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Determinants of Economic Growth for SADC Nations: A Fixed Effects Approach.

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Abstract.

In order to accurately forecast economic growth, it is important that growth determinants are identified. However Africa and Southern African Development Community (SADC) region in particular have not identified any determinants of economic growth that are peculiar to the SADC region. In this study determinants of economic growth are gathered and evaluated for sixteen SADC countries for twenty two years (2000 to 2021), that dictates use of panel data analysis, whereas panel data may have group effects, time effects or both. Data is taken from various sources but mainly the World Bank website for different SADC countries contributing in the world economy. In this article, the comparison of ordinary least squares (OLS) model and fixed effects models (FEM) for SADC nations' panel data were carried out. F-test was used as a specification test to make a selection between OLS model and fixed effects model. A fixed effects model with an adjusted R^2 value of 98% which is very plausible was realised to be the best model to handle the SADC community economic data.

Keywords: Economic Growth; SADC; Fixed effects; Gross domestic product; Panel data analysis; Ordinary least squares; Specification test; Adjusted R^2 value.

1.0 Introduction

There has been negligible empirical work that exclusively looked into factors that determine economic growth in developing economies and no research for the SADC region in recent years. Since economic growth is a very dynamic process, researches that are based on cases many of years ago may not be relevant now. The technological evolutions in the last few decades have changed the way nations and regions attempt to improve their economies. This study will facilitate motivation of more researches and case studies on developing regions and nations from which other countries can learn and benefit. Thus, this study has policy implications.

The ability to accurately forecast economic growth plays a pivotal role in economic planning and economic policy formulation. In order to accurately forecast economic growth, it is important that growth determinants are identified. Imports, exports, external debt, exchange rate, international reserves, labour force, foreign direct investment and interest rate have been identified as determinants of economic growth as measured by gross domestic products (GDP). (Barro, 2003; Adams & Page, 2005; Basu, *et al*., 2000; Dobronogov & Iqbah, 2005; Samuel & Nurina, 2015; Sireesha, 2013; Phale, 2021; Mallick, 2016; Wajeetonggratana, 2020; Agalega & Antwi, 2013 & Yuliadi, 2020). However Africa and Southern African Development Community (SADC) region in particular have not identified any determinants of economic growth that are peculiar to the SADC region. Hence this study intends to use the fixed effects approach to identify the determinants, model and then recommend key areas to focus on in an attempt to achieve and maintain economic growth in the SADC region.

The SADC's regional indicative strategic development plan (RISDP 2020–2030) draws impetus from the organisation's vision 2050, which envisages "a peaceful, inclusive, competitive, middle to high-income industrialised region, where all citizens enjoy sustainable economic well-being, justice, and freedom" (SADC RISDP 2020–2030). The SADC region is one of the centers of promising economic growth for the world's economy, which is currently experiencing stagnation due to the COVID-19 pandemic that has hit almost all countries in the world.

With the potential for economic wealth, both natural resources and human resources, it is very promising for investment in this strategic area (Adema, & Ladaique, 2009). Geographically, it is located in Africa and has boarders with two oceans, namely the Indian Ocean and the Atlantic Ocean, placing the SADC region as an indicator for security and political stability in the

African continent (SADC RISDP 2020–2030). The combination of the wealth of natural resources, the abundance of the workforce, political stability and security, and supported by a harmonious culture of society makes the SADC region one of the priorities of investors in investing in various economic sectors. The SADC region is also a center for trade and financial transactions and services to support the increasing demand for industrial goods and community needs (Epaphra, 2018). Generally all member states of the SADC economic community experienced an increase in GDP for the period under study. When viewed from nominal figures, the largest GDP was from South Africa followed by Angola. However, when viewed from the volume of foreign direct investment, the largest was South Africa followed by Eswatini. Looking at the GDP development from 2000-2021, the SADC region is a potential area in the world economy in developing the primary economic sector, namely food and energy products and becoming an investment choice for the manufacturing and information technology-based industries (SADC RISDP 2020–2030). Hence being able to identify determinants, model and forecast economic growth will be of prime importance and will assist in decision making, economic policy planning and implementation.

1.1 Economic Models and Theoretical Frameworks

Economic development is a lasting process to attain economic prosperity for the whole society as a result of the interaction between economic and non-economic factors (Kei and Nakajima, 2015). Economic development to advance people's welfare requires a boost in economic growth through production factors to bring into being goods and services. Economic growth is manifested by increased per capita income from year to year, obtained through the gross domestic product (GDP) divided by the total population (Gray & Bilsborrow, 2013). Gross domestic product (GDP) is the most commonly used measure of a country's economic wellbeing. It is the number reached by evaluating all the productive activities within the nation at a particular year's prices. Panel data analysis is a two or multi-dimensional data set having observations on multiple variables observed over multiple time periods (Baltagi, 2005; Gujarati, 2003) among many others.

