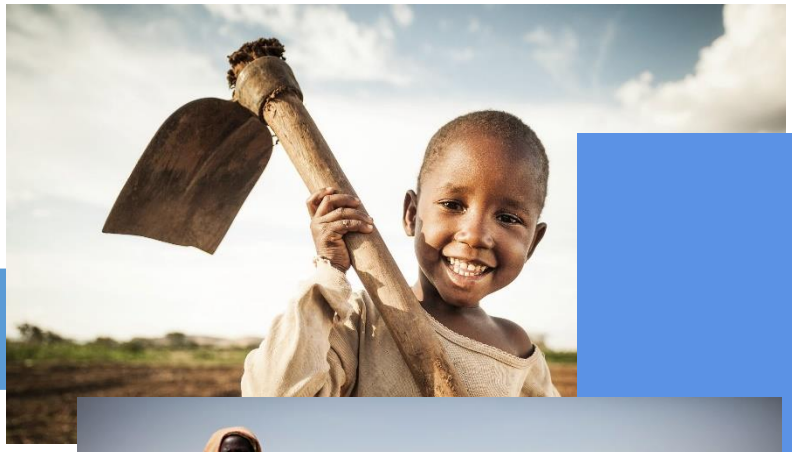
Does International Aid promote economic growth?



Supervisor: Haitao Liu

Project researchers: Shakhnoza Akhmedova, Vinit Keni. Shreya Banerjee. Reeha Naaz, Sid Dani

Big Data Statistics Project

" A project undertaken as part of master's (Hons) Business Analytics degree, Clark University "

December 8, 2019

Acknowledgements

Firstly, we are more than glad to express the deepest gratitude towards our academic advisor ***Haitao Liu*** *for walking with us through the challenging journey of this academic project.*

We are so thankful for his endless support and encouragement at all stages of the project, patiently providing his critical points and great motivation for harnessing our all energy for the amelioration of this research project.

Secondly, we are full of gratitude to ***Hamidreza Ahady Dolatsara*** *for reviewing our project and giving his priceless advice for improvement.*

Finally, we would not be able to finish our research project without the ***support and love of our family members***

Abstract

This paper analyzes the effects of foreign aid on the economic growth of low-income countries. The study uses annual data on a group of 23 low-income countries covering Asia and Africa for the period 1990-2017. The hypothesis that foreign aid can encourage growth in low-income countries was analyzed. The hypothesis was tested utilizing panel data series for foreign aid inflows, while accounting for saving rates, capital formation, foreign direct investment, population growth and trade openness of the countries. The positive effect of aid on the growth of low-income countries identified.

Keywords: Foreign aid, low-income countries, economic growth.

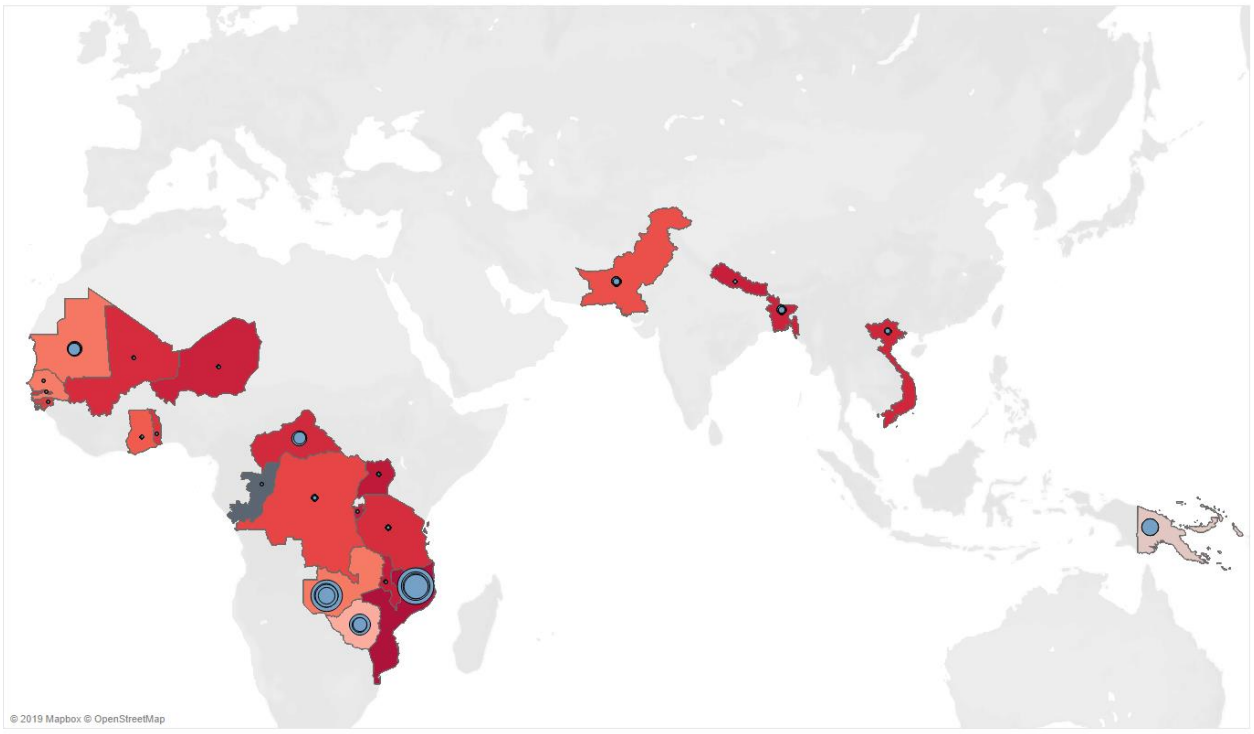
Introduction

Economists have examined the adequacy of Official Development Assistance (ODA) (hereafter 'foreign aid') on the financial development of countries for a few decades. Several methodological impediments hindered work in this literature. The main reason to choose the topic is the desire to make the world a better place.

The flow of foreign funds started after World War II with the introduction of the US-funded Marshal Plan in 1947, which was directed to reconstruct Europe. A victory of the aid in Europe activated US President Truman in 1949 to report a program to support the improvement and poverty reduction in developing countries.

Foreign aid was characterized as an exchange of resources from developed countries or multilateral organizations to developing countries. The foreign resources flow is split into two parts: private and official. Furthermore, the Official type flow is subdivided into two types: bilateral and multilateral. The direct flow of capital from one government to another one is called Bilateral aid, while the Multilateral aid is the capital flow from organizations such as International Monetary Fund (IMF), World Bank (WB), United Nations (UN). These flows mainly come in three forms grants, loans, or grant like contributions. The primary objective of ODA is development and poverty reduction. The paper analyzes the data of low-income countries for the period 1990-2017. Our fundamental objective for the project has been to highlight the heterogeneous effects of foreign aid on growth across less developed countries.

Map - GDP per capita vs AID



Map based on Longitude (generated) and Latitude (generated) and Latitude (generated). Details are shown for Country Name and Time Year. For pane Latitude (generated): Color shows sum of GDP per capita (constant 2010 US$). For pane Latitude (generated) (2): Size shows sum of Population, total. Details are shown for Country Name and Time Year. The data is filtered on Action (Country Name) and Action (Country Name,YEAR(Time)). The Action (Country Name) filter keeps 23 members. The Action (Country Name,YEAR(Time)) filter keeps 644 members. The view is filtered on Country Name, which keeps 23 of 23 members.

GDP per capita (consta..

7,930 143,351

Literature review

"Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist or both." ~ *Kenneth E. Boulding*

The purpose of Foreign aid is characterized as advancing the financial development and welfare in creating nations through enhancing sources of funds, expanding the venture, and capital stock (OECD, 2018). Morrisey (2001) states that aid supplements the development through (i) physical and human capital by promoting investment, (ii) increasing capacity to import, (iii) technology transfers, which stimulate the economy. While another renowned economist McGillivray et al. (2006), contradicted the view on the positive effects of foreign aid as he claimed that aid could be influenced by (i) external and climatic conditions, (ii) political conditions, (iii) intuitional quality, (iv) diminishing returns to foreign aid.

The impact of foreign aid on the economic growth in developing countries is one of the hot topics being discussed for the last decades. The importance of it can be explained by its implications in the development and poverty reduction. Most of the micro-based analyses found a positive effect of aid on economy while macro level works observed ambiguous results, in most of the cases, failed to find a significant relationship between aid and growth.

Theoretical background:

The scholars in the field of Economics can be categorized into two groups depending on their views on models examining the relationship between aid and growth. The first model of the study is “Two or Three Gap Models,” on which most empirical works before the 1990s were based. Recent scholarly articles were based on a second model: “Neoclassical Growth Models” (Morrisey, 2001). The main difference between gap models and neoclassical growth models, which apply to the effects of aid, is that one assumes permanent effects while the other allows temporary effects, respectively.

