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Real growth of government expenditure, Gini index, exports and economic growth: A cross-sectional study

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Abstract
This study attempts to describe the relationship between economic growth (Taken measured by the growth of per capita GDP), government consumption expenditure, exports, and inequality (To measure it uses the Gini coefficient). This study uses cross-sectional data across countries from the World Bank website for 2019. To check for a heteroskedasticity study use White's test and to check the specification of a standard OLS study use the Ramsay Reset test. Our results find an association between economic growth (Dependent variable), government consumption expenditure, exports, and inequality. Government consumption expenditure and export have a significant and positive relation with the economic growth but inequality has significant and negative relation with the economic growth. Our study concludes by saying that government consumption expenditure and exports impact economic growth positively but inequality has a negative impact on economic growth.

Keywords: Regression, GDP, government consumption expenditure, exports, Gini coefficient, OLS, robust regression technique, ramsay reset test, white's test, variance inflation factor (VIF), Residual, normality

Introduction
There are evidences from many studies which show a positive relationship of economic growth with government expenditure and negative relation with the inequality, lahouij (2017) [6]. There are also several studies which show relationship of exports and economic growth within them some of the studies show the positive effects of export performance on economic growth, Krueger (1990) [5]. The purpose of this study is to examine the relationship between per capita GDP and three key variables: Government consumption expenditure, exports, and Gini coefficients. Our objective is to investigate how these factors influence the growth of per capita income. Specifically, we expect to find significant and positive associations between per capita GDP and both export levels and government consumption expenditure. Conversely, we anticipate a significant and negative relationship between the Gini coefficient (A measure of income inequality) and the growth of per capita income.

Understanding the impact of government consumption expenditure, exports, and income inequality on per capita GDP is essential for policymakers and researchers. By exploring these relationships, we can gain valuable insights into the factors that contribute to economic growth and income distribution. This knowledge can guide policymakers in formulating effective strategies to promote economic development, increase export competitiveness, and address income inequality.

In the following sections, we will present the literature review, data sources, methodology, results, analysis and conclusion.

Literature review
By reviewing literature and the paper we have read for this study to see in the mirror of existing literature. Here is a brief literature review presented which can become a helping hand to understand what has been already been done. We hereby present a brief literature review to see economic growth in the lense of government expenditure, inequality and exports with the help of existing literature.

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Government Expenditure and Economic Growth

Barro (1989; 1990) shows the negative association between the government expenditure and economic growth. He in his paper showed to us that the government expenditure has no direct effect on private productivity, but it reduced savings and growth due to the distorting effects of taxation and government expenditure program me.

In contrast to Barro we have Keynesian school of thought which suggests that the government expenditure boosts demand in the economy which in turn positively impacts investments and therefore stimulates economic growth too.

Income inequality and Economic Growth

Though we expect from this study to examine that whether the income inequality affects economic growth negatively or to say it whether more equitable wealth distribution is associated with higher level of economic growth. But in Barro (1989) observed that for poor countries there is a negative influence of income inequality on economic growth but for rich countries a positive relation could be seen between income inequality and economic growth.

Exports and Economic Growth

Exporting is related with static advantages like having access to larger foreign markets and hence taking advantage of economies of scale. There are also dynamic advantages, such as efficiency increases from knowledge and technical spillovers and is also connected with resource allocation efficiency, job creation, and easing foreign exchange limitations. Many a writer, with their empirical work arrived at a positive relationship of exports and economic growth. Some other writers, presented evidence export growth precedes economic development, thereby supporting the export-led growth (ELG) theory.

Research Gap

In all the above-mentioned papers explanatory variable is the only one that explains its relationship with economic growth. But in our study, we have taken three variables (Exports, real government consumption expenditure, and Gini coefficient) simultaneously and regressed them to see the relation with economic growth. So our study will attempt to fill this gap in the study.

Data and Data sources

Data on the per capita GDP growth rate, the real growth rate of government final consumption expenditure, the Gini index, and the export growth rate are used in this study. All data is picked from the World Bank website and data for the real growth rate for government consumption expenditure is obtained by subtracting the inflation from the nominal growth rate of government final consumption expenditure.