1.1.1 Fixed Effects Model

Panel data models looks at fixed effects of individuals or time. A parameter estimate of a dummy variable is a part of the intercept in a fixed effects model. Slopes remain unchanged across groups or time period in fixed effects model. The functional form of one-way fixed effects models is given by equation (1);

Fixed effects model: $y_{it} = (\alpha + u_i) + X_{it}'\beta + v_{it}$ (1)

where u_i is a fixed or random effects specific time to period or individual (group) that is not included in the regression, and errors are independent identically distributed, $v_{it} \sim IID(0, \sigma^2{}_v)$.

A fixed group effect model looks at individual differences in intercepts, assuming the constant variance and same slopes across individual (entity and group). Since an individual specific effect is time invariant and considered a part of the intercept, u_i is allowed to be correlated with other regressors; Thus, ordinary least squares (OLS) assumption is not violated. This fixed effects model is estimated by least squares dummy variable (LSDV) regression (OLS with a set of dummies) and within effect estimation methods. The properties of fixed effects models are summarised in table 1.

Table 1 Properties of Fixed Effects Models

Functional Form	$\boldsymbol{y_{it} = (\alpha + u_i) + X_{it}'\beta + v_{it}}$
Assumptions	None
Intercepts	Varying across group and/or time
Error variances	Constant
Slopes	Constant
Estimation	LSDV, within effect estimation
Hypothesis Test	F test

Fixed effects are examined by the F test, Breusch and Pagan (1980). If the null hypothesis is not rejected in either test, the pooled OLS regression is preferred.

1.1.2 Estimating Fixed Effects Models

There are several approaches for estimating a fixed effects model. The least squares dummy variable model (LSDV) uses dummy variables, while the "within" estimation does not. These approaches, produce indistinguishable parameter estimates of regressors (non-dummy independent variables). The "between" estimation fits a model using individual or time means of dependent and independent variables without dummies.

LSDV with a dummy dropped out of a set of dummies is usually used because it is comparatively easy to estimate and interpret substantively. This LSDV, however, becomes challenging when there are many groups (or individuals) in panel data (Baltagi, 2001). If T is fixed and $n \rightarrow \infty$ (n is the number of groups or firms and T is the number of time periods), parameter estimates of regressors are consistent but the coefficients of individual effects, $\alpha + u_i$, are not (Baltagi, 2001). In this short panel, LSDV includes a large number of dummy variables; the number of these parameters to be estimated increases as n increases (incidental parameter problem); thus, LSDV loses n degrees of freedom but returns less efficient estimators (Baltagi, 2001). Under this situation, LSDV is useless and thus calls for another approach, the within effect estimation.

Unlike LSDV, the "within" estimation does not require dummy variables, but it uses deviations from group (or time period) means. Thus, "within" estimation uses variation within each individual or entity instead of a large number of dummies. The "within" estimation is given by equation (2);

$$(y_{it} - \bar{y}_{i.}) = (x_{it} - \bar{x}_{i.})'\beta + (\varepsilon_{it} - \bar{\varepsilon}_{i.}) \quad (2)$$

Where $\bar{y}_{i.}$ is the mean of dependent variable (DV) of individual (group) i, $\bar{x}_{i.}$ represent the means of independent variables of group i, and $\bar{\varepsilon}_{i.}$ is the mean of errors of group i.

In this "within" estimation, the incidental parameter challenge is no longer a concern. The parameter estimates of regressors in the "within" estimation are the same as those of LSDV. The "within" estimation reports correct the sum of squared errors (SSE). The "within" estimation, however, has several drawbacks. Firstly, data transformation for "within" estimation wipes out all time-invariant variables (e.g., citizenship, gender, and ethnic group) that do not vary within an entity (Kennedy, 2008). Since deviations of time-invariant variables from their average are all zero, it is not feasible to estimate coefficients of such variables in "within" estimation. As a result, we have to fit LSDV when a model has time-invariant independent variables.

Secondly, "within" estimation produces faulty statistics. Since no dummy is used, the within effects model has larger degrees of freedom for errors, accordingly reporting small mean squared errors (MSE), standard errors of the estimates (SEE) or square root of mean squared errors (SRMSE), and incorrect (smaller) standard errors of parameter estimates. Thus, we have to adjust incorrect standard errors using equation (3);

$$se_k^* = se_k\sqrt{\frac{df_{error}^{within}}{df_{error}^{LSDV}}} = se_k\sqrt{\frac{nT-k}{nT-n-k}} \quad (3)$$

Thirdly, R^2 of the "within" estimation is not correct because the intercept term is suppressed. Lastly, the "within" estimation does not report dummy coefficients. We have to compute them, if actually needed, using the formula, $d_i^* = \bar{y}_{i.} - \bar{x}_{i.}\,\beta$.