Positive impact:

Several scholars in the past have examined the positive effects of aid. The flow of foreign funds was first examined and presented by Papanek in 1973. The paper was highly influential in establishing the early findings to analyze the effects of foreign funds on the domestic economy. The effects of ODA on the economic growth of developing countries has been a hot topic of research among economists; there have been several models build using different techniques to understand the implications of foreign aid. The positive effects of foreign aid have suggested that aid positively impacts public education, the government's developmental expenditure(health and education), and negatively non-developmental expenditure

Negative impact:

World Bank published a study in 1998 “Assessing Aid: What Works, What Doesn’t and Why” stating support most work on adverse effects of aid. The work is a landmark for many studies in two ways. Firstly, the report identifies the negative impact of foreign aid on the economic growth of the recipient country. Secondly, it is found that aid effectiveness conditional on the political regime of the aid receiving country. The results have opened the ground for new debates on aid effects. Although most scholars tend to agree on the positive effects of aid, it is the variables surrounding individual countries or a region that has caused the results to vary among economists.

Contribution to the literature

Analyzing abovementioned scholarly works, it has been concluded that most works have been done for the period before 2000s and some authors mentioned that data is also not complete. This paper examines the aid effectiveness for the period from 1990 to 2017 and will analyze new period which has not been studied till present time. On top of that proof to reject World Bank’s report “Assessing Aid” conclusion about negative effect of foreign aid will be presented. Additionally, introducing variables in the model: openness index “wopen” will be new contribution to the literature.

Research Question:

Does foreign aid have impact on economic growth of developing countries?

Research objectives

- To assess the effect of aid to countries with low level of income
- To test relationship between foreign aid and economic growth for the world sample
- To estimate openness index in the model
- To propose areas for further research

Empirical Methodology

The research strategy is performed as a grounded theory based on the applied approach. First of all, as the theory has been conducted and supported with previous research papers in the form of a literature review, the attention is going to be paid on collection and testing the secondary data. World Bank World Development Indicators were a reliable source to obtain the secondary data for a dependent variable and all explanatory variables and based on a panel dataset of 28 years, between 1990 and 2017, for the sample of 23 developing countries all across the world. Moreover, the empty cells have been replaced with "means of means" of the variables to obtain accurate estimations. The advantage of panel data analysis is its uniqueness to capture both cross-section and time-series variations in variables. Prior to our assessment to establish a relationship between economic growth and international aid, it was crucial to perform several diagnostic tests on our datasets. Diagnostic statistical tools such as **Unit Root test** for identification of non-stationarity, the **White tests** for heteroscedasticity, **Variance Inflation Factor (VIF)** for multicollinearity are to be conducted to diagnose whether our dataset has potential statistical redundancies. As long as there is the detection of non-stationarity, heteroscedasticity, serial correlation and multicollinearity, the appropriate statistical tools are to be run in order to eliminate those potential statistical errors from the dataset. Since the research being conducted is based on panel data, *Fixed effects regression model* is to be used in the analysis because it is considered to be an effective measure for controlling for *all time-invariant differences between the individuals, omitted variable bias and is constant across individuals*.

Finally, whether obtained results are in coincidence with the mentioned research theory or are tested to check the reliability of the research hypothesis, the research paper is performed to be explanatory due to this being quantitative type by inquiry and longitudinal type of time period regarding 23 developing countries.

Main Hypothesis: Foreign aid has positive impact on economic growth of developing countries.

Hypothesis 1: The aid has diminishing returns to scale for low income countries.

Hypothesis 2: The effect of foreign aid differs by period before 2000 and after.

Hypothesis 3: Wopen index positively related to growth of developing country.

Model specification

In this section we employ panel data techniques to estimate the relationships between ODA and GDP growth. The technique used for estimation is panel least squares. The reason to choose the technique is based on background research and better results on panel data.

To estimate our hypotheses, the model from Ekanayake and Chatrna (2012)'s paper utilized. The model has been adjusted to our estimates.

The model is derived from production function which includes **domestic capital, labor input foreign aid**. A general representation of the production function can be written as follows:

$$Y = f(L, K, A)$$

Y – Gross Domestic Product (GDP) in real terms

L – labor input

K – domestic capital stock

A – Foreign Aid

It is assumed to be linear in logs, taking logs and differencing the model. The growth rate of real GDP is determined by the following expression:

$$y = a + \beta l + \delta k + \varphi a$$

growth rate of individual variables is denoted by lowercase letters.

Our primary panel data model examines the impact of international aid on economic growth of 23 developing countries for 27 years (1990-2017). In this section, we employ panel data techniques to estimate the relationships between ODA and GDP growth. The technique used for estimation is "panel least squares". This technique was used as a result of the background research conducted and better results were obtained from panel data.

$$GGDP_{it} = \beta_0 + \beta_1 GPOP_{it} + \beta_2 AID_{it} + \beta_3 AID^2_{it} + \beta_4 SAV_{it} + \beta_5 GDS_{it} + \beta_7 GDFI_{it} + \beta_8 T_{it} + \beta_9 WOPEN_{it} + e$$

$GGDP_{it}$ – i country's growth rate of real GDP per capita in year t

$GPOP_{it}$ – i country's annual population growth rate in year t

SAV_{it} – savings of country i in year t

AID_{it} – foreign aid of country i in year t, (quadratic function) i in year t

GDS_{it} – Gross domestic savings (% of GDP) i in year t

$GDFI_{it}$ – Gross fixed capital formation (% of GDP) i in year t

T_{it} – Trade (% of GDP) i in year t

$WOPEN_{it}$ – weighted openness of country i in year t

e – Stands for non-stochastic error term

Explanation of variables

Dependent variable:

- **GDP per capita (constant 2010 US$):** According to the World Bank group (2016), Gross Domestic Product per capita is the calculation of gross value added by total producers in the economy. The indicator is attained in constant 2010 U.S. dollar terms provides the best measure for real growth because it considers exchange and inflation rate differences across diverse nations. The real GDP per capita has been transformed into LN terms to convert its numeric values into percentages. Furthermore, GDP per capita (Ln) is a good measure of income level estimation and thus, GDP per capita is going to be applied for estimation of economic growth level (Dizaji,2012).

Independent variables:

- **Indicators of International Aid – (ODA, AID/GDP, AID/GDP^2):** The foreign aid is, our variable of interest, taken as a percentage of GDP. The variable created as following: ODA in real terms (constant 2015 US$) was divided to GDP (constant 2010 US$). The quadratic function of aid also included in the model assuming that aid has diminishing returns after some point. It is calculated raising AID/GDP to the power of 2.

Matrix of Control variables

- **Savings:** Gross savings is also used as a percentage of GDP in real terms. Gross savings are calculated as gross national income less total consumption, plus net transfers.

- **Gross fixed capital formation**: Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

- **Labor force:** Population growth rate is included as proxy for labor force growth rate. In the data set from WDI labeled as Population growth (annual %).

- **Foreign Direct Investment, net inflows (% of GDP)**. Foreign direct investment is the sum of reinvestment of earnings, equity capital, short-term capital and long-term capital, demonstrates net inflows in economy from foreign investors and is divided by GDP. Foreign direct investment is considered as one of the most important indicators of economic growth. (V. Martínez et al, 2012).

- **Trade as a percentage of GDP.** The trade openness is presently measured by the ratio of the sum of exports and imports over GDP: (X+I)/GDP. This ratio has recently been accepted as the most popular and simple trade openness indicator. The data is obtained from the World Bank Database.

- ***Wopen:*** Several ways, such as hi-tech access from overseas, possibilities of catch-up, input variations to business, and access to more markets that improve the efficacy of local production via better specialization, are the factors of openness to trade that is, on a usual basis, assumed to promote growth. In our paper, we experiment both measures. However, our personal believe is that weighted openness (wopen) will be more appropriate than others. Wopen dominates other indexes by considering the significance of both country's trade balance and intensity. To illustrate, wopen index is calculated as standard openness index (X+I)/GDP divided by current account balance (X-I)/GDP.

Prior expectations

After analyzing scholarly works devoted to the topics related to aid, some prior expectations have been concluded. Aid variable is expected to have a positive sign as it adds capital to the economy of the country. However, the aid square variable expected to have a minus sign, which means that aid has diminishing returns to scale effect. The savings variable also anticipated having a positive

sign. According to Solow growth model savings is equal to investment which increases economic growth. As our regressand, GDP per capita, which is obtained by dividing real GDP by population number of the country, population growth variable is expected to have a negative sign in our regression results. The last variable of trade (wopen) is predicted to be positively related to the economic growth of the countries.