Methodology

In this study, we are working on the cross-sectional data across countries for 2019 only. We start with regressing the growth of real per capita GDP over the growth of real government consumption expenditure (Calculated by subtracting inflation from nominal government consumption expenditure), growth of exports, and Gini coefficients. The regression model is defined as follows:

$$gdp = ß0 + ß1 * govtexp + ß2 * gini + ß3 * \exp + \varepsilon$$

For regression, we used the ordinary least square technique which is a linear regression technique used to estimate the unknown parameters. In this technique, we start by minimizing the sum of the square of the residual (Difference between the actual and predicted values of the dependent variable). This has some specific assumptions if those assumptions are satisfied then only it follows such as: Linear in the parameters, independence of error and independent variable, zero mean value of residual, should not be any heteroskedasticity in the error term, no autocorrelation in the error term, no multi-collinearity between the variables. Since we are working on the cross-sectional data so autocorrelation assumption dropped out. We checked for all the assumptions whether they are satisfied or not we checked for multi-collinearity, to detect it we used VIF test (Variance inflation factor), VIF can estimate can estimate how much the variance of regression coefficient is inflated due to multi-collinearity. For mean of residuals, and independence of error term, we used the analysis bar on Gretl.

We checked for heteroskedasticity by whites' test which is easy to implement because it does not require the normality assumption. To get a basic idea let's consider a three-variable regression model as follows:

$$Yi = \beta1 + \beta2X2i + \beta3X3i + ui \qquad (1)$$

White's test follows in few steps which are as follows:

Step 1. With the given data we estimate the equation (1) and collect the residuals ui^2.

Step 2. After this we run the following regression

$$u\hat{2} = 1 + \alpha2X2i + \alpha3X3i + \alpha4 X2 + \alpha5X2 + \alpha6 X2i X3i + vi$$
$i\ 2i\ 3i\ (2)$

Step 3. Under the null hypothesis we test that there is no heterosckedasticity. It is shown by the product of sample size (n) and the R^2 obtained from the regression of equation follows the chi-square distribution with the degree of freedom (DF) equal to the number of regressors.

$$n.\ R2 \sim X^2\ df$$

Step 4. If the chi-square value obtained from the test statistics is higher than the critical chi-square value at the chosen level of significance and respective DF. Then the null hypothesis is dropped we say that there is heterosckedasticity in the error variance. Or if it is not the case then there is no heterosckedasticity.

If there is heteroskedasticity then to address the potential issue of heteroskedasticity and improve the robustness of the estimates the Robust Ordinary Least Square regression will be employed. In standard OLS regression, the assumption was that the variance of the error term should be constant which is violated. So now the standard errors of the coefficients may be biased. But by using robust regression this problem is resolved. Robust regression method uses iteratively weighted least squares to assign weight to each data point. It is less sensitive to a small part of data as a

result to this it is comparatively less sensitive to outliers than OLS. The robust standard errors are calculated by estimating the variance-covariance matrix using a "sandwich" formula that takes into account the potential heteroskedasticity. Stata then adjusts the standard errors of the estimated coefficients based on this robust variance-covariance matrix.

To detect outliers STATA uses the command if the value of residual for a particular country is greater than 2 then they are considered as outliers and dropped for analysis otherwise they are taken as part of our analysis.

Results

Final regression model of study obtained after dropping for outliers is as follows Gdp = 2.94548 + 0.0416717 *realgovexp −0.0393432*Gini + 0.212904* Export.

Initial results

Regress GDP per capita growth rate, Real growth rate of general government final consumption expenditure, Gini index, Export growth rate

Source	SS	DF	MS
Model	205.546016	3	68.5153386
Residual	141.344309	58	2.43697085
Total	346.890325	61	5.68672664

Number of observations	62
F(3,58)	28.11
Prob > F	0.0000
R-Squared	0.5925
Adj R-squared	0.5715
Root MSE	1.5611

GDP	Coef.	Std. Err.	t	P> |t|	(95% Conf.	Interval)
Real gov exp	0.0397625	0.005855	6.79	0.000	0.0280424	0.0514826
Gini	-0.0582916	0.0294988	-1.98	0.053	-0.1173398	0.0007567
Exports	0.181668	0.0398414	4.56	0.000	0.1019167	0.2614193
_cons	3.622094	1.087831	3.33	0.002	1.444563	5.799624

White's test for Heteroskedasticity

H0: Constant Variance of residual $nR^2 = 10.415730$
Chi 2 (9) = 3.325 nR^2 >chi2 (9)

6. VIF

Variable	VIF	1/VIF
Gini	1.16	0.859348
Realgovexp	1.12	0.890419
exports	1.09	0.921574
Mean VIF	1.12	

9. Summarize GDP per capita growth rate, Real growth rate of general government final consumption expenditure, Gini index, Export growth rate

Variable	Observations	Mean	Std. Dev.	Min	Max
GDP	62	2.077913	2.384686	-8.17732	8.208649
Realgovexp	62	-4.617628	36.17711	-278.802	11.68191
Gini	62	34.92419	7.309228	23.2	53.5
exports	62	3.716744	5.225887	-17.2883	16.2458

10. Sktest gdp realgovexp exports Gini

Skewness/Kurtosis tests for Normality

Variable	OBS	Pr (Skewness)	Pr (Kurtosis)	adj chi2 (2)	Prob>chi2
GDP	62	0.0004	0.0002	19.99	0.0000
realgovexp	62	0.0000	0.0000	.	0.0000
Exports	62	0.0294	0.0013	12.21	0.0022
Gini	62	0.0138	0.9676	5.75	0.0563

Final model after dropping for outliers

Robust regression result after dropping for the 11 outliers presented in our model checked through the above mentioned methodology

	Coefficient	Std. error	t ratio	P value	
Const	2.94548	0.700516	4.205	0.0001	***
Realgovexp	0.0416717	0.00176642	23.59	<0.0001	***
Gini	−0.0393432	0.0171158	−2.299	0.0260	**
exports	0.212904	0.0373622	5.698	<0.0001	***

Mean dependent var	2.091366	S.D. dependent var	2.325075
Sum squared residual	69.47930	S.E. of regression	1.215847
R-squared	0.742954	Adjusted R-Squared	0.726546
F(3, 47)	516.4235	P-value(F)	5.75e-36
Log-likelihood	−80.25055	Akaike criterion	168.5011
Schwarz criterion	176.2284	Hannan-Quinn	171.4539

Test for normality of residual
Null hypothesis: Error is normally distributed Test statistic:

Chi-square (2) = 0.27516 with p-value = 0.871464.
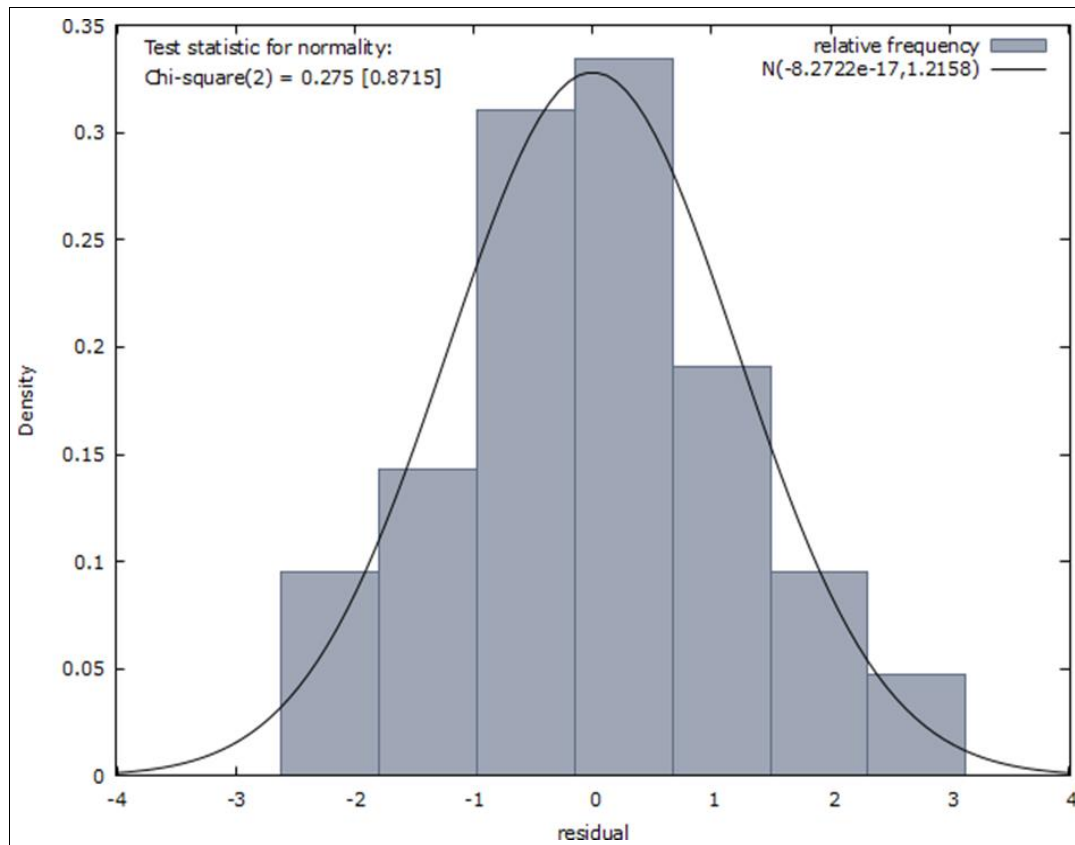
Variance Inflation Factors Minimum possible value = 1.0 Values > 10.0 may indicate a collinearity problem Realgovexp 1.146 Gini 1.150 exports 1.052.

