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FIX EFFECT SUR TO ANALYZE ECONOMIC SUCCESS IN DEVELOPED AND DEVELOPING COUNTRIES

Abstract

This study aims to identify the relationship between population density, inflation and unemployment rates on the human development index, GNP, export import and urbanization in the developed and developing countries category using the Fix Effect Seemingly Unrelated Regression (FE SUR) with a dummy variable as the slope component. This study uses the Fix Effect SUR model because it is assumed that there are different characteristics for each country. The results showed that 98.46% of the diversity of response variables (human development index, GNP, exports, imports and urbanization) could be explained by predictor variables (population density, inflation and unemployment rate), while the other 1.54% was explained by other factors not included in the analysis. model. In addition, the results show that population density has a significant positive relationship to GNP, imports and exports. However, there is a significant negative relationship between unemployment and GNP. There are large differences in the relationship between the unemployment rate and GNP in developed and developing countries, where in developed countries there is a larger and negative relationship compared to developing countries.

Keywords: Fix Effect SUR, Panel SUR, Developed and Growth Country, World Economics, Economic Success

JEL Classification: A10, B23, C33, F00, G00, O10

Introduction

Economic success is something that all countries in the world want to achieve, especially developing countries. A country is said to be developed if it has a high and evenly distributed economic level, a high standard of living and sophisticated technology. Developing countries have a middle level of social welfare and there is no economic equality (Heshmati, et al., 2014). The benchmark for economic success is economic growth and development. Every country must seek economic growth from year to year so that the country does not have problems in the economic field and has a prosperous society. This is still a problem in developing countries where developing countries continue to strive for a better country's economy through various economic actions and policies. Economic success is a process because it is a stage that must be lived by every country so that it requires hard work and cooperation between the community, government and other elements involved in the long term so that economic success can be achieved. Economic success can generally be seen through 2 aspects, namely the economic aspect which includes international trade and GNP and the social aspect which includes the human development index and urbanization (Kuncoro, 2006).

Seemingly Unrelated Regression (SUR) is a form of multivariate regression that can accommodate residual correlations between equations (the structure of the variance between equations) so that each equation in the model seems to stand alone or there is no link between the equations, but in fact the equations have relatedness (Alaba, et al., 2019). However, there is a problem related to multivariate regression analysis on economic variables, namely the dynamic nature of the data so that data at one point in time is not sufficient in modeling the relationship between each predictor variable and each response variable. Therefore, data is needed regarding variables related to several time periods for each research object (panel data) so that the regression model obtained is better at describing the relationship of predictor variables to response variables so that a method that is able to accommodate these problems is developed, namely multivariate regression analysis on panel data. Panel data regression analysis is one of the developments of regression analysis that allows statistical

users to analyze cause-and-effect relationships in the combined cross section and time series data. Through panel data regression analysis, the information obtained becomes more informative because it considers the unit cross section elements in several time periods. Panel data regression analysis is a statistical method that is used to model the relationship of one or more predictor variables to response variables in several observed sectors of a research object over a certain period of time (Baltagi, 2008).

Over time, more complex statistical analysis methods are needed that allow statistical users to analyze the relationship of several predictor variables to more than one response variable at once in panel data. Therefore, a Seemingly Unrelated Regression Panel model was developed which is capable of modeling the relationship of one or more predictor variables to more than one observed response variable of a research object over a certain period of time in panel data. The Seemingly Unrelated Regression Panel Model is one of the developments of multivariate regression analysis and panel data regression analysis that allows statistical users to analyze cause-and-effect relationships in the combined cross section and time series data, not just one response variable. The Fix Effect SUR model is a form of the SUR Panel model which assumes that there are different characteristics between individuals. Through the Fix Effect Seemingly Unrelated Regression model, the information obtained becomes more informative and complex because in addition to considering elements of unit cross sections in several time periods on many response variables at once, the Fix Effect Seemingly Unrelated Regression model also provides information about individual characteristics.

Therefore, this study aims to analyze the factors that influence HDI, GNP, Imports, Exports and Urbanization such as Population Density, Inflation and Unemployment Rates in developed and developing countries using the Fix Effect SUR. Kuncoro (2006) states that economic success is seen from 5 aspects, namely the Human Development Index, GNP, Imports, Exports and Urbanization. Therefore, this study aims to show the differences in the effect of Population Density, Inflation and Unemployment Rate on the Human Development Index, GNP, Imports, Exports and Urbanization in developed and developing countries so that this research can be beneficial for developing countries in maximizing economic activities in their countries as well as aspects what needs to be improved in order to have a high economic level like in developed countries, apart from that this research can be useful for developed countries in order to maintain the economic level in their country.