Results

Descriptive statistics

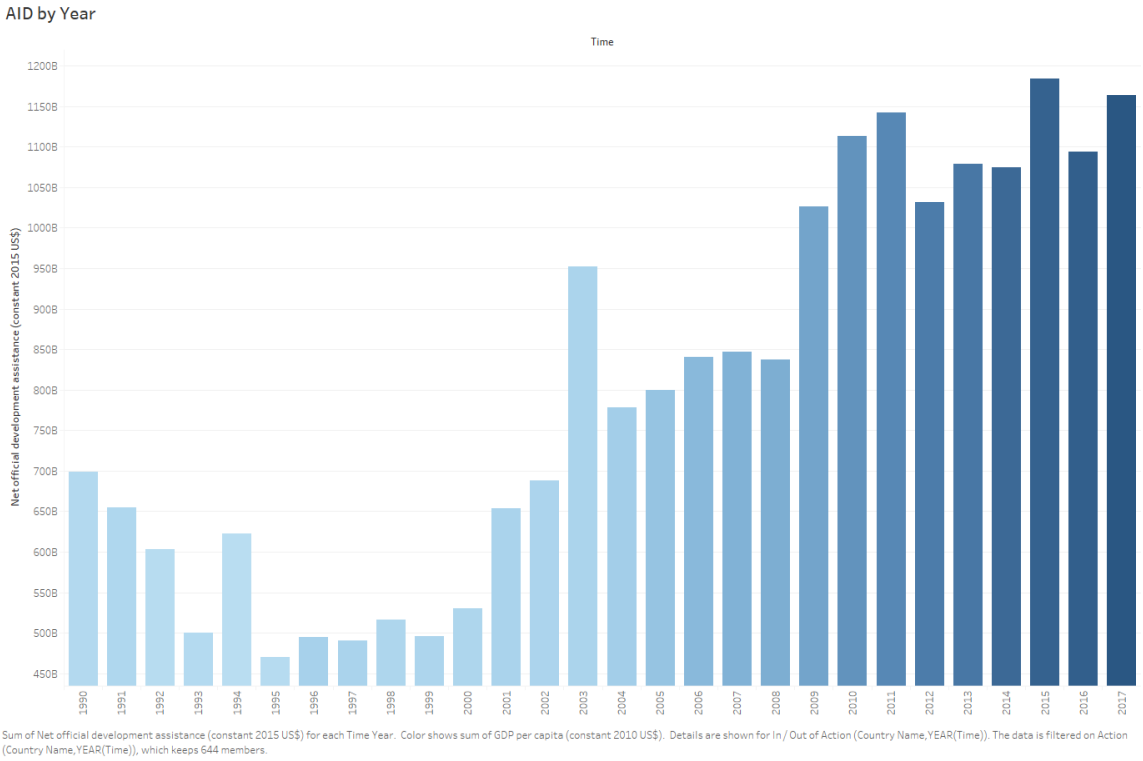
The given table includes descriptive statistics for the sample of selected 23 low income countries. The table columns represent variable names and rows represent mean, median, maximum, minimum, standard deviation of estimated values, which is obtained using Python.

	ln_gdp_pc	GFCF	GDS	Trade	ln_ODA	Pgrowth	FDI	Aid/Gdp	Aid/Gdp_sqr	wopen
count	644	644	644	644	644	644	6.44E+02	6.44E+02	6.44E+02	644
mean	6.505553	18.262909	12.755536	54.069414	16.047974	2.554517	5.38E+06	6.29E+00	8.54E+01	8.884172
std	0.619309	8.259588	12.402386	30.903554	7.069927	0.711251	5.42E+07	6.78E+00	1.69E+02	21.323731
min	5.08657	0	-13.780052	8.174071	3.503873	0.205493	4.84E+00	2.56E-07	6.53E-14	-0.08296
25%	6.055086	12.350478	5.364295	34.337343	4.770573	2.197636	8.25E-01	3.60E-06	1.29E-11	2.549153
50%	6.369195	18.262909	10.757119	47.919828	19.928441	2.681981	2.28E+00	4.59E+00	2.11E+01	4.752489
75%	6.951801	22.73068	17.272821	63.112567	20.840277	3.029991	3.11E+00	1.01E+01	1.01E+02	7.843469
max	7.98123	52.938841	103.632294	200.38458	22.60179	3.968382	6.38E+08	4.50E+01	2.03E+03	337.82236

(See Appendix1.a, python codes)

If we look at the first indicator mean, it is noticeable that GDP per capita on average at 6.50% per year and foreign aid account for 6.29% of GDP of the country on average. This number can alone explain importance of aid in low income countries' economy. Moreover, it is worth noting

that the mean population growth for 23 low-income countries accounted for 2.55% per year from 1990 to 2017.

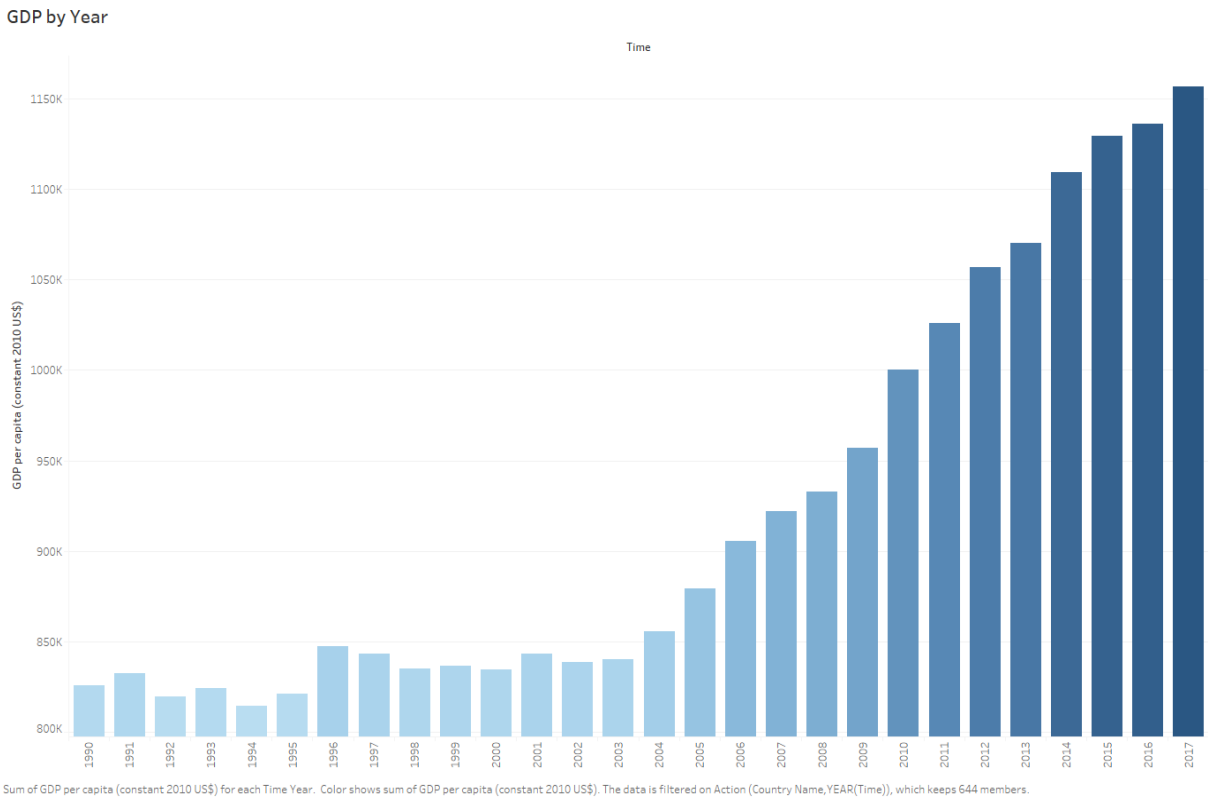


Foreign aid received over the years by the 23 developing countries

At first glance, the figure shows us foreign aid flows to low-income countries decreased slightly from 1990 till 2000 and starts a continuous increase till the end of the period. Foreign aid was in its lowest numbers for eight years (1993-2000) except for one jump in figures in 1994.

In 2003 the amount of aid received increased. The **effect of the financial crisis in 2008 is also noticeable but not big enough**. Ten years of a continuous rise in figures changed to plateau, with a slight decrease in 2012, for the last seven years (2010-2017).

The highest foreign aid flows received by developing countries is almost $1100 million in 2015, which is very close to 2011 and 2017 figures, according to our data.