Table 2 Comparison of Three Estimation Methods of Fixed Effects Models

	LSDV	Within Estimation	Between Estimation
Functional form	$y_i = i\alpha_i + X_i\beta + \varepsilon_i$	$y_{it} - \bar{y}_{i.} = x_{it} - \bar{x}_{i.} + \varepsilon_{it} - \bar{\varepsilon}_{i.}$	$\bar{y}_{i.} = \alpha + \bar{x}_{i.} + \varepsilon_i$
Time invariant variables	Yes	No	No
Dummy variables	Yes	No	No
Dummy coefficients	Presented	Need to be computed	N/A
Transformation	No	Deviation from group means	Group means
Intercept estimated	Yes	No	Yes
R^2	Correct	Incorrect	N/A
SSE	Correct	Incorrect	Not of concern
MSE/SEE (SRMSE)	Correct	Incorrect(smaller)	N/A
Standard errors	Correct	Incorrect(smaller)	N/A
DFerror	$nT - n - k *$	$nT - k$(n larger)	$n - k - 1$
Observations	nT	nT	n

The "between groups" estimation, also known as group mean regression, uses variation between individual groups (entities). Particularly, this estimation calculates group means of the dependent and independent variables and hence reduces the number of observations down to *n*. Then, run OLS on these transformed, aggregated data: $\overline{y}_{i.} = \alpha + \bar{x}_{i.} + \varepsilon_i$. Table 2 contrasts LSDV, "within group" estimation, and "between group" estimation.

1.1.3 Testing Fixed Effects

Fixed effects are tested by F-test. In a regression of $y_{it} = \alpha + \mu_i + X_{it}'\beta + \varepsilon_{it}$, the null hypothesis states that all dummy parameters except for one for the dropped are all zero, H_0 : $\mu_0 = \ldots = \mu_{n-1} = 0$. The alternative hypothesis is that at least one dummy parameter is not zero. This hypothesis is tested using an F test, which is based on loss of goodness-of-fit. This test contrasts LSDV (robust model) with the pooled OLS (efficient model) and examines the extent that the goodness-of-fit measures (SSE or R^2) changed. The test statistic for contrasting OLS and FEM is given by equation (4).

$$F_{(n-1,nT-n-k)} = \frac{(e'e_{pooled} - e'e_{LSDV})/(n-1)}{(e'e_{LSDV})/(nT-n-k)} = \frac{(R^2{}_{LSDV} - R^2{}_{pooled})/(n-1)}{(1-R^2{}_{LSDV})/(nT-n-k)} \quad (4)$$

Where $e'e_{pooled}$ is the SSE of the pooled OLS regression.

If the null hypothesis is rejected (at least one group/time specific intercept u_i is not zero), one may conclude that there is a significant fixed effect or significant increase in goodness-of-fit in the fixed effect model; therefore, the fixed effect model is better than the pooled OLS.

2.0 Materials and Methods

2.1 Econometric Models

This research among other things aims to examine whether unemployment has an influence on the economic growth of the SADC countries. In an attempt to achieve this objective, we first build the production function framework that mirrors the production and certainly proxy for economic growth. Now suppose variable factors of production only influence the output level in an economy, and the model presented by Tiwari & Mutascu in 2011 as shown in equation (5):

$$Y = f(L, K) \quad (5)$$

Where, Y is output level (i.e. GDP), L is labour amount (Labour force) and K denotes the capital (measured by Gross Capital Formation), it can be said that increase in employed labour and capital are responsible to increase the output level of any economy. Then following the above (equation (5)), this production function is expanded according to the growth theory (Barro and Sala-i-Martin, 1995; Tiwari & Mutascu 2011). For our study, we extended the model by including the other explanatory variables. The model would be as shown in equation (6):

$$GDPit = f\,(IMPit, EXPoit, INTRit, LFit, UNEMit, EDit, INFit, FDIit, IRit, EXRit) \quad (6)$$

Where

IMPit = Imports

EXPOit = Exports

INTRit = International Reserves

LFit = Labour Force

GDPit = Real GDP

UNEMit=Unemployment rate

EDit = External Debt

INFit = Inflation rate

FDIit = Foreign direct investment, net inflows

IRit = Interest rate

EXRit =Exchange Rate

Here, i shows country effects in independent variables, and t shows time effects in independent variables and the assumptions of Uit is that, $Uit \approx IID(\delta_u^2)$ i.e. errors are independently identically distributed with zero mean and constant variances. Where i denote a specific country and t denotes a specific time period. Empirical panel data can be analysed through three different methods. The ordinary least square, random effects model, and fixed effects model or least squares dummy variables (LSDV). Akbar, et al, in 2011 has used OLS, FEM and REM for the estimation of GDP per capita for nine (9) Asian countries. The empirical standard methodology presumes that OLS is used to estimates the equations of regression, where the supposition is that omitted variables are identically distributed and are independent of repressors. So this type of estimation may create a challenge of interpretation when we want to study the country specific characteristics like as, policy changes, political regimes and good governance that influences the growth rate but are not considered in the estimation process.