Seemingly Unrelated Regression (SUR)

The SUR model uses m response variables as a function of p predictor variables which can be seen in equation (1) (Moon and Perron, 2006).

$$\begin{aligned}
 Y_{1i} &= \beta_{10} + \beta_{11}X_{1i} + \beta_{12}X_{2i} + \dots + \beta_{1p}X_{pi} + \beta_{20}(0) + \beta_{21}(0) + \dots + \beta_{21}(0) + \dots + \beta_{mp}(0) + \varepsilon_{1i} \\
 Y_{2i} &= \beta_{10}(0) + \beta_{11}(0) + \dots + \beta_{1p}(0) + \beta_{20} + \beta_{21}X_{1i} + \beta_{22}X_{2i} + \dots + \beta_{2p}X_{pi} + \beta_{m0}(0) + \beta_{m1}(0) + \dots + \beta_{mp}(0) + \varepsilon_{2i} \\
 &\square \\
 Y_{mi} &= \beta_{10}(0) + \beta_{11}(0) + \dots + \beta_{1p}(0) + \dots + \beta_{(m-1)p}(0) + \beta_{m0} + \beta_{m1}X_{1i} + \beta_{m2}X_{2i} + \dots + \beta_{mp}X_{pi} + \varepsilon_{mi}
 \end{aligned}
 \tag{1}$$

Equation (1) can be simplified to equation (2).

$$Y_{li} = \beta_{l0} + \sum_{j=1}^p \beta_{lj}X_{ji} + \varepsilon_{li} ; i = 1, 2, \dots, n ; l = 1, 2, \dots, m ; j = 1, 2, \dots, p
 \tag{2}$$

Y_{li} = i-th value of the l-th response variable

X_{ji} = i-th value of the j-th predictor variable

β_{l0} = intercept the response variable to-l

β_{lj} = parameter of the jth predictor variable to the l-th response variable

ε_{lit} = i-th value of the random error variable on the l-th response variable

n= sample size

m= number of response variables

p= number of predictor variables

The form of the SUR equation in the matrix can be seen in equation (3) (Pramoedyo, et al., 2020).

$$Y_{mn \times 1} = X_{mn \times m(p+1)} \beta_{m(p+1) \times 1} + \varepsilon_{mn \times 1} \quad (3)$$

Fix Effect Seemingly Unrelated Regression (FE SUR)

In the fixed effects model, it is assumed that there is a relationship between the characteristics of the object (α_{mi}) and the predictor variables for each response variable. The Fix Effect Seemingly Unrelated Regression model is presented in equation (4) (Xu et al., 2018).

$$\begin{aligned} Y_{1it} &= \beta_{01i} + \beta_{11}X_{1it} + \beta_{12}X_{2it} + \dots + \beta_{1p}X_{pit} + \varepsilon_{1it} \\ Y_{2it} &= \beta_{02i} + \beta_{21}X_{1it} + \beta_{22}X_{2it} + \dots + \beta_{2p}X_{pit} + \varepsilon_{2it} \\ &\vdots \\ Y_{mit} &= \beta_{0mi} + \beta_{m1}X_{1it} + \beta_{m2}X_{2it} + \dots + \beta_{mp}X_{pit} + \varepsilon_{mit} \end{aligned} \quad (4)$$

Slope Dummy Fix Effect SUR

The Slope Dummy Fix Effect Seemingly Unrelated Regression model is presented in equation (5).