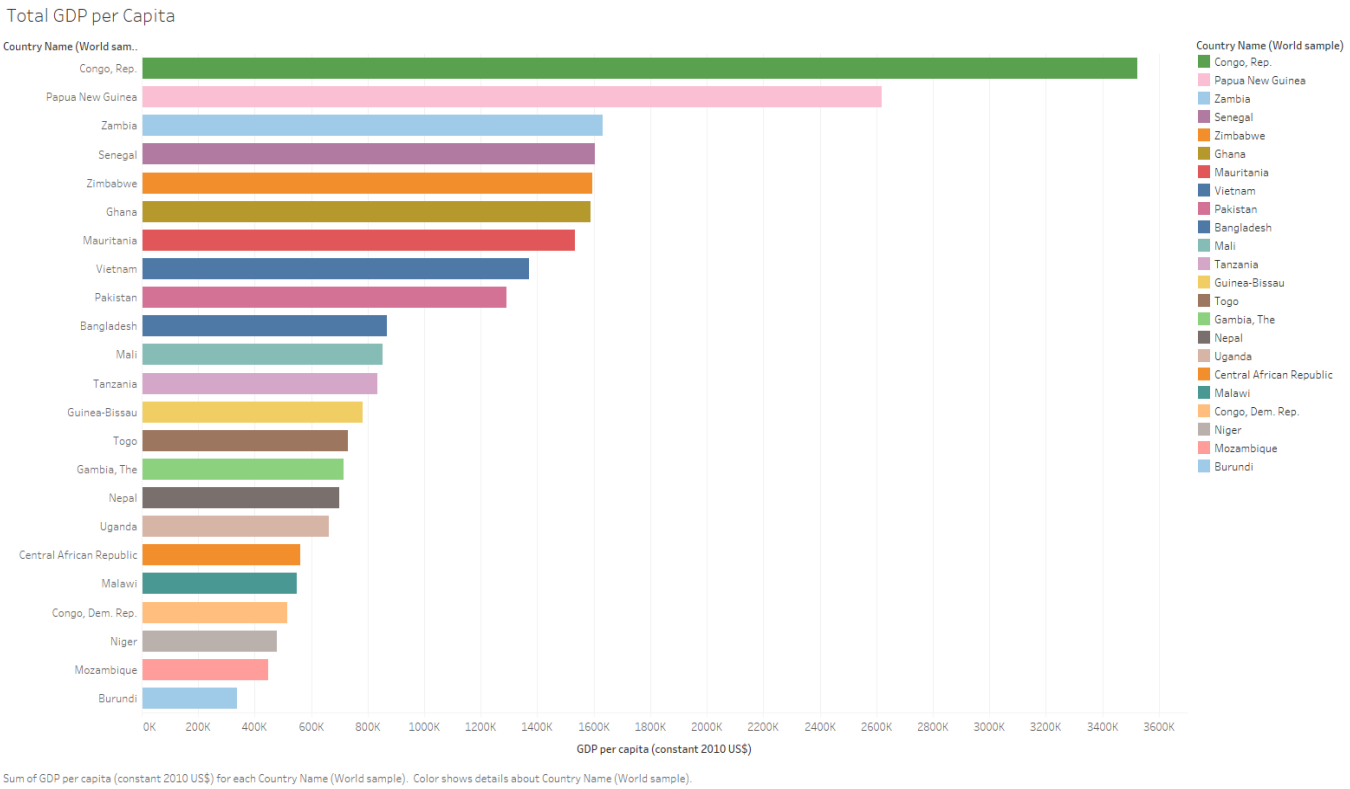


GDP per capita incline over the years of the 23 developing countries

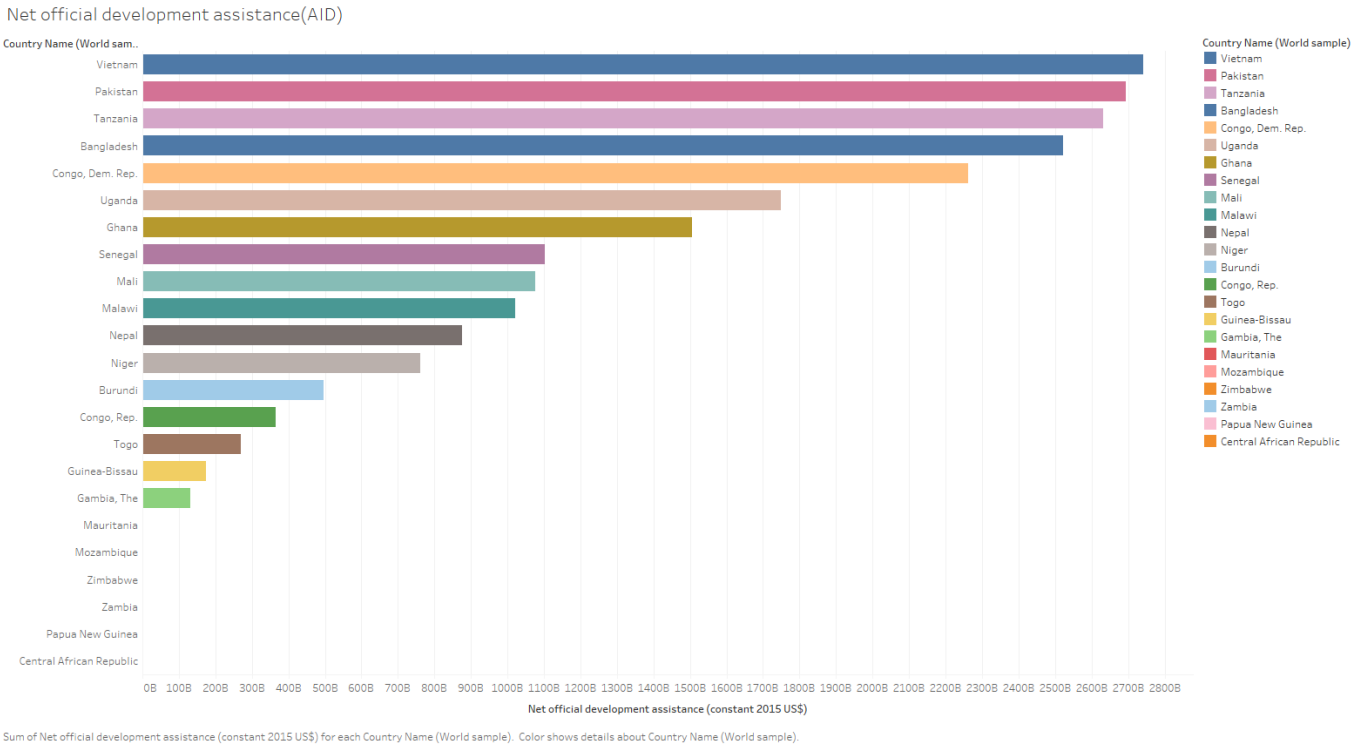
Overall picture of the figure can be seen in two periods: almost stable GDP (1990-2003) and slight increase (2004-2017).

Significant rise in of GDP per capita started from 2004 over 14 years (2004-2017) period.

First five years of the period shows minor changes in the level of GDP per capita which continued by increase in 1996.



The above graph represents the Top 5 performing countries over the years in terms of GDP per capita. We can see that all the countries performing adequately among low-income developing countries are from the central African region. There can be several factors attributed to such a phenom, but to analyze further, we need to understand the geopolitical scenarios and capitalistic practices of these countries.



The graph above represents the top 5 economically challenged countries receiving foreign aid. We can see, Pakistan and Vietnam have received a considerable amount of funding. However, Vietnam has shown a steady incline in GDP per capita growth over the years, while Pakistan has a different incline of GDP, and consequently, their funding has been on the decline.

Correlation

Based on results, the following three correlations illustrated above are worth highlighting. Firstly, Trade is moderately correlated with GDP percentage (ln_gdp_pc) and Financial Aid (ln_ODA). This tells us that increase in Aid (which increased the gdp in some of the countries) does have a slight positive influence on trade. Secondly, Aid per Gdp of a country is inversely proportional (moderately) to the Gross domestic savings. This indicates that there was a decent amount of utilization of aid received by the developing countries.

Table 2. Correlation table.