$VIF(j) = 1/(1-R(j)^2)$, where R(j) is the multiple correlation coefficient between variable j and the other independent variables

Analysis
The result of this study shows that real government consumption expenditure and exports have a positive relationship with the growth of the per capita GDP but the Gini coefficient has a negative relationship with the growth of the per capita GDP. And the result also shows that the coefficients of all explanatory variables are significant at the 5% level of significance. So this tells us that the high level of the Gini coefficient is related to the lower level of growth of per capita GDP. And the high real government consumption expenditure and the exports are related to the high growth of per capita GDP. These three explanatory variables have approximately explained the 60% of the response variable.

We started with the 62 observations where the model was able to explain 59.25% of the variability of the dependent variable by the independent variable. Then we checked for heteroskedasticity with White's test. And the result was found significant. Hence we concluded by saying the presence of heteroskedasticity in the model. And we checked for the outliers by the methodology mentioned above and found the presence of 11 outliers.

To diagnose both of these problems we ran robust regression with the 51 samples (By dropping outliers from the model). Results for the robust regression after dropping

for the outliers are mentioned in the final result section. Within this model all the variables are significant and exports and government expenditures are positively related to economic growth but inequality is negatively related to economic growth and the 74.29% variability of the dependent variable is explained by the dependent variables.

We also checked for multi-collinearity through VIF and found that VIF is nearly 1, so we can conclude by saying that there exists almost no collinearity in the explanatory variables.

And we have also tested for the normality of the residuals (Which can also be observed from the graph in the result section) from which shows that the residual is nearly normally distributed.

Due to the limitations of the data available for this study, the conclusions drawn from the results of this study are tentative. Even it is also important to note that the remaining almost 26% variation in the GDP per capita growth rate is still unexplained by the model and may be influenced by the other factors not included in the analysis. Also, the limitations of cross sectional data in determining the causal relationships between variables must also be kept in mind.

Conclusion
Our regression analysis shows significant relationships between per capita GDP and government consumption expenditure, exports, and Gini coefficients. We find that both exports and government consumption expenditure have a positive and significant impact on per capita income growth. This suggests that an increase in exports and government spending can contribute to economic growth and higher income levels. Additionally, the Gini coefficient,

which measures income inequality, has a significant and negative association with per capita GDP growth. This implies that higher levels of income inequality are associated with slower economic growth. Therefore, policymakers should focus on promoting exports, increasing government spending effectively, and implementing measures to reduce income inequality in order to foster sustainable economic development and improve living standards.

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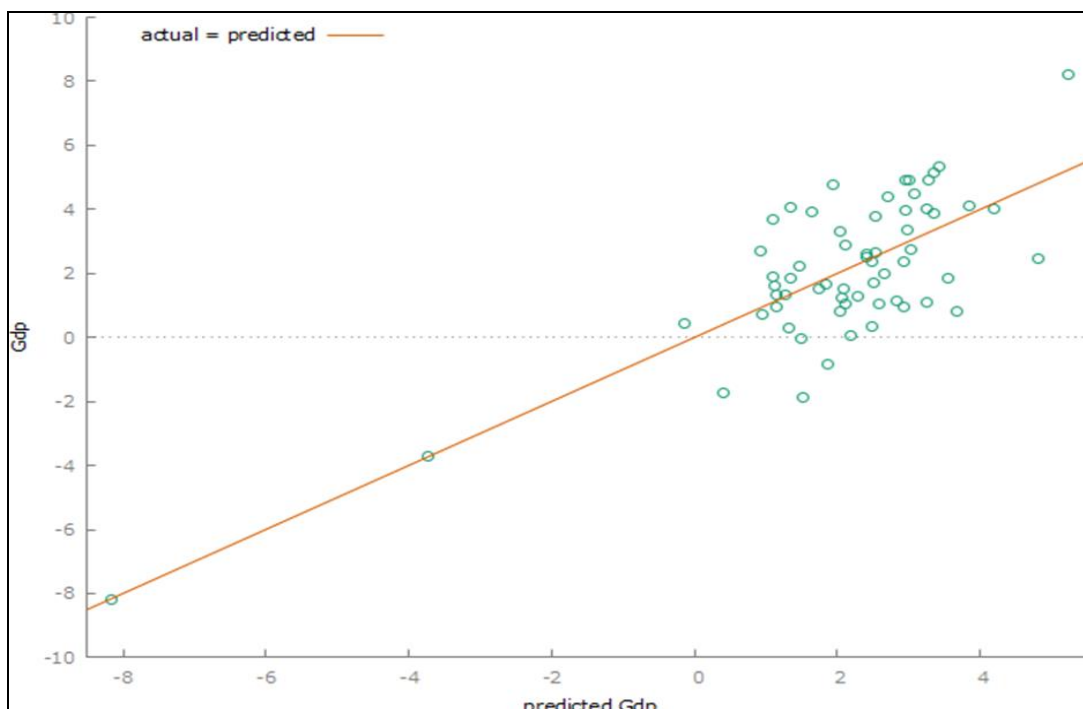## Appendix

Fig 1: Box plot of Residual

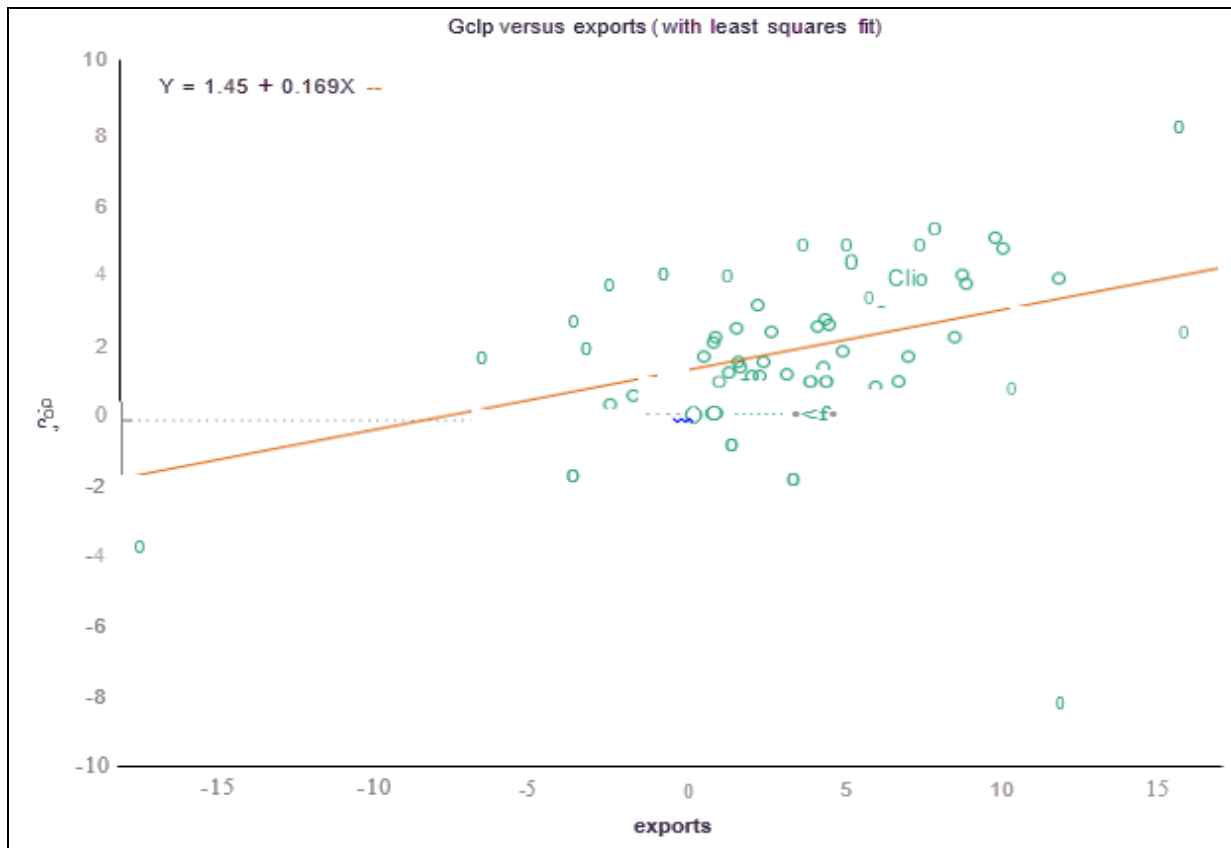**Fig 2:** Actual vs Fitted Plot

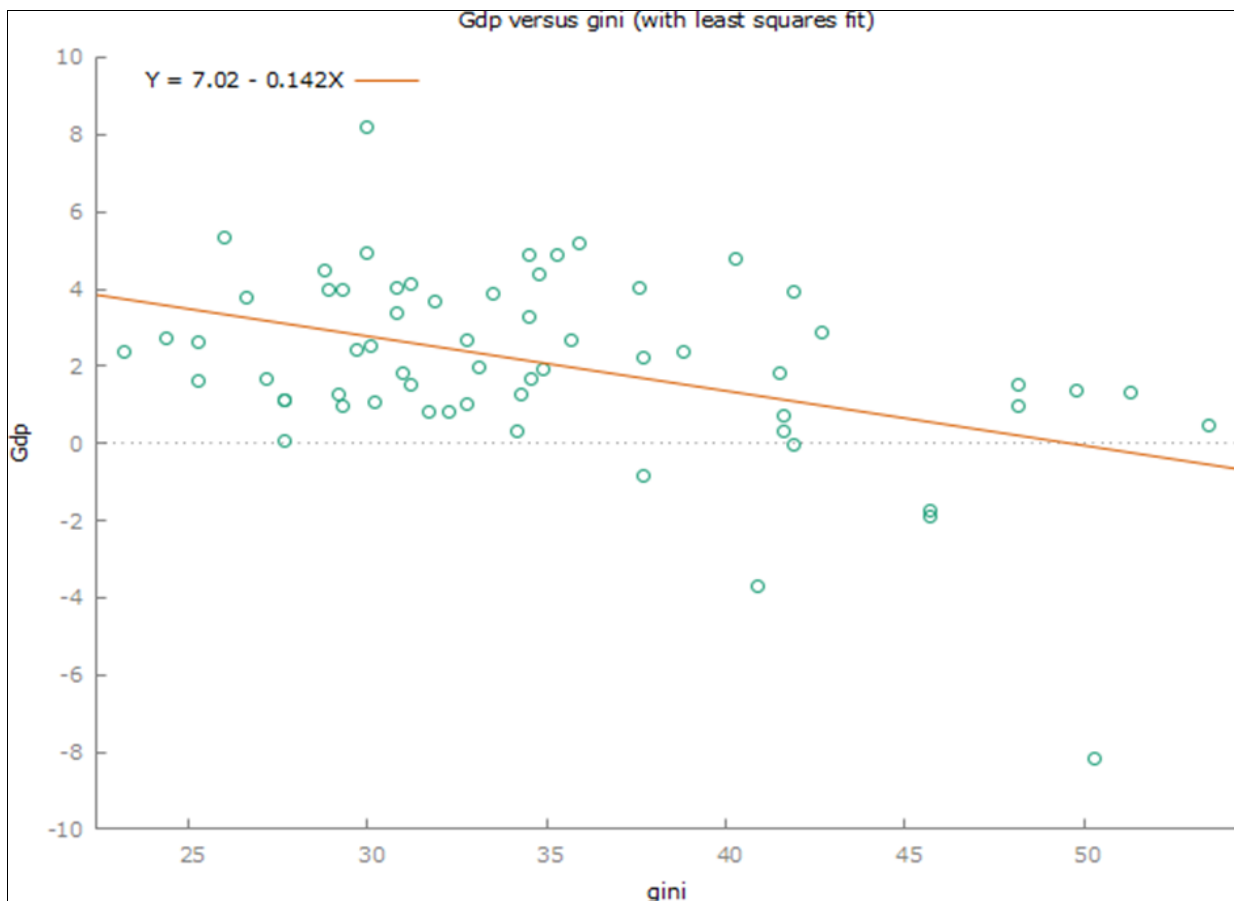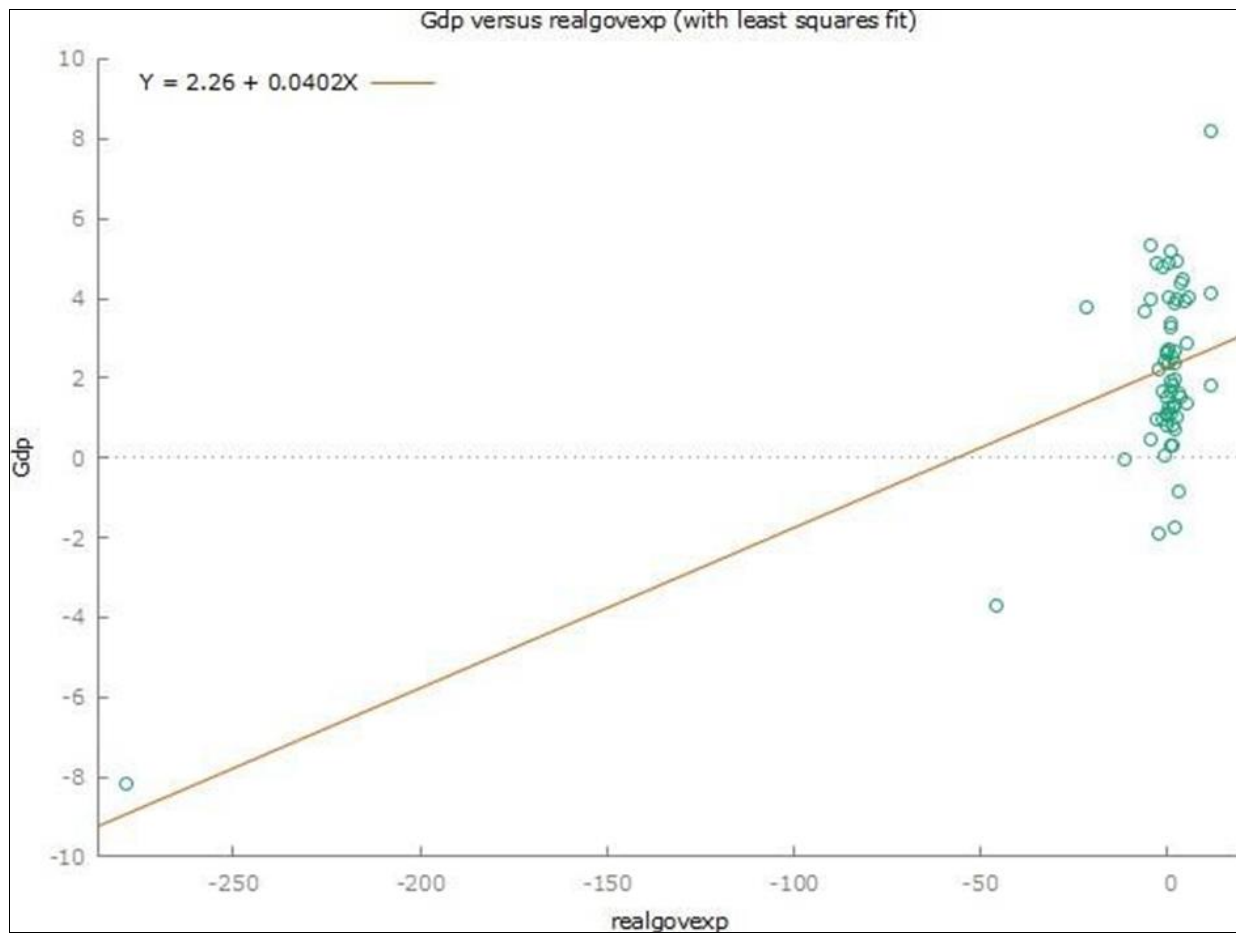**Fig 3:** Scatterplot of GDP vs export

Fig 4: Scatterplot GDP vs Gini

Fig 5: Scatterplot GDP vs real government expenditure