$$\begin{aligned} Y_{1it} &= \alpha_{10i} + \alpha_{112}(D_{2i} \times X_{1it}) + \alpha_{113}(D_{3i} \times X_{1it}) + \dots + \alpha_{11k}(D_{ki} \times X_{1it}) + \alpha_{122}(D_{2i} \times X_{2it}) + \\ &\alpha_{123}(D_{3i} \times X_{2it}) + \dots + \alpha_{12k}(D_{ki} \times X_{2it}) + \dots + \alpha_{1p2}(D_{2i} \times X_{pit}) + \alpha_{1p3}(D_{3i} \times X_{pit}) + \dots + \\ &\alpha_{1pk}(D_{ki} \times X_{pit}) + \beta_{11}X_{1it} + \beta_{12}X_{2it} + \dots + \beta_{1p}X_{pit} + \varepsilon_{1it} \\ Y_{2it} &= \alpha_{20i} + \alpha_{212}(D_{2i} \times X_{1it}) + \alpha_{213}(D_{3i} \times X_{1it}) + \dots + \alpha_{21k}(D_{ki} \times X_{1it}) + \alpha_{222}(D_{2i} \times X_{2it}) + \\ &\alpha_{223}(D_{3i} \times X_{2it}) + \dots + \alpha_{22k}(D_{ki} \times X_{2it}) + \dots + \alpha_{2p2}(D_{2i} \times X_{pit}) + \alpha_{2p3}(D_{3i} \times X_{pit}) + \dots + \\ &\alpha_{2pk}(D_{ki} \times X_{pit}) + \beta_{21}X_{1it} + \beta_{22}X_{2it} + \dots + \beta_{2p}X_{pit} + \varepsilon_{2it} \\ &\vdots \\ Y_{mit} &= \alpha_{m0i} + \alpha_{m12}(D_{2i} \times X_{1it}) + \alpha_{m13}(D_{3i} \times X_{1it}) + \dots + \alpha_{m1k}(D_{ki} \times X_{1it}) + \alpha_{m22}(D_{2i} \times \\ &X_{2it}) + \alpha_{m23}(D_{3i} \times X_{2it}) + \dots + \alpha_{m2k}(D_{ki} \times X_{2it}) + \dots + \alpha_{mp2}(D_{2i} \times X_{pit}) + \alpha_{mp3}(D_{3i} \times X_{pit}) + \\ &\dots + \alpha_{mpk}(D_{ki} \times X_{pit}) + \beta_{m1}X_{1it} + \beta_{m2}X_{2it} + \dots + \beta_{mp}X_{pit} + \varepsilon_{mit} \end{aligned} \quad (5)$$

SUR Model Assumptions

There are several assumptions that must be fulfilled in the Seemingly Unrelated Regression (SUR) model, namely the assumption of non-multicollinearity between predictor variables, and the correlation of errors between equations.

Checking Non-multicollinearity between Predictor Variables

One of the regression assumptions is that there is no relationship between predictor variables. The hypothesis underlying the non-multicollinearity assumption test is

H_0 : there is no multicollinearity between predictor variables vs

H_1 : there is multicollinearity between predictor variables

If H_0 is true, then the VIF statistic is used in the equation (6)

$$VIF_j = \frac{1}{1 - R_j^2}$$

(6)

where:

VIF_j = VIF value of the j-th predictor variable

Accept H_0 if VIF_j statistic < 10 (Bowerman dan O'Connel, 1990).

Testing Correlation Assumptions between Equations Errors

The purpose of testing the assumptions of error correlation is to find out whether there is an error correlation between equations, with the hypothesis:

$H_0: s_{ij} = 0$ for all $i \neq j; i = 1, 2, \dots, m; j = 1, 2, \dots, m$ (there is no error correlation between equations) vs

$H_1: \text{at least one } ij \text{ where } s_{ij} \neq 0$ (there is an error correlation between equations)

If H_0 is true, then the Lagrange Multiplier test statistic is used in the equation (7).

$$LM = nt \sum_{i=1}^m \sum_{j=1}^{i-1} r_{ij}^2 \sim \chi_{\frac{m(m-1)}{2}}^2$$

(7)

where:

r_{ij} = correlation of the residuals of the i-th equation and the j-th equation

n = sample size

t = period of time

m = number of equations

Accept H_0 if LM statistics < $\chi_{\alpha, \frac{m(m-1)}{2}}^2$ or $P \left(LM < \chi_{\alpha, \frac{m(m-1)}{2}}^2 \right) > \alpha$ (Greene, 2012).

Estimation of SUR Model Parameters with GLS

Parameters in the SUR Panel model can be estimated using Generalized Least Square (GLS) by minimizing the sum of squared errors where it is assumed that matrix V (OLS residual matrix of variance) is known as follows (Zellner, 1962; Nisak, et al., 2016).