	Gross fixed capital formation (% of GDP)	Gross domestic savings (% of GDP)	Trade	Population growth (annual %)	FDI, net inflows (% of GDP)	Aid/Gdp	Aid/Gdp_sqr	ln_ODA	ln_gdp_pc	wopen
Gross fixed capital formation (% of GDP)	1	0.265916	0.43328	0.00661685	-0.0166541	-0.0357438	-0.0703157	0.277658	0.369754	0.0922224
Gross domestic savings (% of GDP)	0.265916	1	0.339678	-0.16292	-0.0420026	-0.488846	-0.379304	-0.192596	0.568761	0.149848
Trade	0.43328	0.339678	1	-0.0533228	-0.0303486	0.0446964	-0.0188875	0.395103	0.44061	0.252584
Population growth (annual %)	0.00661685	-0.16292	-0.0533228	1	0.0236591	0.289058	0.185105	0.0924605	-0.162753	-0.086316
FDI, net inflows (% of GDP)	-0.0166541	-0.0420026	-0.0303486	0.0236591	1	0.0325724	0.00339345	0.0521388	-0.102816	-0.0192715
Aid/Gdp	-0.0357438	-0.488846	0.0446964	0.289058	0.0325724	1	0.89687	0.526856	-0.476323	-0.0971464
Aid/Gdp_sqr	-0.0703157	-0.379304	-0.0188875	0.185105	0.00339345	0.89687	1	0.28116	-0.373335	-0.0821201
ln_ODA	0.277658	-0.192596	0.395103	0.0924605	0.0521388	0.526856	0.28116	1	-0.192575	0.112625
ln_gdp_pc	0.369754	0.568761	0.44061	-0.162753	-0.102816	-0.476323	-0.373335	-0.192575	1	0.132506
wopen	0.0922224	0.149848	0.252584	-0.086316	-0.0192715	-0.0971464	-0.0821201	0.112625	0.132506	1

While these features show some meaningful correlations, population growth shows moderate to low correlation (negative and positive) with almost all variables, which makes it harder to understand the influence of Aid on population growth.

Diagnostic Analysis

Unit root test

Since the variables are subject to a change over a time leading to non-stationarity, estimated R square and coefficients will be so high that further may result in wrong conclusions within our data. It is of high importance to check panel data for its stationarity to make sure that variance and mean are stable across time. The Augmented Dickey-Fuller, diagnostic test to be conducted to see whether each variable contains a unit root. In case, nonstationary is detected within the data, the difference between (current year (t) and last year (t-1)) of nonstationary variables will be taken to eliminate the problem of nonstationary of the certain variables.

> ***The null hypothesis:*** the time series can be represented by a unit root, that it is not stationary (has some time-dependent structure).

The alternate hypothesis: (rejecting the null hypothesis) is that the time series is stationary. If p-value of The Augmented Dickey-Fuller test is less than 0.05 significance level, the null of a unit root is rejected and the variable is considered to be stationary

Variable names	(ADF statistic)	(p) value	State
Gross fixed capital formation (% of GDP)	-6.751791	0.0	Stationary
Gross domestic savings (% of GDP)	-4.020887	0.001305	Stationary
Population growth (annual %)	-5.631640	0.000001	Stationary
FDI, net inflows (% of GDP)	-6.435372	0.0	Stationary
Aid/Gdp_sqr	-3.797436	0.002934	Stationary
Aid/Gdp	-4.179194	0.000714	Stationary
ln_ODA	-3.006381	0.34303	Stationary
wopen	-9.394984	0.0	Stationary
Trade	-4.659222	0.000100	Stationary

(See Appendix1.b, python codes)

As can be concluded from the table, p-values accounted for each variable stands at less than 0.05, meaning that all of our variables are stationary.

Multicollinearity

Multicollinearity is the state where two variables are highly correlated and contain similar information about the variance within a given dataset. To detect multicollinearity among variables, simply create a correlation matrix and find variables with large absolute values. A VIF between 5 and 10 indicates high correlation that may be problematic.

Features	**VIF Factor**
const	23.99
Gross fixed capital formation (% of GDP)	1.3321
Gross domestic savings (% of GDP)	1.7135
Population growth (annual %)	1.786
FDI, net inflows (% of GDP)	1.0075
Aid/Gdp_sqr	7.904
Aid/Gdp	12.02
ln_ODA	2.54

wopen	1.108
Trade	1.667

(See Appendix1.c, python codes)

As is indicated in the table, VIF factor values for almost all variables do not depict a statistical error of Multicollinearity. Even though there is a demonstration of Multicollinearity error between Aid/Gdp and Aid/Gdp_sqr at12.02 and 7.9, it is not considered as a statistical error as one is the squared value of the other.

Heteroscedasticity

In statistics, White test is a statistical test that establishes whether the variance of the errors in a regression model is constant: that is for homoskedasticity. In cases, where the White test statistic is statistically significant, heteroskedasticity may not necessarily be the cause; instead the problem could be a specification error. When residuals do not have constant variance (they exhibit heteroscedasticity), it is difficult to determine the true standard deviation of the forecast errors, usually resulting in confidence intervals that are either too wide or narrow. For example, if the variance of the residuals is increasing over time, confidence intervals for out-of-sample predictions will be unrealistically narrow.

White Test is assumed through this hypothesis:

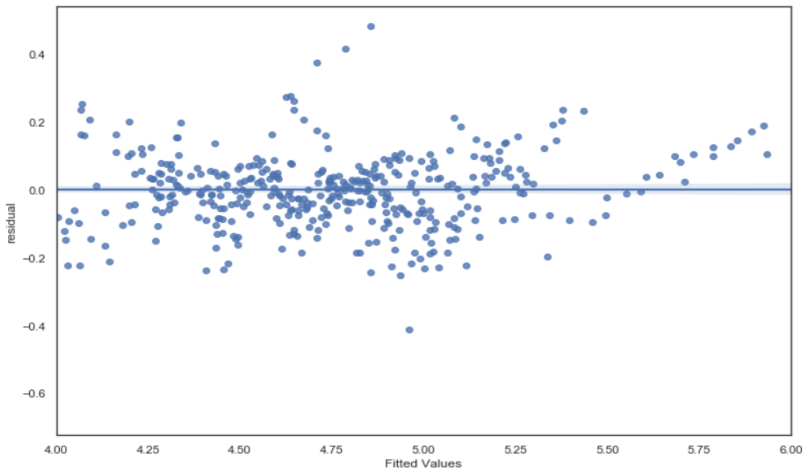
Ho: *Homoscedastic errors*

Ha: *Heteroscedastic errors*

White test
(BP Statistic, 159.91324910885916)
(BP-Test p-value, 1.667575378566256e-30)
(F-Statistic, 23.307326859905583) (F-Test p-value, 1.7381231640763157e-34)

(See Appendix1.d, python codes)

Based on the results of shown, the null hypothesis is rejected at 0.05 significance level, confirming the existence of heteroscedasticity problem within the dataset.



As visible from the graph, there is an indication of unequal distribution of variances along the trend line, showing the heteroscedasticity.

Regression estimator

Since the object of sample is built based on panel data, fixed effects model is being conducted because it is considered to be effective measure for controlling for all time-invariant differences between the individuals, omitted variable bias and is constant across individuals. (FE) model is plausible to meet the researcher's goal if inclusion of those time-invariant characteristics is unique to each individual, entity's constant and the error term ought to be uncorrelated with other individual characteristics. ***FE model regression estimation with robust errors*** has been conducted to eliminate the heteroscedasticity error from the model because it has been earlier identified in the model by White test. It can be seen from the table that p- values for variables have been significantly improved in the fixed effects regression model with robust errors.

Variable names	**FE model regression estimation**	**FE model regression estimation with robust errors**
Gross fixed capital formation (% of GDP)	**0.0012** 0.0029 0.6770	**0.0012** 0.0011 (0.2607)
Gross domestic savings (% of GDP)	**0.0030***** 0.0017 0.0760	**0.0030***** 0.0009*** (0.0009)
Population growth (annual %)	**-0.0631****	**-0.0631****

	0.0395 0.1106	0.0216** (0.0036)
FDI, net inflows (% of GDP)	**-7.944e-11** 1.075e-10 0.4602	**-7.944e-11** 7.515e-11 (0.2909)
Aid/Gdp_sqr	**-0.0674***** 0.0002 0.0000	**-0.0674***** 0.01*** (0.0)
Aid/Gdp	**0.0012***** 0.0132 0.0000	**0.0012***** 0.0003*** (0.0)
ln_ODA	**0.2452***** 0.0510 0.0000	**0.2452***** 0.0305*** (0.0)
wopen	**0.0003** 0.0004 0.3242	**0.0003** 0.0003 (0.2852)
Trade	**0.0033***** 0.0013 0.0105	**0.0033***** 0.0005*** (0.0)
R-Squared Observations	**0.3257** **23**	**0.3257** **23**

(See Appendix1.e, python codes)

PARAMETER/STD ERROR/PROBABILITY

The FE regression with robust errors indicate that R-square is more than 0.30 regarding the sample of 23 low-income countries from 1990 to 2017. The values are low but acceptable for the panel data and comparable to the results obtained in other studies. R-square indicates how well-chosen independent variables can explain regressand, and R-square of 0.3257 means that chosen model can explain 32.57% of variances in GDP per capita in the period. Official Development Assistance indicator has a positive parameter at 0.2452 with accounted statistical significance, meaning 1 percentage increase in ODA, will lead to 24.52% rise in the economic growth of 23 developing countries, highlighting the importance of the Official Development Assistance from 1990 to 2017, ceteris paribus. Even though the variable of interest (AID/GDP) has a positive coefficient at 0.00 and statistically significant, AID squared has a negative coefficient accompanied by statistical significance at 0.01 in 23 low-income countries from 1990 and 2017.

