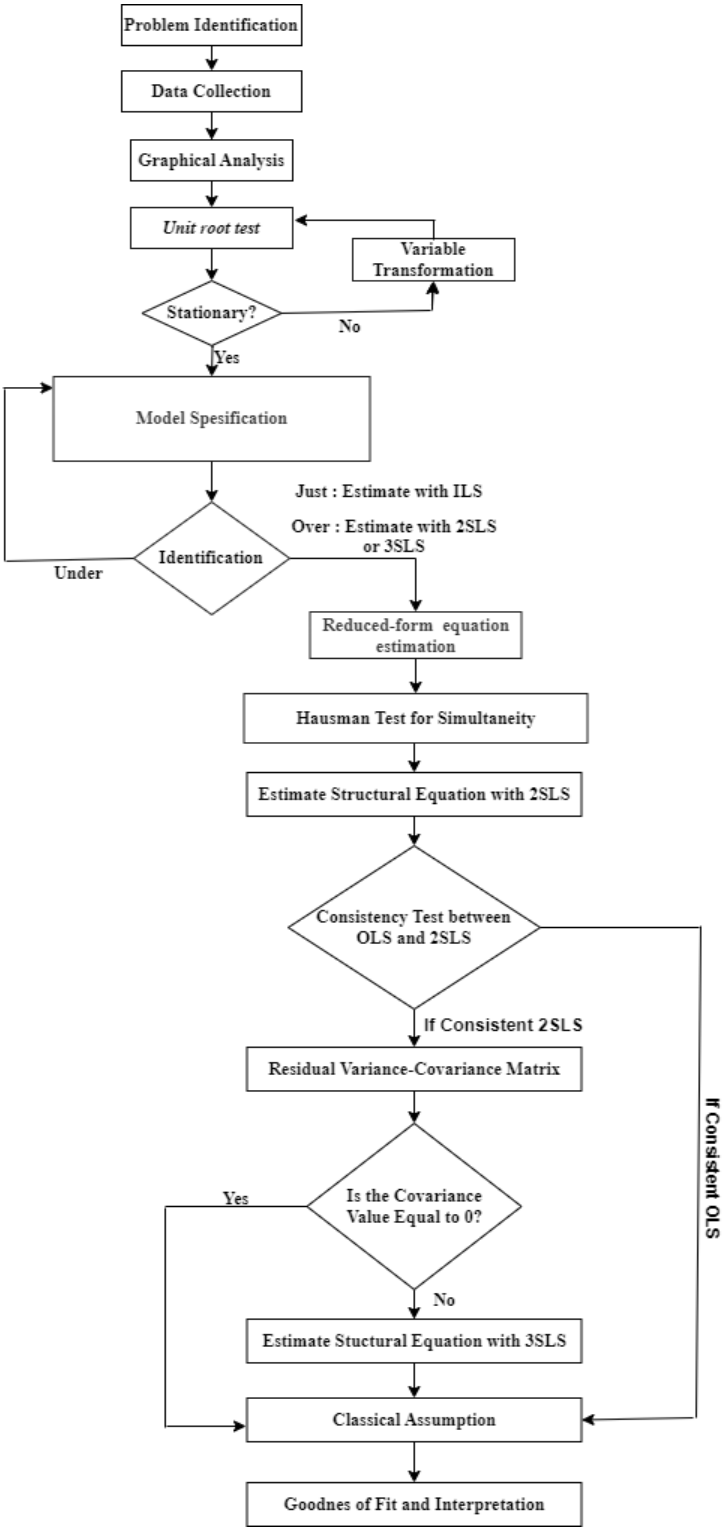

Figure 1. Research flow

2.3 Variable Transformation

Variable transformation is carried out to meet the stationarity assumption while considering the significance of the model in economic theory. Transformation is performed in two ways, namely natural logarithms and differencing.

2.4 Model Specification

A simultaneous equation consists of structural equations and reduced-form equations. The structural equation model is constructed based on economic theory that reflects the economic model. The structural equations are functions of endogenous variables, predetermined variables, and error variable. Endogenous variables are variables whose values are determined in the model (affected by other variables). So the endogenous variable has stochastic properties and is usually correlated with the error term of the equation containing the endogenous variable. Predetermined variables are also called independent variables in simultaneous equations. Predetermined variables are not stochastic because their values are already determined. The error variable is the error term (noise) in the simultaneous equation. The error variable has a relationship or correlation with endogenous variables that are not included in the structural equation. Structural equations i are generally modeled as follows:

$$Y_{it} = \beta_{oi} + \beta_{ij} Y_t + \beta_{ij} X_t + u_{it}$$

Economic globalization model

$$DLNG_t = \beta_{10} + \beta_{11} PE_t + \beta_{12} AHH_t + \beta_{13} INF_t + \beta_{14} IR_t + \beta_{15} DLNKURS_t + \beta_{16} DLNF_t + u_{1t} \quad (1)$$

Economic growth model

$$DPE_t = \beta_{20} + \beta_{21} LNG_t + \beta_{22} DAHH_t + \beta_{23} DM2_t + \beta_{24} DLNF_t + \beta_{25} DLNKURS_t + \beta_{26} INF_t + u_{2t} \quad (2)$$

Human capital model

$$DAHH_t = \beta_{30} + \beta_{31} LNG_t + \beta_{32} DPE_t + \beta_{33} INF_{t-1} + \beta_{34} DUNEM_t + \beta_{35} DLNF_t + \beta_{36} INF_t + u_{3t} \quad (3)$$

with β_{ij} : Regression coefficient of the i-th structural equation and variable j; u_{it} : residual of the i-th structural equation in the current year (t); $DLNG_t$: Change in the growth of the KOF economic globalization index in the current year (t); DPE_t : Change in economic growth in the current year (t); $DAHH_t$: Change in life expectancy in the current year (t); INF_t : Inflation rate in the current year (t); IR_t : BI rate in the current year (t); $DLNKURS_t$: Changes in the current year's exchange rate growth (t); $DM2_t$: Changes in the percentage of money supply in the current year (t); $DLNLF_t$: Changes in the current year's (t) labor force growth; INF_{t-1} : Inflation rate in the previous year ($t-1$); $DUNEM_t$: Changes in the current year's (t) unemployment rate).

2.5 Model Identification

Model identification is related to the advanced estimation method that will be used. Identification issues arise because the same data set can be used for different sets of structural coefficients. The purpose of model identification is to satisfy necessary order conditions and rank conditions. The condition of order is a necessary requirement for identification but not sufficient. Whereas the condition of rank already fulfills two identification criteria, namely necessary and sufficient **[20]**.

Table 2. Identification of Order Condition

Equation	Number of Exogenous Variables	Number of endogenous variables	Order Condition	Identification
	K	M		
System	7	3		
	k	m	$K-k > m-1$	
Economic Globalization	4	3	$3 > 2$	Overidentified
Economic Growth	4	3	$3 > 2$	Overidentified
Human Capital	4	3	$3 > 2$	Overidentified

Table 3. Identification of Rank Condition

Equation	Partitioned matrix	Rank	Identification
1	$\begin{bmatrix} -\beta_{23} & 0 \\ 0 & -\beta_{33} \end{bmatrix} \neq 0$	2	Overidentified
2	$\begin{bmatrix} -\beta_{14} & 0 \\ 0 & -\beta_{33} \end{bmatrix} \neq 0$	2	Overidentified
3	$\begin{bmatrix} -\beta_{14} & 0 \\ 0 & -\beta_{23} \end{bmatrix} \neq 0$	2	Overidentified

Based **Table 2** and **Table 3** show that the rank conditions results conclude that all structural equation are indicated to be over-identified. Therefore, regression estimation using the 2SLS or 3SLS method will be used.

2.7 Forming the Reduced Regression Equation

The reduced form equation is an equation that represents endogenous variables and predetermined variables as independent variables in a simultaneous equation model. Then, each equation is estimated using the Ordinary Least Squares (OLS) method. The parameter estimates are interpreted as total effects **[19]**.

Economic globalization model

$$DLNG_t = \begin{matrix} \Pi_{10} + \Pi_{11} INF_t + \Pi_{12} IR_t + \Pi_{13} DLNKURS_t + \Pi_{14} M2_t \\ +\Pi_{15} DLNF_t + \Pi_{16} INF_{t-1} + \Pi_{17} UNEM_t + v_{1t} \end{matrix} \quad (4)$$

Economic growth model

$$DPE_t = \begin{matrix} \Pi_{20} + \Pi_{21} INF_t + \Pi_{22} IR_t + \Pi_{23} DLNKURS_t + \Pi_{24} M2_t \\ +\Pi_{25} DLNF_t + \Pi_{26} INF_{t-1} + \Pi_{27} UNEM_t + v_{2t} \end{matrix} \quad (5)$$

Human capital model

$$\boldsymbol{DMM_t = \begin{matrix} \Pi_{30} + \Pi_{31} INF_t + \Pi_{32} IR_t + \Pi_{33} DLNKURS_t + \Pi_{34} M2_t \\ +\Pi_{35} DLNF_t + \Pi_{36} INF_{t-1} + \Pi_{37} UNEM_t + v_{3t} \end{matrix}} \quad (6)$$

With **Π** is parameter of reduce form

2.8 Hausman's Test of Endogeneity

The simultaneous equation model needs to be tested to determine whether endogenous variables are truly experiencing statistical simultaneity issues. Simultaneity issues arise because some independent variables are endogenous, making them likely to be correlated with the error term. Simultaneity testing uses the Hausman specification test based on criteria established by **[22].** The testing is carried out by adding the residual of the endogenous variables from the reduced form estimation to the structural equation. Then, the equation is estimated using OLS. If the simultaneous test results in a statistically significant F-statistic, it indicates that the equation is experiencing simultaneity issues.

2.9 Estimation with 2SLS and Testing the Consistency of Estimates between OLS and 2SLS

Estimation with 2SLS is done by substituting the estimated values from the reduced-form equation of endogenous variables into the endogenous variables of the structural equation. Then, estimation is carried out using OLS to obtain the residual values for each structural equation.

According to **[20],** the consistency of an estimator is described as follows: as the sample size increases, the variance of the estimator becomes smaller, and the estimator's value approaches the parameter value. In this study, the Durbin Wu Hausman test is used to compare the consistency between two estimation estimators. The Durbin Wu Hausman hypothesis test between the OLS estimator and 2SLS estimator is as follows **[23]** and **[24]** :

H_0 : cov$(\boldsymbol{\beta}, \boldsymbol{\varepsilon}) = 0$ ($\hat{\beta}_{OLS}$ dan $\hat{\beta}_{2SLS}$ are consistent)

H_1 : cov$(\boldsymbol{\beta}, \boldsymbol{\varepsilon}) \neq 0$ (only $\hat{\beta}_{2SLS}$ is consistent)

Test of statistics **:**

$$H = \left(\widehat{\boldsymbol{\beta}}_{\boldsymbol{2SLS}} - \widehat{\boldsymbol{\beta}}_{\boldsymbol{OLS}}\right)^{t}\left[Cov\left(\widehat{\boldsymbol{\beta}}_{\boldsymbol{2SLS}} - \widehat{\boldsymbol{\beta}}_{\boldsymbol{OLS}}\right)\right]^{-1}\left(\widehat{\boldsymbol{\beta}}_{\boldsymbol{2SLS}} - \widehat{\boldsymbol{\beta}}_{\boldsymbol{OLS}}\right) \quad (7)$$

Rejected H_0 at $H > F_{\alpha;k^*;T-K-k^*}$

With:

α = significance level;

k^*= the number of endogenous variables that become independent variables in an equation;

K = the total number of predetermined variables;

T = the number of observation time.

If the statistical probability value of the Hotelling test is smaller than the significance level α, then it leads to rejecting the null hypothesis, which means that the equation is more likely to be consistent with 2SLS than OLS. If the 2SLS estimator is consistent, further checking the interrelatedness of residual matrices among structural equations

2.10 Estimation of Structural Equation Using Generalized Least Squares (3SLS System)

Estimation of structural equations this study using the General Least Squares (GLS) method. This method is used with the assumption that there is a correlation between error variables on equation $\boldsymbol{i}$ and equation $\boldsymbol{j}$ in the simultaneous equation model, or $\boldsymbol{E(u_i, u_j) \neq 0}$. Next testing the consistency between the 2SLS and 3SLS. If 3SLS is consistent, continue with testing goodness of fit. The goodness of fit model is divided into two aspects, namely its conformity to economic theory and its statistical adequacy **[20].**

GLS (Generalized Least Squares) estimator in simultaneous equations is closely related to the 3SLS (Three-Stage Least Squares) estimator. The 3SLS method is applicable when there is interdependence among the error terms estimated from 2SLS (Two-Stage Least Squares). This interdependence can be detected through a correlation matrix that identifies non-constant variances and non-zero covariances among the errors **[20]**. In the 3SLS estimator, the parameter estimates are systematically based on the variance-covariance matrix of the residuals from the 2SLS estimation. The weighting matrix derived from this variance-covariance matrix is used to address heteroskedasticity among the equation errors. GLS assigns greater weights to observations with lower variance, thereby allowing them to contribute more significantly to the estimation of regression parameters. As a result, GLS provides more efficient and consistent estimations.

3. RESULTS AND DISCUSSION

In this study, both graphical analysis and the simultaneous equations method are utilized to comprehensively analyze the dynamics and interrelationships among economic globalization, economic growth, and human capital in Indonesia from 2000 to 2019. Graphical analysis is employed to visually depict trends and correlations between the variables over time, while the simultaneous equations method is used to rigorously examine the causal links and determinants among these variables. By integrating these analytical approaches, the study aims to provide a robust understanding of how economic globalization impacts economic growth and human capital development in Indonesia over the specified period.

3.1 Graphical Analysis

Graphic analysis is a form of descriptive analysis that describes characteristics regarding research variables. Graphic analysis used in this study consists of a line chart and a scatter plot matrix. Line diagrams in research to determine trends or development patterns of the study variables throughout the year series. The scatter plot matrix is a type of graphic analysis of multivariate data that presents a pairwise scatter relationship between different variables in matrix form.

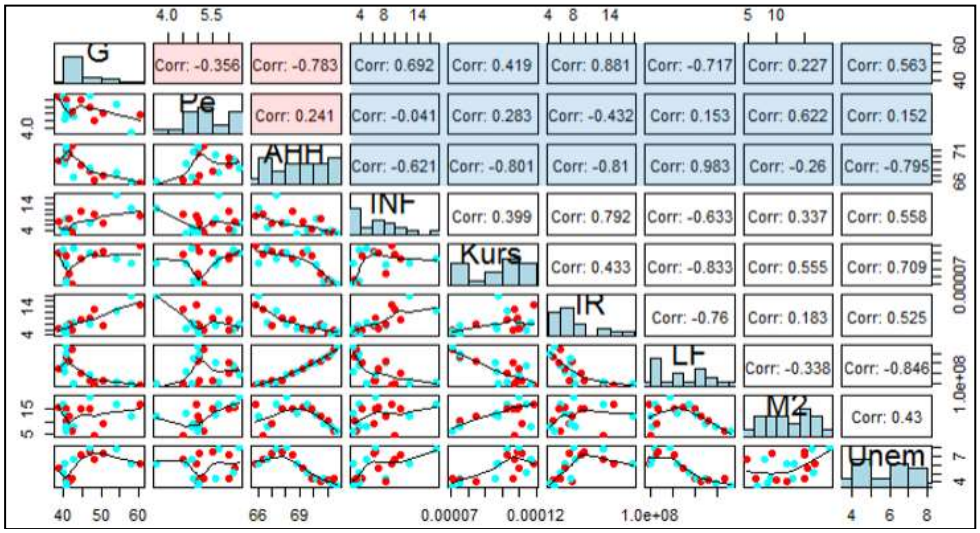

Figure 2. Scatterplot of study variables

Based on **Figure 2**, in the study series from the year 2000 to 2019, the relationship between the economic globalization index and economic growth is negative with a low degree of association at 0.356. A similar inverse relationship also exists between the economic globalization index and life expectancy with a moderate degree of association at 0.783. The relationship between economic growth and life expectancy is positive with a low degree of association at 0.241.

Based on **Figure 2,** The economic globalization index tends to fluctuate with a decreasing trend between 2000 and 2019. Meanwhile, economic growth tends to fluctuate and stagnate. This is further supported by the BAPPENAS study, which suggests that Indonesia's economic growth tends to be stagnant, and there is concern about experiencing a middle-income trap in the long term. On the other hand, life expectancy in Indonesia from 2000 to 2019 shows an increasing trend.

Pre-determined variables also have interrelations among themselves. Based on **Figure 2** there is a relationship between two variables that appears to have a strong degree of association. The exchange rate variable is negatively associated with life expectancy with a degree of association of 0.801. Interest rates have a very high degree of association and are positively related to the economic globalization index at 0.881. Additionally, interest rates also have a strong degree of association with life expectancy at 0.81. Labor force has a strong relationship with life expectancy in the same direction (positive) and with the exchange rate in the opposite direction (negative correlation). So, there is a graph of two-way relationship pattern between economic globalization, economic growth and human capital in Indonesia.

3.2 Stationarity Test

Forming a model with time series data requires testing the stationarity of variables. Stationary data has a tendency to be close to the average and has variations that are not too large. The results of the variable stationarity test are as follows:

Table 4. Results of variable stationarity testing

Variable	Level			First Difference		
	τ	*P-Value*	Decision	τ	*P-Value*	Decision
LNG	-2.576	0.2931	not stationary	-5.359020	0.0027	stationary
PE	-2.349384	0.3908	not stationary	-6.425078	0.0003	stationary
AHH	-2.446958	0.3464	not stationary	-6.186794	0.0006	stationary
INF	-4.835544	0.0061	Stationary			
LNKURS	-1.735884	0.6947	not stationary	-3.990293	0.0307	stationary
IR	-5.104728	0.0037	stationary			
M2	-2.677172	0.2560	not stationary	-4.101787	0.0285	stationary
INF(-1)	-4.666018	0.0091	Stationary			
LNLF	-3.220572	0.1154	not stationary	-4.053899	0.0274	stationary
UNEM	-1.968346	0.5805	not stationary	-2.496643	0.0702	stationary

The general inflation variable, BI rate, and inflation from the previous year have been found to be stationary at the 10 percent significance level at the level. Meanwhile, the other variables are stationary in their first differences. This statement indicates the stationarity properties of different variables in a time series analysis.

3.3 Estimation of the Reduced form Equation

The reduced form equation describes the determinants of endogenous variables, which represent the total effects. This equation is estimated using OLS (Ordinary Least Squares).

$$\begin{aligned}\widehat{dlnG_t} &= 0.075707 + 0.004394INF_t - 0.011029IR_t - 0.462383dlnKURS_t^* + 0.350738dlnLF_t \\ &\quad + 0.047286dUNEM_t^* + 0.006038dM2_t - 0.006526INF_{t-1}^* \\ \widehat{dPE_t} &= 0.284602 + 0.093461INF_t^* - 0.057903IR_t + 6.548807dlnKURS_t^* + 9.9317dlnLF^* \\ &\quad + 0.580723dUNEM_t^* - 0.004453dM2_t - 0.049375INF_{t-1}^* \\ \widehat{dAHH_t} &= 0.214577 + 0.014091INF_t^* - 0.012305IR_t^* - 0.008103dlnKURS_t + 1.708806dlnLF^* \\ &\quad - 0.018424dUNEM_t + 0.004287dM2_t + 0.010858INF_{t-1}^*\end{aligned}$$

*significant at the 0.1

To ensure the presence of simultaneity issues in the model, simultaneity testing is conduct. **Table 5** shows that there are simultaneity issues in the economic globalization model, the economic growth model, and the human capital model. Therefore, at a 10 percent significance level, OLS estimators cannot be used to estimate these models. This is because one of the assumptions of OLS, which is the exogeneity of explanatory variables X from stochastic errors, is violated. Therefore, all equations are estimated using 2SLS.

Table 5. Results of simultaneity Testing of the Model

Model	F-test statistic F	P-value	Decision
Economic Globalization	3.532	0.03292	Simultaneity occurs
Economic Growth	10.84	0.0005048	Simultaneity occurs
Human Capital	2.671	0.07388	Simultaneity occurs

Then, the Hausman Test is conducted to assess the consistency between OLS and 2SLS estimators. The results of the Durbin Wu-Hausman test are as follows:

Table 6. Results of the Wu-Hausman test for 2SLS-OLS

Equation	H	P-Value	Decision
Economic Globalization	2.933	0.09946	Estimation of 2SLS more consistent
Economic Growth	6.573	0.0151	Estimation of 2SLS more consistent
Human Capital	4.318	0.0444	Estimation of 2SLS more consistent

From the **Table 6**, it can be concluded that all three equations with 2SLS estimations are more efficient than OLS. Then, the residuals for each equation are used to create a variance-covariance matrix. The variance-covariance matrix of the 2SLS equation i and j estimated residuals is as follows:

$$\mathrm{Cov}(\hat{\varepsilon}_i, \hat{\varepsilon}_j) = \begin{bmatrix} 0.00439 & -0.03036 & -0.00019 \\ -0.03036 & 0.2438 & 0.0020 \\ -0.00019 & 0.00207 & 0.00192 \end{bmatrix}$$

Correlation matrix of 2SLS estimated residuals :

$$\mathrm{Cor}(\hat{\varepsilon}_i, \hat{\varepsilon}_j) = \begin{bmatrix} 1 & -0.98 & -0.12 \\ -0.98 & 1 & 0.15 \\ -0.12 & 0.15 & 1 \end{bmatrix}$$

Based on the correlation matrix, the correlation values of the structural equation residuals estimated by 2SLS are not equal to zero. This indicates the presence of residual relationships among the structural equations. Correlation among residuals indicates that the model does not have minimum variance, so it requires weighting in the form of a covariance matrix in further estimation **[20]**. Therefore, an advanced method is used to estimate the system using the GLS method. The estimation of the structural equation model with 3SLS in the study aims to determine the bidirectional (two-way) influence of the economic globalization index, economic growth, and life expectancy. The 3SLS estimation with the variance-covariance matrix weighting results in the following estimations:

3.4 Equation for the Change in Economic Globalization Growth

The structural equation of the change in economic globalization index growth reflects the variables that directly influence it. The estimation results with the weighting matrix of the system's residual variance-covariance matrix are as follows.

$$\widehat{dLNG_t} = -0.0671 + 0.15308dPE_t^* + 0.45487dAHH_t - 0.0130INF_t^* - 0.00313IR_t - 1.4571dLNKURS_t^* - 1.47362dLNLF_t \ ;$$

$$R_{adj}^2 = 0{,}144;\ Prob(F_{stat}) = 0{,}0001$$

*significant at the 0.1

The change in economic growth has a direct and positive impact on the change in economic globalization growth. This result is consistent with comparative advantage theory, the Heckscher-Ohlin theory, and the Product Life Cycle (PLC) theory, which conclude that the economic conditions of a country, as reflected in its economic growth, influence the increase in economic globalization index. The change in exchange rate growth also has a direct and negative impact on the change in economic globalization growth. This result aligns with the Mundell-Fleming theory, which states that when a country's currency appreciates, international trade levels decrease. Inflation has a direct and negative impact on the change in economic globalization growth. This result is in line with the theory of prices in international demand and supply. According to **[8]** and **[9]**, increasing inflation implies high production costs for domestic goods. A decrease in consumer purchasing power also affects the production capacity of factors of production. As a result, the level of exports is less than optimal and reduces the interest of foreign investors.

3.5 Equation for the Change in Economic Growth

The structural equation of the change in economic growth index growth reflects the variables that directly influence it. The estimation results with the weighting matrix of the system's residual variance-covariance matrix are as follows.

$$\widehat{dPE_t} = 0.7065 + 0.70653dLNG_t^* - 3.8401dAHH_t + 0.01067dM2_t + 11.22481dLNLF_t + 9.06445dLNKURS_t^* + 0.1028INF_t^*$$

$R^2_{adj} = 0.5687;\ Prob(F_{stat}) = 0.0000$

*significant at the 0.1

Changes in economic globalization growth have a direct and positive impact on changes in economic growth. This result is consistent with a theory modified from Solow, which suggests that international trade and foreign investment can encourage a country to leverage economic globalization **[25]**. Changes in exchange rate growth also have a direct and positive impact on changes in economic growth. Inflation also has a direct and positive impact on changes in economic growth. According to **[26]**, inflation does not always indicate a slowing economy; it depends on the relative stability and control of inflation, as well as the level of extreme inflation. Furthermore, **[9]** states that relatively low and stable inflation is actually necessary to promote a country's economic growth.

3.6 Equation for the Change in Life Expectancy

The structural equation of change in life expectancy index growth reflects the variables that directly influence it. The estimation results with the weighting matrix of the system's residual variance-covariance matrix are as follows.

$$\widehat{dAHH_t} = 0.14073 + 0.827603dLNG_t^* + 0.05664dPE_t^* + 0.01812INF_{t-1}^* - 0.0995dUNEM_t^* + 0.75136dLNLF_t + 0.00562INF_t^*$$

$$R^2_{adj} = 0.2769;\ Prob(F_{stat}) = 0.0001$$

*significant at the 0.1

Changes in economic globalization growth have a direct and positive impact on changes in life expectancy. This result aligns with the theory that an increase in the globalization index signifies that a country has a surplus in both international trade and foreign investment **[25].** Furthermore, **[9]** explains that both domestic and foreign investments are used to drive development programs, including meeting human needs in the healthcare sector.

Changes in economic growth have a direct and positive impact on changes in life expectancy. This finding is in line with the theory proposed by **[15]** that increased economic growth in a country enhances human capital. Inflation and inflation from the previous year have a direct and positive impact on changes in life expectancy. Although inflation occurs, if it is at a controlled level, it leads to an increase in people's income. Therefore, in the Health Production Function theory, increased income implies improved access to healthcare and nutritional fulfillment. Hence, controlled inflation and inflation from the previous year, as observed in Indonesia from 2000 to 2019, can enhance changes in life expectancy.

Changes in the unemployment rate have a direct and negative impact on changes in life expectancy. This result is consistent with the Health Production Function theory, which explains that an individual's health also depends on their ability to access nutrition, medications, and healthcare facilities, with cost constraints being a limiting factor. The cost side is derived from people's earnings.

3.7 Consistency Test of Parameters Between the 2SLS and 3SLS Estimators

To determine whether the estimation results of 3SLS are more consistent anda efficient compared to 2SLS estimations, a Hausman extension test is performed. The Hausman extension test can also detect consistency of parameters between 2SLS estimators and the 3SLS system estimator.

Hypothesis :

H_0 : $\text{Cov}(\boldsymbol{\gamma}, \boldsymbol{u}) = 0$ (All exogenous variables are uncorrelated with all error disturbance terms, so both estimators, 2SLS and 3SLS, are consistent. However, only the 3SLS estimator is asymptotically efficient.)

H_1 : The 2SLS estimator is consistent, but the 3SLS estimator is not consistent.

Test of statistics :

$H = \left(\widehat{\boldsymbol{\beta}}_{\boldsymbol{2SLS}} - \widehat{\boldsymbol{\beta}}_{\boldsymbol{3SLS}}\right)^{t}\left[Cov\left(\widehat{\boldsymbol{\beta}}_{\boldsymbol{2SLS}}\right) - Cov\left(\widehat{\boldsymbol{\beta}}_{\boldsymbol{3SLS}}\right)\right]^{-1}\left(\widehat{\boldsymbol{\beta}}_{\boldsymbol{2SLS}} - \widehat{\boldsymbol{\beta}}_{\boldsymbol{3SLS}}\right)$
Critical region: $H > \mathrm{X}^2_{\alpha;\, p}$ With p estimated parameters and level of significance $\alpha = 10\%$
H = 7.9875 with p-value = 0.9999917

With a 90% confidence level, it can be concluded that only the 3SLS estimator is asymptotically efficient in estimating all three structural equation systems.

3.8 Classical Assumption

Classical assumption on the 3SLS estimates are multivariate normality and detection of non-multicollinearity. This study uses the Henze-Zirkler multivariate normality test, which tests the normality of 3SLS residuals based on the distance between two distribution functions [27]. The hypothesis is :

H_0 : system errors are normal multivariate distribution or $N_i \sim (\boldsymbol{\mu}, \sum)$
H_1 : system errors are not normal multivariate distribution

with $N_i \sim (\boldsymbol{\mu}, \sum)$ are multivariate normal distribution in dimension i with mean $\boldsymbol{\mu}$ dan covariance matrix $\sum$.

Test statistic :

$$HZ = \frac{1}{T^2}\sum_{t=1}^{T}\sum_{j=1}^{T} e^{\frac{\beta^2}{2}D_{tn}} - 2(1+\beta^2)^{-\frac{i}{2}}\left(\frac{1}{T}\right)\sum_{t=1}^{T} e^{-\frac{\beta^2 D_t}{2(1+\beta^2)}} + (1+\beta^2)^{-\frac{i}{2}}$$

where :

$\beta \quad = \frac{1}{\sqrt{2}}\left(\frac{n(2i+1)}{4}\right)^{\frac{1}{i+4}}$
$\boldsymbol{D_{tn}} = (\boldsymbol{u_t} - \boldsymbol{u_n})^T \boldsymbol{S^{-1}} (\boldsymbol{u_t} - \boldsymbol{u_n})$ is the Mahalanobis distance between observation residuals t and n.
$\boldsymbol{D_t} \quad = (\boldsymbol{u_t} - \bar{\boldsymbol{u}})^T \boldsymbol{S^{-1}} (\boldsymbol{u_t} - \bar{\boldsymbol{u}})$
with
i : number of equations
T : size in terms of time units.
$\boldsymbol{S^{-1}}$: variance-covariance residuals matrix.

The Henze-Zirkler test resulted in a value of 0.6841 with a p-value of 0.188. At a 90% confidence level, the residuals of the 3SLS system are multivariate normally distributed. Then According to [20], the detection of multicollinearity can be observed from the pairwise correlation among independent variables. If the correlation between independent variables exceeds 0.8, then multicollinearity is an issue. The results of multicollinearity detection using the correlation matrix are as follows :

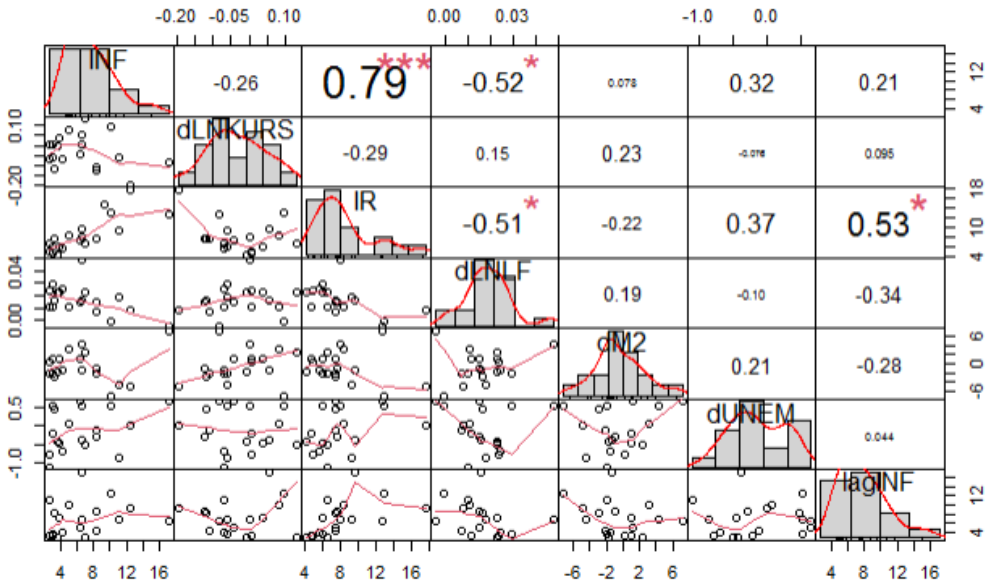

Figure 3. Correlation Matrix Among Variables

From the **Figure 3,** there is no correlation between independent variables that exceeds 0.8. Thus, the requirement for non-multicollinearity in the model is satisfied. This shows that there is no perfect collinearity between the independent variables. Multicollinearity is a situation where there is an almost perfect linear relationship between independent variables.

4. CONCLUSIONS

The development of economic globalization index, economic growth, and life expectancy has been fluctuating since 2000-2019. In general, Indonesia's economic globalization index tends to show a decreasing trend, economic growth is relatively stagnant, and life expectancy is on an increasing trend. All three variables are found to be experiencing simultaneity issues. The estimation results using the 3SLS method reveal a bidirectional relationship between economic globalization and economic growth. Economic globalization and economic growth affect human capital. However, human capital does not have a reciprocal impact on economic globalization or economic growth.

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