$$\begin{aligned} \hat{\varepsilon}'\hat{\varepsilon} &= (Y' - X'\hat{\beta})'V^{-1}(Y - X\hat{\beta}) \\ \hat{\varepsilon}'\hat{\varepsilon} &= (Y' - X'\hat{\beta}')V^{-1}(Y - X\hat{\beta}) \\ \hat{\varepsilon}'\hat{\varepsilon} &= Y'V^{-1}Y - Y'V^{-1}X\hat{\beta} - YV^{-1}X'\hat{\beta}' + X\hat{\beta}V^{-1}X'\hat{\beta}' \\ \hat{\varepsilon}'\hat{\varepsilon} &= Y'V^{-1}Y - 2X'V^{-1}\hat{\beta}'Y + X\hat{\beta}V^{-1}X'\hat{\beta}' \\ \frac{\partial(\hat{\varepsilon}'\hat{\varepsilon})}{\partial(\hat{\beta})} &= \frac{\partial(Y'V^{-1}Y - 2X'V^{-1}\hat{\beta}'Y + X\hat{\beta}V^{-1}X'\hat{\beta}')}{\partial(\hat{\beta})} = 0 \\ \frac{\partial(\hat{\varepsilon}'\hat{\varepsilon})}{\partial(\hat{\beta})} &= -2X'V^{-1}Y + 2X'V^{-1}X\hat{\beta} = 0 \\ -X'V^{-1}Y + X'V^{-1}X\hat{\beta} &= 0 \\ X'V^{-1}X\hat{\beta} &= X'V^{-1}Y \\ \hat{\beta} &= (X'V^{-1}X)^{-1}X'V^{-1}Y \end{aligned}$$

(8)

di mana:

Y = response variable vector is $mn \times 1$ in size

X = predictor variable matrix of size $mn \times m(p+1)$

V = error variance matrix of size $mn \times mn$

$\hat{\beta}$ = parameter estimator vector of size $m(p+1) \times 1$

m = number of response variables
n = sample size
p = number of predictor variables

Simultaneous Testing

The purpose of testing simultaneously is to find out the relationship between the predictor variables together with the response with the hypothesis:

$$H_0: \beta_{11} = \dots = \beta_{1p} = \dots = \beta_{2p} = \dots = \beta_{mp} = 0 \text{ vs}$$

$$H_1: \text{there is one or more } l \text{ where } \beta_{lj} \neq 0;$$

$$l = 1, 2, \dots, m; j = 1, 2, \dots, p$$

If H_0 is true, then the F test statistic is used in the equation (9).

$$F = \frac{\text{Mean square regression}}{\text{Mean square error}} \sim F_{mp, mn-mp} \quad (9)$$

Accept H_0 if $F > F_{mp, mn-mp}^{\alpha/2}$ or $P(F < F_{mp, mn-mp}^{\alpha/2}) > \alpha$.

Partial Testing

The purpose of doing partial testing is to find out the relationship of each predictor variable individually to the response with the hypothesis:

$$H_0: \beta_{lj} = 0 \text{ vs}$$

$$H_1: \beta_{lj} \neq 0; l = 1, 2, \dots, m; j = 1, 2, \dots, p$$

If H_0 is true, then the t test statistic is used in the equation (10).

$$t = \frac{\hat{\beta}_{lj}}{s(\hat{\beta}_{lj})} \sim t_{mn-mp}; l = 1, 2, \dots, m; j = 1, 2, \dots, p \quad (10)$$

di mana:

$\hat{\beta}_{lj}$ = parameter estimator β_{lj}

$S(\hat{\beta}_{lj})$ = standard error of parameter estimator β_{lj}

Accept H_0 if $t < t_{mn-mp}^{\alpha/2}$ or $2P(t < t_{mn-mp}^{\alpha/2}) > \alpha$.

Research Method

This study uses the Fix Effect Seemingly Unrelated Regression (Fix Effect SUR) model because the five aspects of economic success (HDI, GNP, Import, Export and Urbanization) are related and it is assumed that there are different characteristics between countries. This study uses data on aspects of economic success (HDI, GNP, Import, Export and Urbanization) in 145 countries in the world where there are 35 developing countries and 110 developed countries obtained from the official websites of the World Bank and IMF. The procedure of this research is as follows.

1. Checking the relationship between predictor variables (assuming non-multicollinearity) using VIF statistics as in equation (6)
2. Estimating the parameters of the Fix Effect SUR model using the general least squares (GLS) method in equation (8)
3. Checking the assumption of error correlation between equations using the Lagrange Multiplier test statistic as in equation (7)

4. Testing the relationship of the predictor variables to the response variables of the Fix Effect SUR model together as in equation (9) and individually as in equation (10)
5. Checking the feasibility of the Fix Effect SUR model using the coefficient of determination
6. Interpretation of the model obtained

The research hypothesis is as follows.