Therefore, the first hypothesis is failed to be rejected in the case of AID squared, meaning that the effect of aid start diminishing after some point which means that low income countries have capacity constraint for incoming aid flows. On top of that, Gross capital formation is insignificant at 26.07 with a positive parameter of 0.001. Notably, there is a significant relationship between savings rate and economic growth, at 0.00 rate with a positive sign.

Moreover, the population growth variable has a negative sign during the period of our regression and statistically significant. The target variable of trade openness (wopen) is found to be statistically insignificant at 0.2852 and represent a positive sign only. In contrast, trade as % of GDP has been used to indicate the openness as well, which shows the significant result with a positive sign, accordingly. Overall outcomes represent that effect of aid variable is higher, than other variables, to the domestic income per capita. To sum up, our results for the low-income countries is found to be reliable and meaningful, meaning that the contribution of AID to the economic growth of 23 developing countries is indisputably important.

Conclusion:

In our paper, we have focused on understanding the effects of foreign aid on the economic growth of the 23 low-income developing countries. The effects of foreign aid are analyzed utilizing panel data series covering the period 1990-2017. By employing Ekanayake and Chatrna (2012)'s model conjoined with trade openness variable and panel data estimation method Panel Least Squares, the empirical results observed that foreign aid has a positive impact on the economic growth of 23 low-income countries.

In general, the findings of the study indicate that foreign aid inflows appear to have a positive impact ***on the economic growth of recipient countries after 2000***, when the amount of aid flows increased significantly.
Empirical results have also confirmed the second hypothesis on the diminishing return of aid**.** ***Adding a trade openness variable*** to the model is not found to confirm the prior expectations.

The study emphasizes on the **period 2000-2010** for 23 aid-receiving low-income countries. One of the contributions of the paper is **identifying the positive effect of foreign aid** with diminishing returns to scale effect in low-income countries. Also, the conclusions of the World Bank's report in 1998 on adverse aid effects are found to be applicable only for the period before 2000. Moreover, **wopen – index of trade openness is not found to have a significant effect on our model** when ***low-income countries sample analyzed.***

To conclude, the results of the paper from ***empirical analysis*** facilitate and make contributions to the studies of the role of foreign aid in economic growth. The governments and policymakers in low-income countries to acquire such l**evel of aid that does not diminish**; this assists the *world, not to over-help aid recipient countries.* Moreover, the effective utilization of aid in low-income countries might lead to a stable increase in foreign aid inflows in the future.

Policy recommendation:

Findings from our empirical analysis reveal that a standard set of economic fundamentals and policies are associated with various dimensions of economic improvements. Economic development implies an improvement in economic welfare through higher real GDP, but also through an improvement in other economic indicators, such as improved literacy, better infrastructure, reduced poverty, and improved healthcare standards. Economically challenged countries have many health and human development needs, but they are also challenged by the lack of investment and foreign aid to developing infrastructure like roads.

1. Improved macroeconomic conditions (create a stable economic climate of low inflation and positive economic growth)
2. Free market supply-side policies – privatization, deregulation, lower taxes, less regulation to stimulate private sector investment.
3. Government interventionist supply-side policies – increased spending on 'public goods' such as education, public transport, and healthcare.
4. Export-oriented Development – Reduction in tariff barriers and promoting free trade as a way to improve economic development.

5. Diversification away from agriculture to manufacturing as a way to promote economic development.

Research limitation and path for future investigation

The paper is devoted to aiding effectiveness in low-income countries. While working on this paper, it has been found out that most required data is available online, and other required information can be obtained from the internet. Although in World Bank Indicators database includes different aid series, only net official development assistance has complete numbers for all countries. According to the findings, it can be suggested to increase the capital capacity of low-income aid recipients to increase the practical implication of aid. We would suggest to other researchers who work on the topic to use more advanced econometric techniques to support the idea of the positive impact of aid on the economy actively.

Bibliography

Bacha, E. (1990). A three-gap model of foreign transfers and the GDP growth rate in developing countries. *Journal of Development Economics*, 32(2), pp.279-296.

Barro, R. and Sala-I-Martin, X. (1995). Economic growth. New York: McGraw Hill.

Burnside C, Dollar D. 1997. Aid, Policies and Growth. *Policy Research Working Papers*, 1777. World Bank: Washington DC.

Chenery, H. and W. Strout (1966). Foreign Assistance and Economic Development. *American Economic Review*, Vol. 56, pp. 679-753.

Durbarry, R., Gemmell, N. and Greenaway, D. (1998). New evidence on the impact of foreign aid on economic growth. *Centre for Research in Economic Development and International Trade*.

Ekanayake, E & Chatrna, Dasha. (2010). The effect of foreign aid on economic growth in developing countries. *Journal of International Business and Cultural Studies,* Vol. 3.

Morrissey, O. (2001). Does aid increase growth? Progress in Development Studies, 1(1), pp.37-50.

Michael Dooley, Jeffrey Frankel and Donald J. Mathieson (1987). International Capital Mobility: What Do Saving-Investment Correlations Tell Us? *Palgrave Macmillan Journals.* Vol. 34, No 3 pp 503-530.

Mankiw, N. (2019). *Macroeconomics*. 8th ed. New York: Worth Publishers, pp.189-199.

Maddala, G. and Wu, S. (1999). A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics*, 61(s1), pp.631-652.

MosleyP. 1980.Aid, savings and growth revisited. *Oxford Bulletin of Economics and Statistics* 42(2): 79–95

United Nations. (2019). *Ending Poverty*. [online] Un.org. Available at: http://www.un.org/en/sections/issues-depth/poverty/ [Accessed 23 Jan. 2019].

Levin, A., Lin, C. and James Chu, C. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, 108(1), pp.1-24.

Refaei, R. (2015). Official Development Assistance and Economic Growth in Iran. *International Journal of Management, Accounting and Economics*, [online] 2(2), pp.125-135. Available at: https://www.researchgate.net/publication/273136694_Official_Development_Assistance_and_Economic_Growth_in_iran [Accessed 20 Mar. 2019].

World Bank (1998). Assessing aid: what works, what doesn't, and why. Washington, DC: Oxford University Press for the World Bank.

Appendix

1.a

In [8]:
```
#descriptive stats
data_new.describe()
```

Out[8]:

	Time	GDP (constant 2010 US$)	GDP per capita (constant 2010 US$)	Gross fixed capital formation (% of GDP)	Gross domestic savings (% of GDP)	Imports	Exports	Trade	ODA	Total_Population	Population growth (annual %)
count	644.000000	6.440000e+02	644.000000	644.000000	644.000000	644.000000	644.000000	644.000000	6.440000e+02	6.440000e+02	644.000000
mean	2003.500000	2.263967e+10	817.347300	18.262909	12.755536	29.866617	30.311150	54.069414	7.092432e+08	2.089264e+08	2.554517
std	8.084026	3.846919e+10	569.172263	8.259588	12.402386	18.134253	18.574272	30.903554	8.594486e+08	4.043168e+08	0.711251
min	1990.000000	4.724591e+08	161.833816	0.000000	-13.780052	-42.593931	4.685804	8.174071	3.324395e+01	9.168080e+05	0.205493
25%	1996.750000	3.216717e+09	426.275401	12.350478	5.364295	20.043357	17.004159	34.337343	1.179871e+02	9.749322e+06	2.197636
50%	2003.500000	9.640964e+09	583.588145	18.262909	10.757119	30.706781	25.277662	47.919828	4.516650e+08	2.826498e+07	2.681981
75%	2010.250000	1.814163e+10	1045.029937	22.730680	17.272821	37.721848	38.382794	63.112567	1.124140e+09	1.784961e+08	3.029991
max	2017.000000	2.408567e+11	2925.527748	52.938841	103.632294	98.791145	101.593436	200.384580	6.543840e+09	3.111140e+09	3.968382

1.b

DIAGNOSTIC ANALYSIS

1. Unit root test

The Augmented Dickey-Fuller test is a type of statistical test called a unit root test The null hypothesis of the test is that the time series can be represented by a unit root, that it is not stationary (has some time-dependent structure). The alternate hypothesis (rejecting the null hypothesis) is that the time series is stationary.