Thus we will conduct our methodology by way of FEM. The Hausman (1978) test answers this question of comparing the FEM and REM. The test examines, if country specific effects are associated with other regressors, then REM violates the assumptions of Gauss-Markov and is no longer considered as a best linear unbiased estimator (BLUE), this is so since country effects are only the part of error term in a REM. But if country effects were a part of intercept and correlation amongst regressors and intercept would not violate the assumptions of Gauss-Markov, then a FEM is still BLUE.

2.2 Group Effects where all Coefficients are Constant across Time and Countries

Of primary interest is to investigate how selected specific variables influence the economic growth in SADC countries. The baseline model in order to check the group effects, where all coefficients are constant across time and countries, would be written as shown in equation (7);

$$GDPit = \beta_0 + \beta_1 LFit + \beta_2 UNEMit + \beta_3 EDit + \beta_4 INFit + \beta_5 FDIit + \beta_6 IRit + \beta_7 EXRit + \beta_8 IMP + \beta_9 EXPOit + \beta_{10} INTRit + Uit \quad (7)$$

Where U_{it} = is the error term.

In this case, estimated model assumes that the values of intercept for all countries or country entities are the same. Also, slope coefficients of all independent variables are constant for all sixteen countries. As a result of the highly restricted assumptions in above equation (7) this may distort the actual picture of the model. But we have to determine the country effects of different countries; this can be spelt out in the next section.

2.3 Slope Coefficient Constant but Intercept Varies Across Countries

To the individuality of each country, suppose intercept varies by country but slope coefficients of respective countries are assumed to be constant. If there is a situation that error term and independent variables are correlated then LSDV approach may be inappropriate (Gujrati, 2003). To see this model would be of the format as in equation (8);

$$GDPit \ = \ \beta_{0i} + \beta_1 LFit + \beta_2 UNEMit + \beta_3 EDit + \beta_4 INFit + \beta_5 FDIit + \beta_6 IRit + \beta_7 EXRit + \beta_8 IMP + \beta_9 EXPOit + \beta_{10} INTRit + \ Uit \quad (8)$$

Here, subscript i in β_{0i} (intercept) suggests that the sixteen countries have different intercepts that are due to different political systems, different monetary and fiscal policy styles, and different managerial abilities. Fixed effect model has constant slopes but intercept differences (Akbar, et al, 2011). The above equation (7) is the fixed effect model with "with-in" effects. Fixed effect model shows that, intercept differs across countries but still is a time invariant. The equation assumes that slope coefficients of individual countries are not varying across countries and over time.

Now, for estimating the fixed effect intercept of different countries, the method of least square dummy variables (LSDV) will be employed and the model is as in equation (9);

$$GDPit \ = \ \beta_{0i} + \beta_1 LFit + \beta_2 UNEMit + \beta_3 EDit + \beta_4 INFit + \beta_5 FDIit + \beta_6 IRit + \beta_7 EXRit + \beta_8 IMP + \beta_9 EXPOit + \beta_{10} INTRit + \propto_i + \sum_{i=j=2}^{16} \propto_i C_{ij} + Uit \quad (9)$$

Where,

j = 2, 3,…, 16 are showing the individual country dummies.

i = shows Country effects in explanatory variables,

t = Shows time effects in explanatory variables

Here, $C_{i2} = 1$ if the research observation is belonging to country two i.e. Botswana and would be zero (0) otherwise. Same dummies would be for remaining countries (up to 16 countries). As we have sixteen countries, therefore we have to use only fifteen country dummies to prevent dummy variable trap that would be a situation of perfect multicollinearity. It can be said that no dummy for first country and represents the intercept of first country Angola. And $\propto_1 \propto_2 \propto_3 \dots \dots .. \propto_{15}$ are intercepts for respective dummies for countries. $\beta_1, \beta_2, \beta_3 \dots \dots .. \beta_{15}$ are slopes for explanatory variables such as unemployment, real interest rate, FDI respectively.

Since we are interested in determining the country effects that are due to different political systems, different monetary and fiscal policies and different managerial abilities, so we use the dummies to estimates the country specific effects, which is also referred to as LSDV (least-square dummy variables) method in literature. So the term LSDV and fixed effect model are used interchangeably, and also occasionally the LSDV model and covariance model are used interchangeably.

2.4 Constant Slope Coefficient but Intercept Varies across Countries as well as Time

Dummy variables can also be used in checking for the time effects with making a sense that changes occurs in different countries over a time, due to the factors like change in government regulatory, tax policies, technological changes, changes in overall education level and sometimes external effects like as wars and also other conflicts. For time effects time dummies are introduced, one for each year. As data set is for 22 years from 2000 to 2021, so we introduce only 21dummies for preventing from dummy variable trap. The model would be as given by equation (10);

$$GDPit = \gamma_1 + \gamma_2 T_2 + \gamma_3 T_3 + \cdots + \gamma_{21} T_{21} + \beta_1 LFit + \beta_2 UNEMit + \beta_3 EDit + \beta_4 INFit + \beta_5 FDIit + \beta_6 IRit + \beta_7 EXRit + \beta_8 IMP + \beta_9 EXPOit + \beta_{10} INTRit + Ui. \quad (10)$$

Here, T_2 take the value of 1 for observation in year 2001 and zero (0) otherwise, etc. Now, for showing the both countries country effects and time effects, the model would be written as in equation (11);

$$GDPit = \propto_1 + \propto_2 C_2 + \cdots + \propto_{16} C_{16} + \gamma_1 + \gamma_2 T_{2001} + \gamma_3 T_{2002} + \cdots + \gamma_{20} T_{2019} + \beta_1 LFit + \beta_2 UNEMit + \beta_3 EDit + \beta_4 INFit + \beta_5 FDIit + \beta_6 IRit + \beta_7 EXRit + \beta_8 IMP + \beta_9 EXPOit + \beta_{10} INTRit + Uit. \quad (11)$$

Above model can also be written as shown in equation (12);

$$GDPit = \sum_{i=j=2}^{16} \propto_1 C_{ji} + \sum_{t=k=2001}^{2021} \gamma_k T_{kt} + \beta_1 LFit + \beta_2 UNEMit + \beta_3 EDit + \beta_4 INFit + \beta_5 FDIit + \beta_6 IRit + \beta_7 EXRit + \beta_8 IMP + \beta_9 EXPOit + \beta_{10} INTRit + Uit \quad (12)$$

Where,

j = 2, 3, …, 16 showing the country dummies.

k = 2001, 2002, …, 2021 shows time changes from 2001 to 2021.

i = shows the country effects in explanatory variables

t = shows the time effects in explanatory variables

Here, $C_{2i} = 1$ if observation belongs to country 2 and 0 otherwise and same as for respective country. Here, we are treating 2000 as a base year that's intercept value is γ_1.Due to restrictions in F-Test, some of the year or time effects would not be statistically significant. This may suggest that explanatory variables for that specific country have not changed over time. It is quite possible that country effects would be significant but the individual years effects would not be significant.

2.5 All Coefficients Vary Across Countries

Here, intercepts and slopes coefficients are different for all countries, we can say that every labour function of Angola, Botswana, Comoros, DRC, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe are all different. This situation can easily be handled by expending our LSDV model. Here we will introduce the slope dummies or interaction terms, that they will show how they are account for differences in slope coefficients. We will multiply country dummies by each of the regressors. This can be shown in equation (13);

$$GDPit = \beta_0 + \beta_1 LFit + \beta_2 UNEMit + \beta_3 EDit + \beta_4 INFit + \beta_5 FDIit + \beta_6 IRit + \beta_7 EXRit + \beta_8 IMP + \beta_9 EXPOit + \beta_{10} INTRit + \sum_{i=k=2}^{16} \alpha_k C_{ki} + \sum_{i=L=1}^{16} \gamma_L C_L\, LFit + \sum_{i=L=1}^{16} \gamma_L C_L\, UNEMit + \sum_{i=L=1}^{16} \gamma_L C_L\, EDit + \sum_{i=L=1}^{16} \gamma_L C_L\, INFit + \sum_{i=L=1}^{16} \gamma_L C_L\, FDIit + \sum_{i=L=1}^{16} \gamma_L C_L\, IRit + \sum_{i=L=1}^{16} \gamma_L C_L\, EXRit + \sum_{i=L=1}^{16} \gamma_L C_L\, IMP + \sum_{i=L=1}^{16} \gamma_L C_L\, EXPOit + \sum_{i=L=1}^{16} \gamma_L C_L\, INTRit + Uit. \quad (13)$$

Where,

K = 2,3, , … ,16 are representing the respective country dummies

L = 2,3, , … ,16 are representing the slope dummies or showing the interaction terms

i = showing country effects in explanatory variables

t = showing time effects in explanatory variables

Here, γ's are differential slope coefficients just like $\propto'$s are differential intercepts. If one or more than one γ coefficients are presenting the value that is statistically significant, then it can be said that slope coefficients are different than base group. If there is a situation that all differential slope coefficients and differential intercepts are statistically significant then we can conclude that the unemployment function of one country is different from the other country. It is quite possible that some or none of differential intercepts would be statistically significant.

3.0 Results and discussions

3.1.1 Empirical Findings

Following thorough discussions regarding the methods used in the in-progress research**,** we have settled on the following findings

Table 3 Summary Results for Specific Models

Covariates	**Estimate**	**Std.Error**	**t-value**	**P-value**	**Signif codes**	
OLS Results for SADC Data						
(Intercept)	-1.036e+04	1.651e+03	-6.274	1.07e-09	***	
Inflaton	-2.759e-04	4.209e-04	-0.655	0.512659		
Imports	2.734e+00	1.491e-01	18.337	< 2e-16	***	
Exports	3.484e-01	1.047e-01	3.326	0.000976	***	
EDebt	5.342e-01	7.458e-02	7.162	4.92e-12	***	
ERate	2.742e-04	4.198e-04	0.653	0.514145		
IReserves	6.631e-02	2.445e-01	0.271	0.786360		
LForce	6.904e-01	1.148e-01	6.016	4.61e-09	***	
Unemployment	2.030e+02	5.233e+01	3.879	0.000126	***	
FDI	-1.232e+00	5.165e-01	-2.385	0.017641	*	
IRate	-2.688e+01	2.799e+01	-0.960	0.337489		
Total Sum of Squares:	**2.3377e+12**					
Residual Sum of Squares:	**5.3237e+10**					
R-Squared:	**0.97723**					
Adj. R-Squared:	**0.97656**					
F-statistic:	**1463.28 on**	**10 and 341**	DF			
p-value	**< 2.22e-16**					
Fixed Effects Model (FEWITHIN) for SADC Data						
Inflaton	-1.7634e-04	3.7515e-04	-0.4701	0.638625		
Imports	1.9377e+00	1.6422e-01	11.7998	< 2.2e-16	***	
Exports	2.9410e-01	1.1007e-01	2.6719	0.007920	**	
EDebt	2.4733e-01	7.7163e-02	3.2053	0.001483	**	
ERate	1.6558e-04	3.7598e-04	0.4404	0.659944		
IReserves	1.1309e+00	2.7618e-01	4.0949	5.333e-05	***	
LForce	1.5977e+00	3.6787e-01	4.3432	1.877e-05	***	

Unemployment	1.8080e+02	1.0585e+02	1.7080	0.088584	.	
FDI	-1.2494e+00	4.7780e-01	-2.6149	0.009341	**	
IRate	-3.1631e+01	2.5709e+01	-1.2304	0.219449		
Total Sum of Squares:	**2.5263e+11**					
Residual Sum of Squares:	**3.9218e+10**					
R-Squared:	**0.84476**					
Adj. R-Squared:	**0.83286**					
F-statistic:	**177.398 on**	**10 and 326**	DF			
p-value	**< 2.22e-16**					
Fixed Effects Model (BETWEEN) for SADC Data						
Intercept	-1699.48543	4537.27743	-0.3746	0.72335		
Inflaton	0.46130	1.76911	0.2608	0.80468		
Imports	2.74241	1.28630	2.1320	0.08618	.	
Exports	-0.38734	0.41669 -	0.9296	0.39526		
EDebt	1.54063	0.86147	1.7884	0.13374		
ERate	-0.40994	1.56944	-0.2612	0.80435		
IReserves	-0.16692	0.89035	-0.1875	0.85866		
LForce	0.15009	0.22451	0.6685	0.53341		
Unemployment	-23.15248	133.68740	-0.1732	0.86930		
FDI	-4.20909	2.66623	-1.5787	0.17525		
IRate	28.91778	209.28400	0.1382	0.89549		
Total Sum of Squares:	**9.4777e+10**					
Residual Sum of Squares:	**71069000**					
R-Squared:	**0.99925**					
Adj. R-Squared:	**0.99775**					
F-statistic:	**666.293 on**	**10 and 5**	DF			
p-value	**3.6046e-07**					
Fixed Effects Model (LSDV) for SADC Data						
Inflaton	-1.763e-04	3.751e-04	-0.470	0.638625		
Imports	1.938e+00	1.642e-01	11.800	< 2e-16	***	
Exports	2.941e-01	1.101e-01	2.672	0.007920	**	
EDebt	2.473e-01	7.716e-02	3.205	0.001483	**	
ERate	1.656e-04	3.760e-04	0.440	0.659944		
IReserves	1.131e+00	2.762e-01	4.095	5.33e-05	***	
LForce	1.598e+00	3.679e-01	4.343	1.88e-05	***	
Unemployment	1.808e+02	1.059e+02	1.708	0.088584	.	

FDI	-1.249e+00	4.778e-01	-2.615	0.009341	**	
IRate	-3.163e+01	2.571e+01	-1.230	0.219449		
Angola	-1.476e+04	4.546e+03	-3.246	0.001292	**	
Botswana	-1.501e+04	4.641e+03	-3.235	0.001340	**	
Comoros	-4.746e+03	2.902e+03	-1.635	0.102938		
DRC	-3.312e+04	8.990e+03	-3.683	0.000269	***	
Eswatini	-1.043e+04	5.711e+03	-1.827	0.068591	.	
Lesotho	-1.063e+04	4.663e+03	-2.280	0.023227	*	
Madagascar	-1.474e+04	4.578e+03	-3.219	0.001416	**	
Malawi	-9.334e+03	3.354e+03	-2.783	0.005704	**	
Mauritius	-9.439e+03	3.404e+03	-2.773	0.005868	**	
Mozambique	-1.872e+04	4.631e+03	-4.042	6.63e-05	***	
Namibia	-1.236e+04	5.089e+03	-2.429	0.015681	*	
Seychelles	-3.491e+03	2.693e+03	-1.296	0.195788		
South Africa	4.011e+04	1.087e+04	3.691	0.000262	***	
Tanzania	-2.186e+04	8.198e+03	-2.667	0.008041	**	
Zambia	-1.103e+04	3.845e+03	-2.869	0.004388	**	
Zimbabwe	-1.048e+04	3.560e+03	-2.944	0.003471	**	
Residual standard error:	**10970 on**	**326 DF**				
Multiple R-squared:	**0.9858**					
Adj. R-Squared:	**0.9847**					
F-statistic:	**871 on 26**	**and 326**	**DF**			
p-value	**< 2.2e-16**					
Significance. codes:	**0 : '***'**	**0.001: '**'**	**0.01: '*'**	**0.05: '.'**	**0.1:' '**	**1**

From table 3, it is evident that LSDV is the superior model with an adjusted R^2-value of 98%. Imports, exports, external debt, international reserves, unemployment and labour force have a significant positive impact on economic growth for the SADC community. Foreign direct investment has a negative impact on the growth. Inflation, exchange rate, and Interest rate have no significant relationship with the economic growth. To take into account the uniqueness of each country/ cross-sectional unit, intercept is varied by using dummy variable for fixed effects. Usual OLS method is applied for all variables. A low p-value =6.606e-15 in the F test, counts against the null hypothesis that the pooled OLS model is adequate, which is in favour of the fixed effects as an alternative. Individuality of each country/ cross-sectional unit is accounted by letting the intercept vary for each country. It is also assumed that the slope coefficients are still constant across cross-section (Gujarati & Porter, 2003). From Table 3, it is evident that the estimated coefficients dummy for South Africa has a positive impact on economic growth, while for all other SADC nations have negative relationships with economic growth except for Comoros, and Seychelles whose estimated dummy coefficients have no significant relations with GDP as the measure of economic growth in the SADC region. The differences in the intercepts of the countries may be due to the unique policy of government about trade of import and export of goods, prices of goods in other countries, exchange rate, GDP relative to major economies and/ or other economic variables.

3.1.2 Checking the basic assumption of homoscedasticity for OLS Model

Heteroscedasticity assumes variability in the observations of the dependent variable. It is simply the converse of homoscedasticity. First, we will obtain the residuals and fitted values from the OLS model. We will plot the residuals against GDP and residuals against fitted values and have an assessment of the relationship of the model.

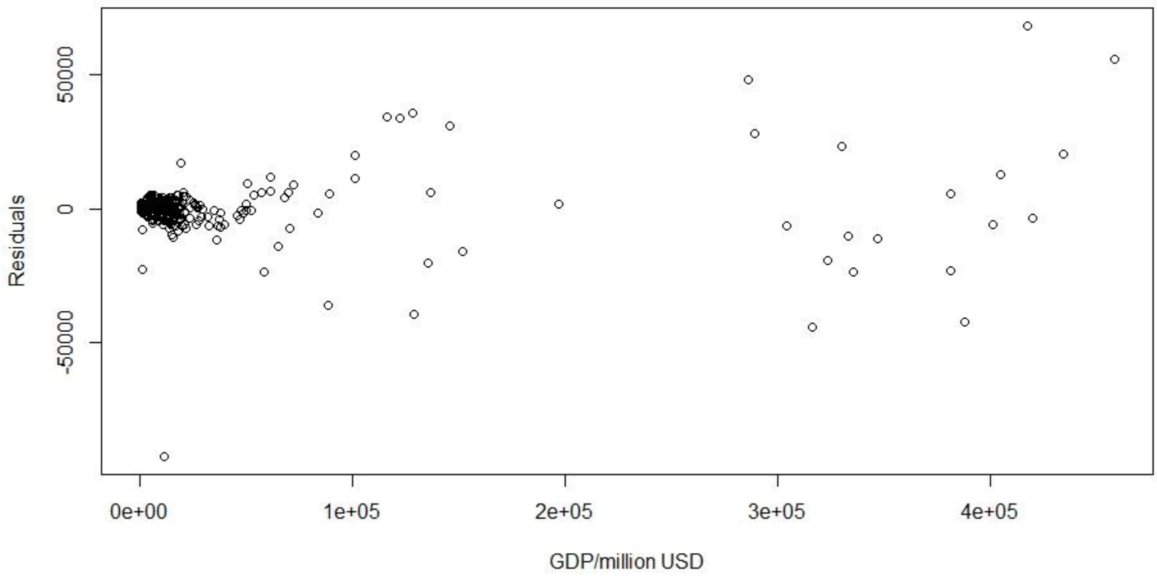

Fig 1 Plot of residuals against observed values for SADC GDP data

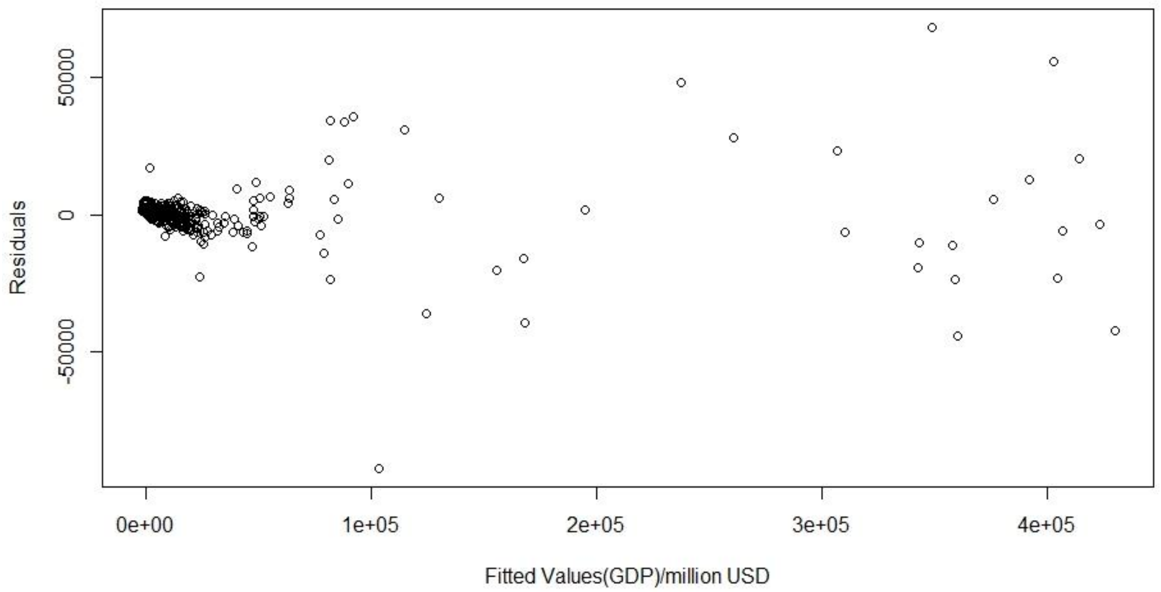

Fig 2 Plot of residuals against fitted values for SADC GDP data

It can be seen from Fig 1 and Fig 2 that the spread of the data points which ensures the heteroscedastic nature as clustered patterns are visible. This just translates to the variability of the dependent variable which is GDP for our dataset. Hence, we can conclude that OLS is not really the best model to analyze our dataset.

3.1.3 Testing to see if Fixed Effect Model is better than OLS

Following F-test analysis, the F-statistic the following test statistics were obtained;

`F = 7.7688, df1 = 15, df2 = 326, p-value = 6.606e-15.`

Here, null hypothesis is OLS is superior compared to fixed effects model. If it is rejected at alpha of 0.05, thus we can progress with the fixed effects model. We can see the p-value =6.606e-15 is much smaller than 0.05. Therefore, we can reject the null hypothesis and proceed with fixed effects model.

4. Conclusions and Recommendations

This study specifically examined the impact of imports, exports, external debt, exchange rate, international reserves, labour force, foreign direct investment and interest rate on economic growth in 16 SADC countries over the period from 2000 to 2021. The empirical findings show that, exports, external debt, international reserves, employment level and labour force have a significant positive impact on economic growth for the SADC community. Foreign direct investment has a negative impact on the growth. Inflation, exchange rate, and Interest rate have no significant relationship with the economic growth. Thus, countries in SADC region should focus on: imports, exports, external debt, international reserves, employment levels and labour force in the long run so as to promote economic growth. It is crucial for the SADC community to improve the quality of imports and focusing on strategic commodities needed for primary national economic growth by improving domestic production for local use and exports. Having examined the impact of imports, exports, external debt, exchange rate, international reserves, labour force, foreign direct investment and interest rate on economic growth in SADC region in detail, there is need to scrutinize the direction of causation between the aforesaid variables in an attempt to enhance evidence-based policy making and policy implementation as regards to trade-driven regional economic growth agenda. Also, this study captures some important growth determinants that may have a strong connection with economic growth such as policy stability, education level (human capital) and other macro-economic variables that were not incorporated in the estimation process mainly due to lack of available data for the period of this research. It may nevertheless be intuitive to include an extended set of socio-economic indicators in the analysis. Also the data set and the model needs to be continuously updated and there is need to try other modelling procedures and evaluate then against the fixed effects approach.

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