H1: Population density affects HDI

H2: Population density affects GNP

H3: Population Density affects Imports

H4: Population Density affects Exports

H5: Population Density affects Urbanization

H6: Inflation affects HDI

H7: Inflation affects GNP

H8: Inflation affects imports

H9: Inflation affects exports

H10: Inflation affects urbanization

H11: Unemployment rate affects HDI

H12: Unemployment rate affects GNP

H13: Unemployment Rate affects Imports

H14: Unemployment Rate affects Exports

H15: Unemployment Rate affects Urbanization

H16: Different Effects of Population Density on HDI in Developed and Developing Countries

H17: Different Effects of Population Density on GNP in Developed and Developing Countries

H18: Different Effects of Population Density on Imports in Developed and Developing Countries

H19: Different Effects of Population Density on Exports in Developed and Developing Countries

H20: Different Effects of Population Density on Urbanization in Developed and Developing Countries

H21: Different Effects of Inflation on HDI in Developed and Developing Countries

H22: Different Effects of Inflation on GNP in Developed and Developing Countries

H23: Different Effects of Inflation on Imports in Developed and Developing Countries

H24: Different Effects of Inflation on Exports in Developed and Developing Countries

H25: Different Effects of Inflation on Urbanization in Developed and Developing Countries

H26: Different Effects of Unemployment Rate on HDI in Developed and Developing Countries

H27: Different Effects of Unemployment Rate on GNP in Developed and Developing Countries

H28: Different Effects of Unemployment Rates on Imports in Developed and Developing Countries

H29: Different Effects of Unemployment Rates on Exports in Developed and Developing Countries

H30: Different Effects of Unemployment Rates on Urbanization in Developed and Developing Countries

Result and Discussion

Fix Effect SUR Parameter Estimation

After analysis, the parameter estimators for the Fix Effect SUR model are obtained as follows.

$$\begin{aligned}
 HDI_{it} &= \alpha_{1i} + 0.005(D_{2i} \times Population\ Density_{it}) - 0.003(D_{2i} \times Inflation_{it}) \\
 &\quad - 0.001(D_{2i} \times Unemployment\ Rate_{it}) + 0.001Population\ Density_{it} \\
 &\quad + 0Inflation_{it} - 0.002Unemployment\ Rate_{it} \\
 GNP_{it} &= \alpha_{2i} + 12.931(D_{2i} \times Population\ Density_{it}) - 9.768(D_{2i} \times Inflation_{it}) \\
 &\quad - 16.019(D_{2i} \times Unemployment\ Rate_{it}) + 28.68Population\ Density_{it} \\
 &\quad - 0.055Inflation_{it} - 10.358Unemployment\ Rate_{it}
 \end{aligned}$$

$$\begin{aligned}
Import_{it} &= \alpha_{3i} + 11.711(D_{2i} \times Population\ Density_{it}) + 3.776(D_{2i} \times Inflation_{it}) \\
&\quad - 4.474(D_{2i} \times Unemployment\ Rate_{it}) + 2.952Population\ Density_{it} \\
&\quad - 0.009Inflation_{it} - 2.195Unemployment\ Rate_{it} \\
Eksport_{it} &= \alpha_{4i} + 19.459(D_{2i} \times Population\ Density_{it}) + 0.471(D_{2i} \times Inflation_{it}) \\
&\quad - 4.718(D_{2i} \times Unemployment\ Rate_{it}) + 2.657Population\ Density_{it} \\
&\quad + 0.002Inflation_{it} - 2.019Unemployment\ Rate_{it} \\
Urbanization_{it} &= \alpha_{5i} + 0.169(D_{2i} \times Population\ Density_{it}) - 0.081(D_{2i} \times Inflation_{it}) \\
&\quad - 0.015(D_{2i} \times Unemployment\ Rate_{it}) + 0.103Population\ Density_{it} \\
&\quad - 0.009Inflation_{it} - 0.072Unemployment\ Rate_{it}
\end{aligned}$$

Checking Non-Multicollinearity Assumption

Examination of non-multicollinearity assumptions is carried out to determine the relationship between predictor variables whether there is multicollinearity or not. The results of examining the non-multicollinearity assumptions between predictor variables are presented in Table 1.

Table 1. Results of Examination of Non-Multicollinearity Assumptions

The j-th Predictor Variable	VIF_j
Population Density	1.008598
Inflation	1.001373
Unemployment Rate	1.008285

Through Table 1, VIF statistics are obtained for population density (1.008598), inflation (1.001373) and unemployment rate (1.008285) < 10. Therefore, sufficient evidence is obtained to accept H_0 so that it can be concluded that there is no multicollinearity between predictor variables and non-multicollinearity assumption between predictor variables in the fixed effect SUR model has been fulfilled.