H0: If failed to be rejected, it suggests the time series has a unit root, meaning it is non-stationary. It has some time dependent structure.

H1: The null hypothesis is rejected; it suggests the time series does not have a unit root, meaning it is stationary. It does not have time-dependent structure.

In [46]:
```
##Unit root test on our dependent variable
X=df['ln_gdp_pc'].values
result = adfuller(X)
print('ADF Statistic: %f' % result[0])
print('p-value: %f' % result[1])
print('Critical Values:')
for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))
```

```
ADF Statistic: -3.635003
p-value: 0.005126
Critical Values:
        1%: -3.441
        5%: -2.866
        10%: -2.569
```

For our dependent variable, p-value is less than 0.05. We reject the null hypothesis and say there is no unit root and data is stationary

In [47]:
```
##Unit root test on our independent varible
for col in independent_vars:
    X=df[col].dropna().values
    result = adfuller(X)
    print()
    print('column name:',col, '\nADF Statistic: %f' % result[0])
    print('p-value: %f' % result[1])
```

```
column name: Gross fixed capital formation (% of GDP)
ADF Statistic: -6.751791
p-value: 0.000000

column name: Gross domestic savings (% of GDP)
ADF Statistic: -4.020887
p-value: 0.001305

column name: Population growth (annual %)
ADF Statistic: -5.631640
p-value: 0.000001

column name: FDI, net inflows (% of GDP)
ADF Statistic: -6.435372
p-value: 0.000000

column name: Aid/Gdp_sqr
ADF Statistic: -3.797436
p-value: 0.002934

column name: Aid/Gdp
ADF Statistic: -4.179194
p-value: 0.000714

column name: ln_ODA
ADF Statistic: -3.006381
p-value: 0.034303

column name: wopen
ADF Statistic: -9.394984
p-value: 0.000000

column name: Trade
ADF Statistic: -4.659222
p-value: 0.000100
```

All of the ADF for independent variables have p-value of less than 0.05, which means they are stationary.

1.c

2. VIF for multicollinearity

Colinearity is the state where two variables are highly correlated and contain similiar information about the variance within a given dataset. To detect colinearity among variables, simply create a correlation matrix and find variables with large absolute values.

A VIF between 5 and 10 indicates high correlation that may be problematic.

In [48]:
```
from statsmodels.tools.tools import add_constant
X = add_constant(df[independent_vars].dropna())
vif = pd.DataFrame()
vif["VIF Factor"] = [variance_inflation_factor(X.values, i) for i in range(X.shape[1])]
vif["features"] = X.columns
vif
```

Out[48]:

	VIF Factor	features
0	23.991193	const
1	1.332177	Gross fixed capital formation (% of GDP)
2	1.713542	Gross domestic savings (% of GDP)
3	1.179620	Population growth (annual %)
4	1.007579	FDI, net inflows (% of GDP)
5	7.904766	Aid/Gdp_sqr
6	12.024027	Aid/Gdp
7	2.541917	ln_ODA
8	1.108306	wopen
9	1.667139	Trade

1.d

3. Homoscedasticity

When residuals do not have constant variance (they exhibit heteroscedasticity), it is difficult to determine the true standard deviation of the forecast errors, usually resulting in confidence intervals that are too wide/narrow. For example, if the variance of the residuals is increasing over time, confidence intervals for out-of-sample predictions will be unrealistically narrow.

In [49]:
```
from statsmodels.stats.diagnostic import het_breuschpagan
from statsmodels.stats.diagnostic import het_white

# breuschpagan test
bp_test = het_breuschpagan(res.resids, df[independent_vars].dropna())
labels = ['BP Statistic', 'BP-Test p-value', 'F-Statistic', 'F-Test p-value']
print(pd.Series(zip(labels, bp_test)))
```

```
0          (BP Statistic, 159.91324910885916)
1    (BP-Test p-value, 1.667575378566256e-30)
2           (F-Statistic, 23.307326859905583)
3    (F-Test p-value, 1.7381231640763157e-34)
dtype: object
```

1.e

n [117]:
```
# Creating a dataset for regression analysis
entity = data_new[group_5]['Country'].unique()
time = list(pd.date_range('1-1-1990',freq='A', periods=28))
index = pd.MultiIndex.from_product([entity, time])
allvars = ['Gross fixed capital formation (% of GDP)','Gross domestic savings (% of GDP)',
           'Population growth (annual %)','FDI, net inflows (% of GDP)',
            'Aid/Gdp_sqr','Aid/Gdp', 'ln_ODA',
       'ln_gdp_pc', 'wopen','Trade']

df = pd.DataFrame(np.array(data_new[group_5][allvars]),
                  index=index, columns = allvars)
```

n [118]:
```
from linearmodels.panel import PanelOLS
# fixed effects
# documentation: https://bashtage.github.io/linearmodels/panel/models.html#linearmodels.panel.model.PanelOLS

independent_vars = ['Gross fixed capital formation (% of GDP)','Gross domestic savings (% of GDP)',
          'Population growth (annual %)','FDI, net inflows (% of GDP)',
           'Aid/Gdp_sqr','Aid/Gdp', 'ln_ODA','wopen','Trade']

mod = PanelOLS(df['ln_gdp_pc'],
               df[independent_vars],
               entity_effects=True, time_effects=True) # you can turn on or off both entity_effects and time_effects

res = mod.fit(cov_type='clustered', cluster_entity=True) # here cov_type means covariance estimators type.
# cov_type can be 'unadjusted', 'homoskedastic' or 'robust', 'heteroskedastic' or 'clustered` - One or two way clustering.

print(res)
```

PanelOLS Estimation Summary

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:              ln_gdp_pc   R-squared:                        0.3257
Estimator:                   PanelOLS   R-squared (Between):              0.7419
No. Observations:                 644   R-squared (Within):               0.5023
Date:                Wed, Nov 20 2019   R-squared (Overall):              0.7417
Time:                        23:42:34   Log-likelihood                   365.20
Cov. Estimator:             Clustered
                                        F-statistic:                      31.401
Entities:                          23   P-value                           0.0000
Avg Obs:                       28.000   Distribution:                  F(9,585)
Min Obs:                       28.000
Max Obs:                       28.000   F-statistic (robust):             8.8939
                                        P-value                           0.0000
Time periods:                      28   Distribution:                  F(9,585)
Avg Obs:                       23.000
Min Obs:                       23.000
Max Obs:                       23.000

                                Parameter Estimates
================================================================================================================
                                  Parameter  Std. Err.     T-stat    P-value    Lower CI    Upper CI
----------------------------------------------------------------------------------------------------------------
Gross fixed capital formation (% of GDP)     0.0012     0.0029     0.4167     0.6770     -0.0046      0.0070
Gross domestic savings (% of GDP)            0.0030     0.0017     1.7777     0.0760     -0.0003      0.0063
Population growth (annual %)                -0.0631     0.0395    -1.5979     0.1106     -0.1407      0.0145
FDI, net inflows (% of GDP)             -7.944e-11  1.075e-10    -0.7389     0.4602  -2.906e-10   1.317e-10
Aid/Gdp_sqr                                  0.0012     0.0002     5.3227     0.0000      0.0008      0.0017
Aid/Gdp                                     -0.0674     0.0132    -5.0911     0.0000     -0.0935     -0.0414
ln_ODA                                       0.2452     0.0510     4.8096     0.0000      0.1451      0.3453
wopen                                        0.0003     0.0004     0.9867     0.3242     -0.0003      0.0010
Trade                                        0.0033     0.0013     2.5684     0.0105      0.0008      0.0058
================================================================================================================

F-test for Poolability: 99.258
P-value: 0.0000
Distribution: F(49,585)
```

WEIGHTED REGRESSION

In [51]:

```
##Weighted regression minimizes the sum of the weighted squared residuals.
##When you use the correct weights, heteroscedasticity is replaced by homoscedasticity.