Testing Correlation between Errors Assumptions

Table 2. Results Examination of Correlation between Errors Assumption in the SUR Fixed Effect Model

The i-th and j-th equation	$r_{i,j}$	$r_{i,j}^2$
First and second equation	-0.108	0.012
First and third equation	-0.003	0.000
First and 4 th equation	-0.018	0.000
First and 5 th equation	0.671	0.450
Second and third equation	0.753	0.567
Second and 4 th equation	0.719	0.517
Second and 5 th equation	0.026	0.001
Third and 4 th equation	0.918	0.843

Third and 5 th equation	0.058	0.003
4 th and 5 th equation	0.041	0.002
$LM = nt \sum_{i=1}^m \sum_{j=1}^{i-1} r_{ij}^2$		3472.873

Through Table 2, the LM test statistics for the fixed effect SUR model (3472.873) > $\chi_{0.05,10}^2$ (3.94) or p-value (0) > α (0.05) are obtained. Therefore, sufficient evidence is obtained to reject H_0 so that it can be concluded that there is an error correlation between equations and the assumption of an error correlation between equations in the fix effect SUR model has been fulfilled.

F Test

Simultaneous testing using the F test was carried out to find out whether population density, inflation and unemployment rates have simultaneous affect to the human development index, GNP, imports, exports and urbanization in the fix effect SUR model. Through the results of the analysis, it is obtained that the F test statistic for the fix effect SUR model is 92692.37 which is greater than $F_{755,1093995}$ (1.96). Therefore, it can be decided that H_0 is rejected so that it can be concluded that simultaneously the SUR fix effect model is significant or at least there is one predictor variable (population density, inflation or unemployment rate) that has a significant relationship to the response variable (human development index, GNP, import, export or urbanization).

t Test

Tests individually using the t test were carried out to find out whether individually population density, inflation and unemployment rates have a significant relationship to the human development index, GNP, imports, exports and urbanization in the fix SUR effect model. There are several variables that have a significant relationship namely population density to GNP, unemployment rate to GNP, differences in the effect of the unemployment rate on GNP in developed and developing countries, population density on imports and population density on exports. Meanwhile, there is no significant relationship between predictor variables and other response variables.

Therefore, it was found that there were 5 significant research hypotheses namely H2, H3, H4, H12 and H27. While 25 other research hypotheses (H1, H5, H6, H7, H8, H9, H10, H11, H13, H14, H15, H16, H17, H18, H19, H20, H21, H22, H23, H24, H25, H26, H28, H29 and H30) are not significant at the 5% level of significance.

SUR Fix Effect Model Interpretation

Through the results of the analysis, it is obtained that the fix effect SUR model is as follows.

$$\begin{aligned}
 HDI_{it} &= \alpha_{1i} + 0.005(D_{2i} \times Population\ Density_{it}) - 0.003(D_{2i} \times Inflation_{it}) \\
 &\quad - 0.001(D_{2i} \times Unemployment\ Rate_{it}) + 0.001Population\ Density_{it} \\
 &\quad + 0Inflation_{it} - 0.002Unemployment\ Rate_{it} \\
 GNP_{it} &= \alpha_{2i} + 12.931(D_{2i} \times Population\ Density_{it}) - 9.768(D_{2i} \times Inflation_{it}) \\
 &\quad - 16.019(D_{2i} \times Unemployment\ Rate_{it}) + 28.68Population\ Density_{it} \\
 &\quad - 0.055Inflation_{it} - 10.358Unemployment\ Rate_{it} \\
 Import_{it} &= \alpha_{3i} + 11.711(D_{2i} \times Population\ Density_{it}) + 3.776(D_{2i} \times Inflation_{it}) \\
 &\quad - 4.474(D_{2i} \times Unemployment\ Rate_{it}) + 2.952Population\ Density_{it} \\
 &\quad - 0.009Inflation_{it} - 2.195Unemployment\ Rate_{it} \\
 Eksport_{it} &= \alpha_{4i} + 19.459(D_{2i} \times Population\ Density_{it}) + 0.471(D_{2i} \times Inflation_{it}) \\
 &\quad - 4.718(D_{2i} \times Unemployment\ Rate_{it}) + 2.657Population\ Density_{it} \\
 &\quad + 0.002Inflation_{it} - 2.019Unemployment\ Rate_{it}
 \end{aligned}$$

$$\begin{aligned}
Urbanization_{it} &= \alpha_{5i} + 0.169(D_{2i} \times Population\ Density_{it}) - 0.081(D_{2i} \times Inflation_{it}) \\
&- 0.015(D_{2i} \times Unemployment\ Rate_{it}) + 0.103Population\ Density_{it} \\
&- 0.009Inflation_{it} - 0.072Unemployment\ Rate_{it}
\end{aligned}$$

Model for Reference Country (Indonesia)

$$\begin{aligned}
HDI_{it} &= 0.403 + 0.001Population\ Density_{it} + 0Inflation_{it} - 0.002Unemployment\ Rate_{it} \\
GNP_{it} &= -6376 + 28.68Population\ Density_{it} - 0.055Inflation_{it} \\
&- 10.358Unemployment\ Rate_{it} \\
Import_{it} &= -543.31 + 2.952Population\ Density_{it} - 0.009Inflation_{it} \\
&- 2.195Unemployment\ Rate_{it} \\
Eksport_{it} &= -466.17 + 2.657Population\ Density_{it} + 0.002Inflation_{it} \\
&- 2.019Unemployment\ Rate_{it} \\
Urbanization_{it} &= 26.888 + 0.103Population\ Density_{it} - 0.009Inflation_{it} \\
&- 0.072Unemployment\ Rate_{it}
\end{aligned}$$

- The average human development index for Indonesia is 0.403, the average GNP for Indonesia is -US\$ 6376, the average export for Indonesia is -US\$ 543.31, the average export for Indonesia is -US\$ 466.17, the average urbanization rate for Indonesia is 26.888%
- Every increase of 1 million population in Indonesia will increase the human development index in Indonesia by 0.001, increase GNP in Indonesia by US\$ 26.68 billion, increase imports in Indonesia by US\$ 2,952 billion, increase exports in Indonesia by US\$ 2,657 billion and increase urbanization by 0.103%
- Every 1 unit increase in inflation will not change the human development index in Indonesia in the least, reducing GNP in Indonesia by US\$ 0.055 billion, reducing imports in Indonesia by US\$ 0.009 billion, reducing exports in Indonesia by US\$ 0.002 billion and reducing urbanization in Indonesia by 0.009%
- Every 1% increase in the unemployment rate will reduce the human development index in Indonesia by 0.002, reduce GNP in Indonesia by US\$ 10,358 billion, reduce imports in Indonesia by US\$ 2,195 billion, reduce exports in Indonesia by US\$ 2,019 billion and reduce urbanization in Indonesia by 0.072%

Models for Developing Countries (Example: Jamaica)

$$\begin{aligned}
HDI_{it} &= 0.754 + 0.001Population\ Density_{it} + 0Inflation_{it} - 0.002Unemployment\ Rate_{it} \\
GNP_{it} &= 59.75 + 28.68Population\ Density_{it} - 0.055Inflation_{it} \\
&- 10.358Unemployment\ Rate_{it} \\
Import_{it} &= 25.899 + 2.952Population\ Density_{it} - 0.009Inflation_{it} \\
&- 2.195Unemployment\ Rate_{it} \\
Eksport_{it} &= 21.943 + 2.657Population\ Density_{it} + 0.002Inflation_{it} \\
&- 2.019Unemployment\ Rate_{it} \\
Urbanization_{it} &= 55.415 + 0.103Population\ Density_{it} - 0.009Inflation_{it} \\
&- 0.072Unemployment\ Rate_{it}
\end{aligned}$$

- The average human development index for Jamaica is 0.754, the average GNP for Jamaica is US\$ 59.75, the average import for Jamaica is US\$ 25,899, the average export for Jamaica is US\$ 21,943, the average -the average urbanization rate for the country of Jamaica is 55.415%
- Every increase of 1 million population will increase the human development index in Jamaica by 0.001, increase GNP in Jamaica by US\$ 28.68 billion, increase imports in Jamaica by US\$

2,952 billion, increase exports in Jamaica by US\$ 2,657 billion and increase urbanization in Jamaica 0.103%

- Every increase of 1 unit of inflation will not change the human development index in Jamaica in the slightest, reducing GNP by US\$ 0.055 billion, reducing imports in Jamaica by US\$ 0.009 billion, reducing exports in Jamaica by US\$ 0.002 billion and reducing urbanization in Jamaica by 0.009 %
- Every 1% increase in the unemployment rate will reduce the human development index in Jamaica by 0.002, reduce GNP in Jamaica by US\$ 10,358 billion, reduce imports in Jamaica by US\$ 2,195 billion, reduce exports in Jamaica by US\$ 2,019 billion and reduce urbanization in Jamaica by 0.072%

Model for Developed Countries (Example: Norway)

$$\begin{aligned}
 HDI_{it} &= 0.935 + 0.006Population\ Density_{it} - 0.003Inflation_{it} \\
 &\quad - 0.003Unemployment\ Rate_{it} \\
 GNP_{it} &= 351.095 + 41.611Population\ Density_{it} - 9.823Inflation_{it} \\
 &\quad - 26.377Unemployment\ Rate_{it} \\
 Import_{it} &= 77.559 + 14.663Population\ Density_{it} + 3.767Inflation_{it} \\
 &\quad - 6.669Unemployment\ Rate_{it} \\
 Eksport_{it} &= 82.122 + 22.116Population\ Density_{it} + 0.473Inflation_{it} \\
 &\quad - 6.737Unemployment\ Rate_{it} \\
 Urbanization_{it} &= 79.987 + 0.272Population\ Density_{it} - 0.9Inflation_{it} \\
 &\quad - 0.087Unemployment\ Rate_{it}
 \end{aligned}$$

- The average human development index for Norway is 0.935, the average GNP for Norway is US\$ 351,095, the average import for Norway is US\$ 77,559, the average export for Norway is US\$ 82,122, the average -the average urbanization rate for Norway is 79.987%
- increase of 1 million population will increase the human development index in Norway by 0.006, increase GNP in Norway by US\$ 41,633 billion, increase imports in Norway by US\$ 14,633 billion, increase exports in Norway by US\$ 22,116 billion and increase urbanization in Norway 0.272%
- Every 1 unit increase in inflation will reduce the human development index in Norway by - 0.003, reduce GNP in Norway by US\$ 9,823 billion, increase imports in Norway by US\$ 3,767 billion, increase exports in Norway by US\$ 0.473 billion and reduce urbanization in Norway by 0.9%
- Every 1% increase in the unemployment rate will reduce the human development index in Norway by 0.003, reduce GNP in Norway by US\$ 26,377 billion, reduce imports in Norway by US\$ 6,669 billion, reduce exports in Norway by US\$ 6,737 billion and reduce urbanization in Norway by 0.087%

R^2

Through the analysis results, it is obtained that the R^2 statistic is 0.9846, which means that the Fix Effect SUR model is very good where 98.46% of the variety of the values of the human development index, GNP, imports, exports and urbanization can be explained by population density, inflation and the unemployment rate, while the remaining 1.54% explained by other variables that are not included in the Fix Effect SUR model.

Through the results of the t test it was found that only 5 of the 30 research hypotheses were significant. However, the R^2 statistic shows a very high value where 98.46% of the variation in the values of the human development index, GNP, imports, exports and urbanization can be explained by

population density, inflation and unemployment rates. This indicates that there are individual effects in each country (country characteristics) which causes the Fix Effect SUR model to be very good at modeling the relationship between population density, inflation and unemployment rates on the human development index, GNP, imports, exports and urbanization in developed and developing countries.

Conclusion

Through testing the significance of the parameters separately in the SUR fix effect model, it is found that population density has a significant positive relationship to GNP, imports and exports. In addition, there is a significant negative relationship between the unemployment rate and GNP. Through testing the significance of the parameters separately in the SUR fix effect model, it was found that there were not many significant differences between the magnitude of the relationship between population density, inflation and the number of unemployed on the human development index, GNP, imports, exports and urbanization in developed and developing countries. There are large differences in the relationship between the unemployment rate and GNP in developed and developing countries, where in developed countries there is a larger and negative relationship compared to developing countries. Therefore, it is expected that all countries pay attention to population density and the unemployment rate because it can affect the country's GNP, imports and exports. In addition, it is hoped that developing countries will be able to carry out population efficiency so that with an increasing population, the influence on GNP, imports and exports will be greater like developed countries where most of the population of developed countries has good quality human resources. On the other hand, it is hoped that developing countries will be able to add decent jobs to the population in order to reduce the unemployment rate so that the influence on GNP, imports and exports will be greater like developed countries where most of the population of developed countries are already working and have decent jobs and salaries.

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