from linearmodels.panel import PanelOLS
# fixed effects
# documentation: https://bashtage.github.io/linearmodels/panel/models.html#linearmodels.p

independent_vars = ['Gross fixed capital formation (% of GDP)','Gross domestic savings (%
          'Population growth (annual %)','FDI, net inflows (% of GDP)',
          'Aid/Gdp', 'Aid/Gdp_sqr', 'ln_ODA','wopen','Trade']

mod = PanelOLS(df['ln_gdp_pc'],
               df[independent_vars],
               entity_effects=True, time_effects=True) # you can turn on or off both enti

res = mod.fit(cov_type='heteroskedastic') # here cov_type means covariance estimators typ
# cov_type can be 'unadjusted', 'homoskedastic' or 'robust', 'heteroskedastic' or 'cluste

print(res)
```

```
                          PanelOLS Estimation Summary
================================================================================
Dep. Variable:              ln_gdp_pc   R-squared:                        0.3257
Estimator:                   PanelOLS   R-squared (Between):              0.7419
No. Observations:                 644   R-squared (Within):               0.5023
Date:                Wed, Nov 20 2019   R-squared (Overall):              0.7417
Time:                        12:32:13   Log-likelihood                   365.20
Cov. Estimator:                Robust
                                        F-statistic:                      31.401
Entities:                          23   P-value                           0.0000
Avg Obs:                       28.000   Distribution:                  F(9,585)
Min Obs:                       28.000
Max Obs:                       28.000   F-statistic (robust):             26.529
                                        P-value                           0.0000
Time periods:                      28   Distribution:                  F(9,585)
Avg Obs:                       23.000
Min Obs:                       23.000
Max Obs:                       23.000
```

PanelOLS Estimation Summary

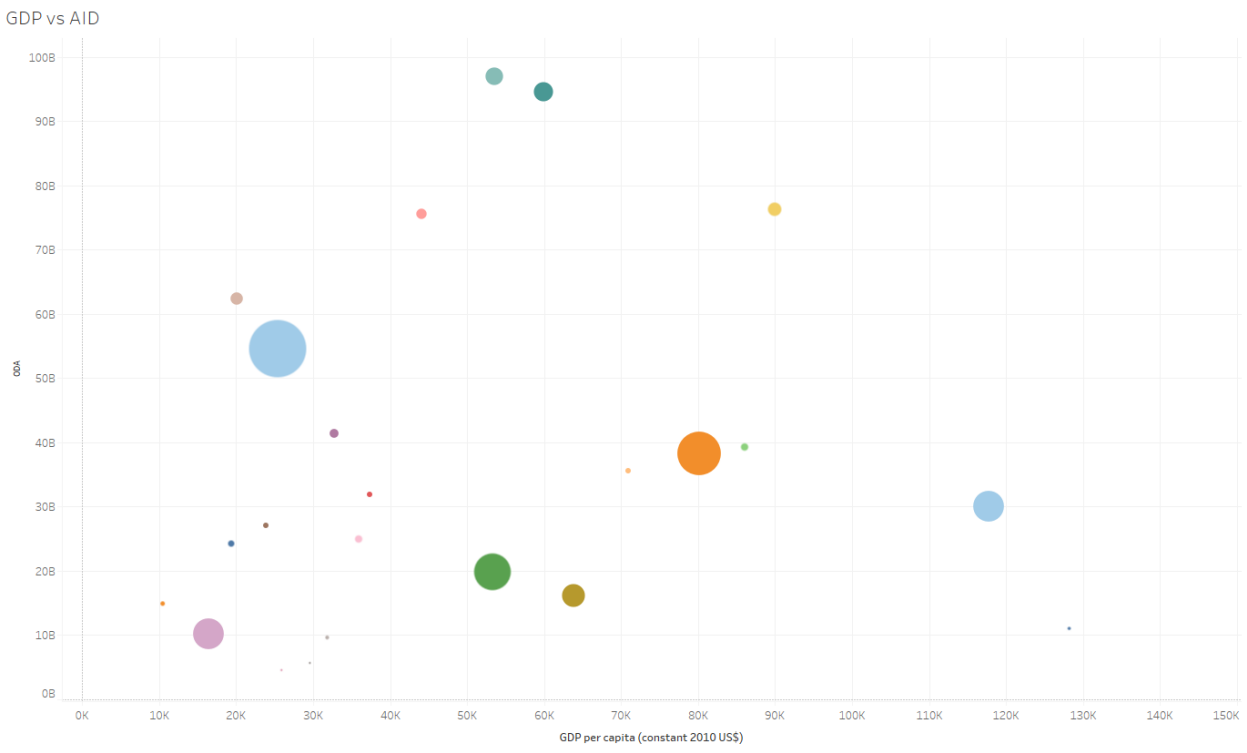
Dep. Variable:	ln_gdp_pc	R-squared:	0.3257
Estimator:	PanelOLS	R-squared (Between):	0.7419
No. Observations:	644	R-squared (Within):	0.5023
Date:	Wed, Nov 20 2019	R-squared (Overall):	0.7417
Time:	12:32:13	Log-likelihood	365.20
Cov. Estimator:	Robust		
		F-statistic:	31.401
Entities:	23	P-value	0.0000
Avg Obs:	28.000	Distribution:	F(9,585)
Min Obs:	28.000		
Max Obs:	28.000	F-statistic (robust):	26.529
		P-value	0.0000
Time periods:	28	Distribution:	F(9,585)
Avg Obs:	23.000		
Min Obs:	23.000		
Max Obs:	23.000		

Parameter Estimates

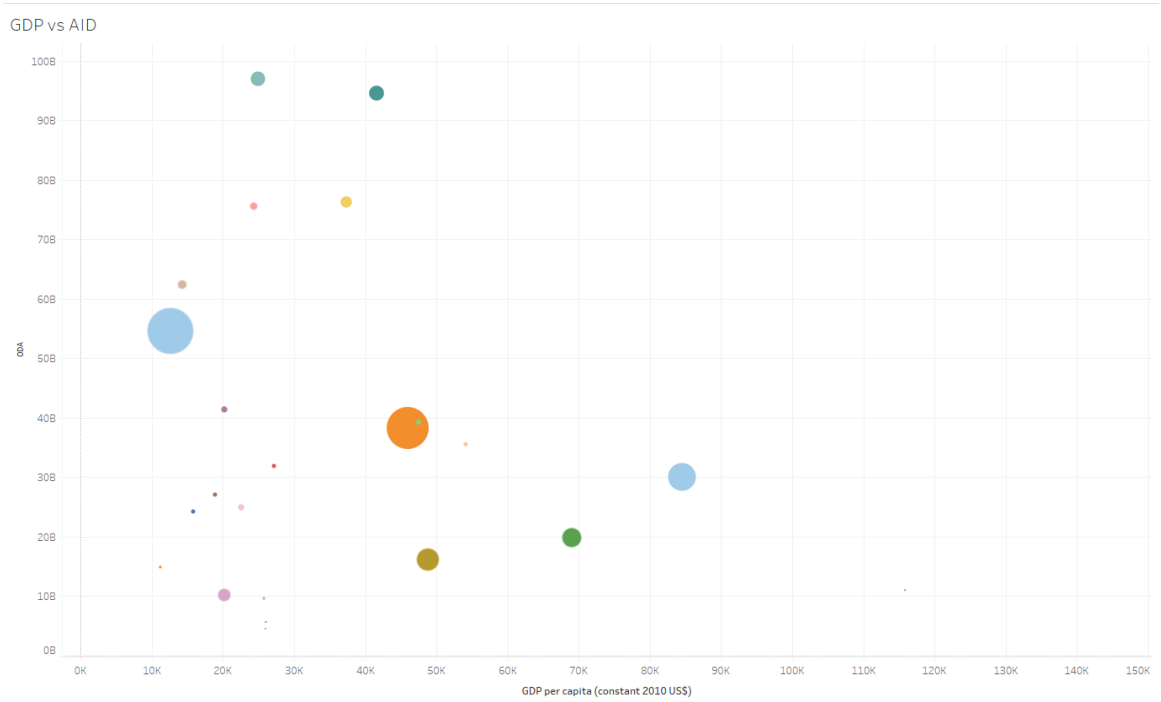
	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
Gross fixed capital formation (% of GDP)	0.0012	0.0011	1.1258	0.2607	-0.0009	0.0034
Gross domestic savings (% of GDP)	0.0030	0.0009	3.3266	0.0009	0.0012	0.0047
Population growth (annual %)	-0.0631	0.0216	-2.9207	0.0036	-0.1056	-0.0207
FDI, net inflows (% of GDP)	-7.944e-11	7.515e-11	-1.0571	0.2909	-2.27e-10	6.815e-11
Aid/Gdp	-0.0674	0.0100	-6.7575	0.0000	-0.0871	-0.0478
Aid/Gdp_sqr	0.0012	0.0003	4.3845	0.0000	0.0007	0.0017
ln_ODA	0.2452	0.0305	8.0284	0.0000	0.1852	0.3052
wopen	0.0003	0.0003	1.0696	0.2852	-0.0003	0.0010
Trade	0.0033	0.0005	6.2766	0.0000	0.0022	0.0043

F-test for Poolability: 99.258
P-value: 0.0000
Distribution: F(49,585)

GDP/AID in 2017



GDP/AID in 2000



Interactive dashboard: