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Master Thesis

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Can foreign aid (ODA) effectively contribute to the UNs sustainable development goal for economic growth in the least developed countries?

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Can Foreign Aid (ODA) Effectively Contribute to the UNs Sustainable Development Goal for Economic Growth in the Least Developed Countries?

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MSc in Business – Major in Finance

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Abstract

Examining a panel of 40 countries and variables observed over the past 24 years, this study provides evidence of foreign aids' short- and long-term effects on real Gross Domestic Product (GDP) growth. By including both governance and social variables as exogenous we observe a significant positive long-term effect of aid on GDP. The short-term effect is reported to be negative, but at a lower level of significance. The results are robust to different regression methods and aligns with economic growth theory. We find evidence suggesting that aid contributes to sustained GDP growth as defined by the UNs sustainable development goals.

1. Introduction

Does Official Development Assistance (ODA) lead to an increase in the recipient country's GDP? Numerous researchers have studied this question over the years; however, the results of the studies are ambiguous and dependent on model specifications and various definitions of aid and growth. This study aims to isolate the long-term effects of foreign aid (ODA) on GDP growth of the recipient countries by combining recent studies, their critiques and data from the past 24 years. The results are compared to a short-term model to shed additional light on the adverse effects of aid that may cause these ambiguous research results.

This question is encouraged by the research conducted by Burnside and Dollar (Burnside & Dollar, 2000) on aid effectiveness. Our model is based on the same neoclassical framework and like Burnside and Dollar we apply the OLS technique when estimating the long-term effects of aid. Burnside and Dollar (Burnside & Dollar, 2000) used a definition of aid, Effective Development Assistance, which is ODA less concessional loans. We aim to look at aid from the perspective of the UNs sustainable development goals in which aid is defined as ODA. Hence, ODA is the natural definition of foreign aid for this study. Easterly (Easterly, 2003) tested the results of Burnside and Dollar and found that the policy variable they introduced lacked robustness for various definitions of aid. This especially was the case when using the ODA definition of aid. Consequently, we have excluded the policy variable from this study.

A few countries are excluded as the lack of observations are severe, and a new variable comprised of the world government indicators as a measure for the quality of governance in the recipient countries. Furthermore, we study the current list of least developed countries and the most recent data available to answer the research question in the best possible way. This study combines recent research with new data and applications to provide new evidence to the field of development research.

The objective is to provide evidence of whether foreign aid has a positive effect on GDP growth in the least developed countries, and by that is effectively contributing

to the UNs sustainable development goal of sustained economic growth. By combining recent data with a broad spectrum of acknowledged research findings into our model construction, this study aims to fill a gap in the development research available today.

2. Background and Motivation

The amount of money spent on official development assistance (ODA) globally is tremendous. Foreign aid has developed from colonial powers aiding in building infrastructure in their colonies to it being a natural part of any developed country's budget. In fact, for 2019 the Norwegian government has budgeted to spend NOK 37.8 billion on foreign aid. This corresponds to approximately 1% of the nations' gross national income (Ministry of Foreign Affairs, 2018) OECD reports that foreign aid from official donors amount to USD 146.6 billion in 2017 globally (OECD, 2018a). With the large sums of money invested in foreign aid, its effectiveness is an important concern in development research. Based on classic economic theory, and to the extent foreign aid is being deployed, expectations are that foreign aid should lead to economic growth. However, researchers find ambiguous evidence on the subject.

3. Definitions

3.1 Foreign Aid

To break down the content of the research question we will define each part of it, beginning with foreign aid. A broad definition is as follows; foreign aid consists of all resources, physical goods, skills and technical know-how, financial grants or concessional loans transferred by donors to recipients (Fike, 2009). The definition used in this study however is limited to development aid which is concerned with

humanitarian, development and poverty needs (Fike, 2009). The type of aid we examine is Official Development Assistance (ODA). This definition is developed by The Development Assistance Committee (DAC). DAC defines and monitors global standards in key areas of development as well as supporting the UN in ensuring the success of the sustainable development goals (OECD, 2019). The DAC defines ODA in the following way;

"*Those flows to countries and territories on the DAC List of ODA Recipients and to multilateral institutions which are:*

i. *provided by official agencies, including state and local governments, or by their executive agencies; and*

ii. *each transaction of which:*

> ***a)*** *is administered with the promotion of the economic development and welfare of developing countries as its main objective; and*
>
> ***b)*** *is concessional in character and conveys a grant element of at least 25 per cent (calculated at a rate of discount of 10 per cent)*"(OECD, 2018b).

This is the most widely acknowledged definition of foreign aid aimed at development. Data concerning this type of aid is very accessible through the World Bank Data Bank. We will return to how the ODA variable is specified in section 9.3.

3.2 Economic Growth

Economic growth in this case will be defined as real growth in the recipient country's gross domestic product (GDP). There are several other parameters that can be used to measure economic growth, but GDP growth is the most widely used in recent literature regarding this subject (e.g.(Burnside & Dollar, 2000; Easterly, 2003; Rajan, 2005)) The UN also use annual growth rate of real GDP per capita as a target indicator for the 8th goal of economic growth (The UN, 2018b).

There are several factors that in theory should lead to economic growth. It seems quite clear that aid as a form of income transfer has the potential to drive economic growth. However, what researchers and growth theory emphasize is that how the money is spent determines whether it will lead to economic growth. Generally, one can say that if aid stimulates domestic investment rather than government consumption, one can expect to observe economic growth as a consequence (Attanasio, Picci, & Scorcu, 2000). This aligns well with traditional growth theory.

3.3 Aid Effectiveness

The main objective of this thesis is to measure the effectiveness of dollars spent on foreign aid on the economic growth in the least developed countries. The analysis is aimed at observing whether we can see a statistically significant positive relationship between foreign aid (ODA) and economic growth (in GDP terms) in the recipient country. Through this analysis we hope to determine whether foreign aid contributes to the economic growth goal presented in the UNs 2030 agenda for sustainable development.

3.4 The UNs Sustainable Development Goals

The 2030 Agenda for Sustainable Development was agreed upon by all United Nations members in 2015 replacing the millennium goals that had its deadline for completion in 2015. The sustainable development goals (hereby SDGs) work as "A blueprint for peace and prosperity for people and planet, now and into the future" (The UN, 2018b). There are in total 17 goals aimed at raising a global effort to reduce inequality and poverty, address the climate crisis and paving the way for a sustainable future. The 8th goal part 1 focuses on promoting sustained economic growth of at least 7% in the least developed countries. Development aid will play a central role in the global strategy for reaching this goal. This makes this study highly relevant and of great importance. All members of the UN have signed off on these goals and by that they are committed to contribute to their fulfilment.

3.5 The Least Developed Countries

This study will focus on the UNs list of countries currently defined as least developed. This is to contribute to the understanding of whether foreign aid is an effective tool for achieving the UNs SDG of economic growth in these countries. The UN define least developed countries in the following way;

> *"Least developed countries (LDCs) are low-income countries confronting severe structural impediments to sustainable development. They are highly vulnerable to economic and environmental shocks and have low levels of human assets.» (The UN, 2019)*

The list of LDCs, that is updated every third year and most recently in March 2018, are currently comprised of 47 countries.

List of Least developed countries (as of December 2018)

Country	Year of inclusion	Country	Year of inclusion
Afghanistan	1971	Malawi	1971
Angola[1]	1994	Mali	1971
Bangladesh	1975	Mauritania	1986
Benin	1971	Mozambique	1988
Bhutan[2]	1971	Myanmar	1987
Burkina Faso	1971	Nepal	1971
Burundi	1971	Niger	1971
Cambodia	1991	Rwanda	1971
Central African Republic	1975	São Tomé and Príncipe[3]	1982
Chad	1971	Senegal	2000
Comoros	1977	Sierra Leone	1982
Democratic Republic of the Congo	1991	Solomon Islands[4]	1991
Djibouti	1982	Somalia	1971
Eritrea	1994	South Sudan	2012
Ethiopia	1971	Sudan	1971
Gambia	1975	Timor-Leste	2003
Guinea	1971	Togo	1982
Guinea-Bissau	1981	Tuvalu	1986
Haiti	1971	Uganda	1971
Kiribati	1986	United Republic of Tanzania	1971
Lao People's Democratic Republic	1971	Vanuatu[5]	1985
Lesotho	1971	Yemen	1971
Liberia	1990	Zambia	1991
Madagascar	1991		

(The UN, 2018a)

4. Our Contribution to the Subject

The importance of this subject and its size in economic terms demands detailed and updated research. Much of the effectiveness-studies conducted on foreign aid and economic growth is based on older data sets and are not directly aimed at the least developed countries as defined by the UN. The most impactful research conducted over the past 20 years might be that of Craig Burnside and David Dollar (Burnside & Dollar, 2000) who found that aid effectiveness on growth largely depend on good economic policies in the receiving countries which cannot be said to be present in several of the LDCs. Later, many have responded to their research and suggested alterations and augmentations of models (E.g. Easterly, 2001). This study will start with a model developed by Burnside and Dollar (Burnside & Dollar, 2000). With the critiques of their work in mind we will develop a new model that isolates the effect of foreign aid on real GDP growth in the least developed countries applying the most recent data available. Our goal is to provide new evidence of the effectiveness of foreign aid in the current macroeconomic landscape.

5. Literature Review

To what extent foreign aid has an economic effect on the recipient country has been a controversial and well discussed topic among researchers. Rosenstein-Rodan (1961) stated early that aid both indirectly and directly made it possible to shorten the time to achieve self-sustained economic growth through increase in income, savings and investments. Their findings were later criticized by several researchers such as Raham (1968), Griffin and Enos (1970) and Weisskopf (1972). They all supported the view that foreign aid did not increase savings nor accelerated growth for the recipient country, but they were not able to determine how strong the negative impact was. Gustav F. Papanek conducted in 1970 a cross-country analysis to provide quantitative evidence on the relationship between saving, aid and growth in less developed countries. One of his findings was that savings and foreign capital inflows explained more than one third of the country's growth. Even though his sample lacked observations in Africa and the analysis may suffer from cross-country defects, it is a noteworthy contribution.

In 1996 Peter Boone published "Politics and the effectiveness of foreign aid" where he tested the aid effectiveness depending on different political regimes. He found that aid did not significantly increase investment nor improvements in human development. From his sample (1971-1990) most long-term aid, provided on a regular basis, showed no effect. In addition, there were no results suggesting that the impact of aid vary due to a liberal democratic government or a more repressive government. Thus, Boone concluded that there were no incentives for the recipient country to adjust their policies when receiving aid. Nonetheless, Boone discovered an increase in overall consumption, but higher consumption did not benefit the poor (Boone, 1996).

Paul Mosely addressed a paradox with aid effectiveness, namely the micro-macro paradox. "Over the last 20 years measured aid-effectiveness has been high at the project level, in the sense that ex post rates of return are more than satisfactory, but low at the macro level, in the sense that it is impossible to establish any statistically significant correlation between aid flows and increases in growth across a sample of recipient countries" (Mosley, 1986). The micro-macro paradox has later been addressed by several researchers.

H. Hansen and F. Tarp (2000) attempted to address the issue concerning macroeconomic impact of foreign aid with the article "Aid Effectiveness Disputed", especially with respect to savings, investment and growth. They considered three generations of empirical studies on aid effectiveness, the Harrod-Domar models, reduced form aid-growth models and new-growth-theory reduced-form models. They found a consistent pattern of results and concluded that; aid increases aggregated savings, this increases investments and that there is a positive relationship between aid and growth in reduced form models. (Tarp & Hansen, 2003). Furthermore, they concluded that the micro-macro paradox is non-existent and the extreme view of aid only working in areas with good policy appears to be wrong.

"New Evidence on the impact of Foreign Aid on Economic Growth" published in 1998 by Ramesh Durbarry, Norman Gemmell and David Greenaway assessed the impact of foreign aid on growth for 68 developed countries. On a micro-level, earlier research agrees mostly upon a significant impact of aid, while on the macro-level the results are ambiguous. They found robust evidence that inflow of foreign aid has a beneficial effect on the least developed countries´ growth, conditional on a stable policy in the recipient country. A definition for a good/stable policy in the recipient country is "developing countries with good fiscal, monetary and trade policies"(Burnside & Dollar, 2000). In addition, they stressed the importance of controlling appropriately for growth determinants and also confirmed that external economic environment has an important implication for growth performance. However, low-income countries which received small amounts of aid (less than 13% of GDP) had insignificant growth parameters. (Durbarry, Gemmell, & Greenaway, 1998). This result may explain why earlier studies with large samples of low-income with a small fraction of aid inflow relative to GDP had insignificant aid-growth effect. Furthermore, they argued that the cause for insignificant results from the mid 1980´s research and the statistically significant aid-growth results on recent data can be interpreted as a result of less effective aid in the pre-liberalization phase. Thus, policy reforms made aid more effective.

The idea behind the Washington Consensus, which was supported by World Bank, U.S Treasury and the International Monetary Fund was to help developing countries in economic crisis through a set of free-market policies (Williamson, 1993). Ever since the policy of the recipient country became a topic in allocation of foreign aid, many researchers have stressed the importance of a good policy. One of the most famous papers considering the effectiveness of aid with respect to policy was published in The American Economic Review, namely, "Aid, Policies and Growth" by (Burnside & Dollar, 2000). In this paper Burnside and Dollar studied the relationship between foreign aid, economic policies and growth by using a new database developed by the World Bank. They concluded that, on average, aid had little impact on growth, even though there were robust findings that aid had more positive impact on growth in recipients countries with good economic policies (Burnside & Dollar, 2000). Moreover, they did not find a significant tendency in

the allocation of total/bilateral aid to favor good policy, but on the other hand, allocation of multilateral aid was approximately one third of the aid allocated in favor of good policy. In addition, bilateral aid was found to be positively correlated with government consumption. These two findings together may explain why the aid impact on growth is not more positive.

Burnside and Dollar´s article caused repercussions in the foreign aid debate the following years. Several well-known newspapers, such as Financial Times and the New Yorker published articles based on "Aid, Policy and Growth" and embraced their findings about aid effectiveness on growth in countries with good policies (Easterly, 2003). Implicitly these articles led to a global debate on whether to increase foreign aid and the allocation of it. In the wake of the "Financing for Development" U.N conference in 2002 the Bush administration proposed a 50-percent increasing in their budget for development assistance (UN, 2002).

In 2003 William Easterly published the article "Can Foreign Aid Buy Growth?" in the Journal of Economic Perspectives. He argued against the statement that "aid promotes growth in good policy environment". In general, he argued that with new data and alternative definitions, such as "aid", "policy", the findings were not robust. Easterly concluded that aid should set more modest goals, such as helping some of the people some of the time, rather than ensuring a society transformation (Easterly, 2003).

William Easterly, Ross Levine and David Roodman reassessed the relationship between aid, policy and growth by using Burnside and Dollars´ (2003) methodology. They extended the data series, added new available information and more observations. (Easterly, Levine, & Roodman, 2004). When additional data was added to Burnside and Dollars´s methodology, they raised new doubts regarding the aid effectiveness on growth. Thus, economist and politicians should be less optimistic in thinking that foreign aid contributes to growth in developing countries with good policies.

In the IMF working paper "What Undermines Aid's Impact on Growth" (Rajan, 2005), Rajan and Subramanian discussed the reasons for the ambiguous empirical results of aid effectiveness on long-term economic growth in poor countries. By looking at both cross-country and within-country variation they found some evidence that aid has negative effects on the recipient country's competitiveness as it leads to a "decline in the share of labor intensive and tradable industries in the manufacturing sector". They found that these effects seemed to originate from real exchange rate overvaluation caused by the aid inflows. They pointed out the fact that a large amount of money being poured into the economy push the nominal interest rate up and renders the traded goods sector uncompetitive in the international markets. This problem is commonly known as the "Dutch Disease" and it may be a significant part of why researchers have had trouble obtaining unambiguous positive results on aid's effect on GDP growth.

Most findings in recent studies confirm the so-called "macro-micro paradox". That is, macro-economic studies fail to prove positive effects of aid on growth, while micro-studies such as project assessments tend to provide evidence of positive effects e.g. Clemens, Radelet and Bhavnanis study of the short-term effect of aid on growth (Clemens, Radelet, & Bhavnani, 2004). Arndt, Jones and Tarp however, did find positive long-term effects using "point estimates at levels suggested by growth theory". (Arndt, Jones, & Tarp, 2010).

6. Theory and Methodology

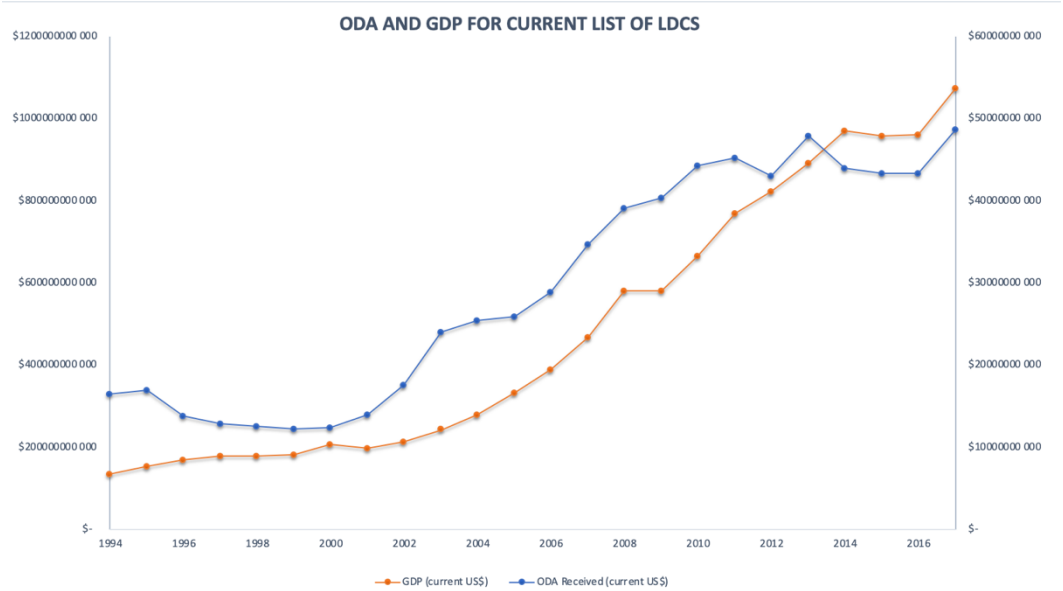
As mentioned previously, our regression model will be based on the work of Burnside and Dollar (Burnside & Dollar, 2000) including some alterations to take into account its critics. Nevertheless, the theoretical framework remains the same. It builds on the neoclassical model of long-run economic growth.

6.1 The Neoclassical Growth Model (Solow, 1956)

The model is essentially a production function with constant returns of scale in capital and labor. Its equilibrium state is defined as a "steady state"-growth where both consumption and capital grows at a constant rate (Rebelo, 1991). The model predicts that a deviation from the steady state is temporary and the abnormal growth will converge back to the steady state level. The convergence hypothesis states that countries with the same level of savings, population growth and access to technology ultimately will converge to the same level of per capita income. Countries with a low initial level of income will display a higher growth rate than that of a high-income but otherwise similar country. This is due to the fact that poor countries with low capital to labor ratio has higher marginal products of capital than rich countries (R. J. Barro, 1991). Hence, in theory, development aid would be most effective when given to countries with a low initial GDP. However, although theory predicts income convergence, the empirical evidence has failed to confirm the theory completely. Barro found some evidence of it through a cross-section study where initial human capital was held constant. The rate of convergence between poor and rich countries was 2% (R. J. Barro, 1991). Others have argued that the poverty trap prevents the theory to gain greater empirical evidence as some countries seem to be unable to escape poverty due to corruption, bad governance and other exogenous circumstances (D. Quah, 1995; D. T. Quah, 1996).

Furthermore, to be most effectively allocated, ODA should decrease with increases GDP as its effectiveness is declining when the receiving country's GDP approaches the steady state level. It is quite clear from the data collected from the World Bank that this is not the case. Figure 1 graphs the total ODA received and GDP in the current list of least developed countries for the past 24 years. What becomes clear from looking at the graphs is that the two have a strong positive correlation. In fact, for the past 24 years, the correlation has been as high as 0.94.

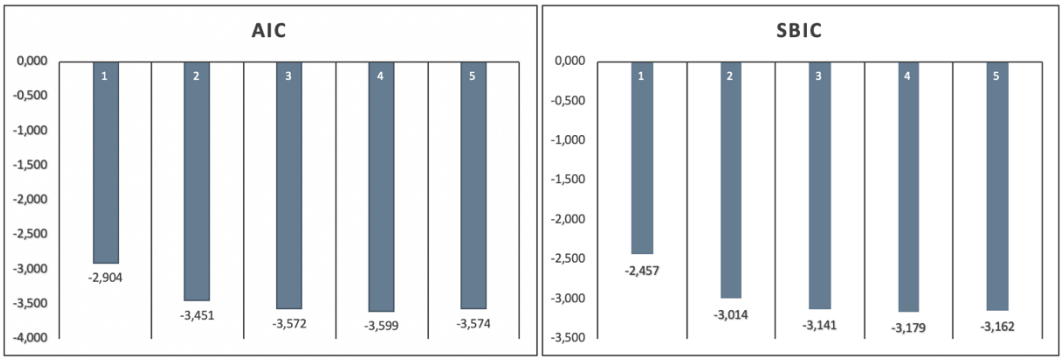
Figure 1: Total GDP and ODA from 1994 to 2017.



Notes: Total GDP (current US $) and ODA received (current US $) from 1994-2017. Total of all countries currently listed as least developed. (data extracted from the World Bank Databank)

Another outtake from this graph is that GDP reacts to some extent to changes in ODA with a lag. The lagged effect can be explained through the purpose of a large part of the aid provided, which is to sustain long-term growth. This leads to much of the aid being invested in long-term projects, thus having a visible effect on GDP later rather than instantly. The intuition of the lagged effects of aid on GDP growth will be discussed further in section 12. To test whether the model improves when adding lags to ODA we conducted tests using a combination of the Akaike (AIC) and the Schwarz-Bayesian (SBIC) information criterion. They measure the relative quality of the models and reports estimates on how much information is lost in the model. Hence, the lowest estimates indicate the best model specification. Neither of the two information criteria presented here are superior to the other and they do not always deliver the same results. SBIC is strongly consistent (but inefficient), whereas AIC is not consistent but more efficient. A combination of the two often give a better view of the optimal model (Brooks, 2008). The test is based on lags of one to five years, and we limit the testing to a maximum of five years as introducing more lags reduce the models' degrees of freedom. The results are presented in figure 2.

Figure 2: Information criterion for number of lags in ODA



Notes: AIC and SBIC estimates based on fixed effects regression models lags in ODA from one to five.

We see that both information criteria report 4 lags to be optimal for this model as it minimizes the loss of information. We will include these results in the regression and formally test them. Burnside and Dollar (Burnside & Dollar, 2000) based their research on time intervals of 4 years to capture the long-term effects of aid. We will use 4 lags in ODA to capture the long-term effects of aid. The long-term effect of aid is important as long-term growth is essential for sustained poverty reduction. Furthermore, the allocation of aid can be subject to the current situation in the recipient countries. A country facing a crisis may not be able to convert aid to short-term growth, but the effects are more likely to be visible over a few years' time.

Foreign aid acts as an income transfer that may or may not lead to economic growth, depending on how it is used (Burnside and Dollar, 2000). A key outtake from the neoclassical growth model is the long-term effects on growth from the use of national income. The national income is divided between consumption and saving/investments. Government consumption will increase the living standard in a country short-term, but it has no long-term effects on growth. These results also become clear in Burnside and Dollar (2000) as they found no significant effect of government consumption on long-run growth, consequently they chose to omit this variable from their regressions. Furthermore, the model states that increased investments may lead to increased GDP and consumption per capita in the long run.

The model assumes perfect market conditions in the country that is being studied. This is an assumption that rarely hold in the real world, at least not to its full extent. One big barrier for effective markets and effective use of aid is corruption. This is a serious issue in the less developed countries, where corruption levels tend to be high and very costly to development (Shleifer & Vishny, 1993). Collier and Dollar emphasize the implications corruption has on aid effectiveness:

"*However, aid allocation needs to take corruption into account because, even if aid cannot significantly reduce corruption, corruption can significantly impair aid effectiveness»(Collier & Dollar, 2004).*

6.2 "Aid Policies and Growth", Burnside and Dollar (2000)

To answer the question whether aid has an impact on growth, Burnside and Dollar (2000) estimated variants of the following equation, derived from the neoclassical growth model:

$$g_{it} = y_{it}\beta_y + a_{it}\beta_a + p'_{it}\beta_p + a_{it}p_{it}\beta_1 + z'_{it}\beta_z + g_t + \varepsilon_{it}^{g} \qquad (6.1)$$

i and t represent country and time, respectively. g_{it} is real GDP growth per capita, y_{it} is the logarithm of initial GDP level per capita, a_{it} is aid received relative to GDP in the recipients´ country. p_{it} is policy that can affect growth and z_{it} is exogenous variables that might affect growth and allocation of aid. The variables included in z_{it} are initial income, policy index, institutional quality, ethnic fractionalizations, assassinations, interaction term between ethnic and assassinations, broad money. g_{it} is fixed-time effects to capture worldwide business cycle and ε_{it}^{g} is the zero mean error term. Income, aid, policy and the aid-policy interaction term are included in the regression as GDP growth normally depend on them.

Burnside and Dollar argue that if aid is added to the equation (6.1), aid a_{it} should be interacted with policy p_{it}. A lump-sum of aid should yield a positive effect on

growth and if policies affects growth it would also affect how productive aid is used.

Burnside and Dollar estimated an aid equation to determine whether the recipient country´s policy affected the allocation of aid. We exclusively want to look at the aid effectiveness on growth. Thus, we decided not to include the allocation function depending on policy in this study.

Burnside and Dollar also use a definition of foreign aid similar to the definition presented by DAC, although excluding the component of "concessional loans" which are long-term, low interest loans. This was criticized by Easterly (2003) for being a somewhat inaccurate modification of the term. We choose to include the concessional loans for the data to fit the DAC definition of ODA. The correlation between these two measures is high (0.933), however it does affect the results quite severely (Easterly, 2003). Furthermore, when applying other plausible variants of aid, Easterly finds the interaction term aid-policy not to be robust. In fact, it is insignificant when using DAC´s definition of aid.

y_{it}, is the logarithm of GDP per capita. From empirical literature on growth we know by the convergence hypothesis that poor countries tend to grow faster than rich countries. To capture the convergence effect, we will let growth g_{it} depend on real GDP per capita y_{it} at the beginning of the period.

7. Our Modifications to the Model

7.1 Estimation

One can control for omitted variables in entity and time with fixed effects OLS estimation. However, the fixed effects model cannot control for effects that depends both on cross-section and time. In addition, it is unable to control for correlation with the error term. Hence, it can be problematic to analyze whether economic growth affect the amount of ODA received or the other way around. To avoid

correlation with the error term and obtain consistent estimators one solution is to introduce instrument variables. The instrument variable should be highly correlated with the independent variable, but uncorrelated with the error term (Gujarati, 2009). Moreover, an instrument variable needs to fulfill both the instrument relevance condition and the instrument exogeneity condition. When these two conditions are fulfilled it is possible to estimate 2SLS regression for the panel data (Wooldridge, 2015).

"Concern has intensified in recent year that many instrumental variables in widely-cited growth regressions may be invalid, weak or both". (Bazzi & Clemens, 2013). Burnside and Dollar (2000) estimated both OLS with fixed effects and 2SLS regressions. They used population and country size alongside other variables as instruments to their model. Bazzi and Clemens show that the instruments are valid and strong, but when relaxing the excludability of political instruments, the instrument strength drops considerably. In this case, you assume to have a strong and valid instrument, but it turns out to be weak, and it may cause severe bias to the regression results (Tarp, 2006).

Many researchers have addressed the difficulty by deploying instrument variables to panel data. For some reason it is not transparent that the instrument correlate with the variable of interest (strength of the instrument) and that the instrument does not affect growth through other channels than the variable of interest (instrument validity) (Bazzi & Clemens, 2013). Thus, in growth studies, the risk of an instrument to be weak, invalid or both is severe.

7.2 The Fixed Effects Regression Assumptions.

The first assumption is that the error term, ε_{it}^{g} has conditional mean zero. This assumption is violated if current error term is correlated with any values of X. For OLS (1)-(7) the residuals have zero mean (appendix 15.4). Therefore, for any value of the independent variables, the expected value of ε_{it}^{g} is zero (Stock & Watson, 2015).

The second assumption, that variables are identically and independently distributed across entities for I=1, 2..., n, holds if entities are selected by simple random sampling from the population. For panel data, assumption 2 holds if the variables are independent across entity, but makes no such restriction within an entity (Stock & Watson, 2015). We have chosen to omit 7 countries that lacked a substantial amount of data, acknowledging the fact that it might lead to sample selection bias and by that might violate the condition of random sampling. Nevertheless, it was necessary and superior to the alternative solutions. The rationale behind the choice is discussed further in section 7.7.

The third and fourth assumption is that large outliers are unlikely and that there is no perfect multicollinearity, respectively. The data set does not contain any large outliers, but there are some smaller ones. These can lead to an overestimation, however, as Burnside and Dollar mentioned, we should emphasize that including the outliers leads to estimates that are consistent with effects of aid on growth (Burnside & Dollar, 2000). There is no evidence of perfect multicollinearity, this is further discussed in section 10.1.

For a large sample size and having fulfilled the fixed effects assumptions, the estimator is unbiased, consistent and normally distributed. With a sufficiently large sample size, the central limit theorem states that the distribution of the estimators becomes normal (Stock & Watson, 2015). If the OLS estimators are to be the best linear unbiased estimators (BLUE), according to the Gauss-Markov theorem, the variance of the error term should be constant, thus no heteroskedasticity. In the data set used for this study the error terms are heteroskedastic as they often are in economical applications. Moreover, we apply heteroskedasticity-robust standard errors of the type proposed by White (White, 1980), and therefore the OLS estimators are still unbiased, consistent and normal. Hence, when heteroskedasticity-robust standard errors are used, the additional assumption regarding homoskedasticity is no more needed for the validity of OLS regression analysis (Stock & Watson, 2015). Another option is to apply the weighted least squares estimator, but as it is difficult to determine the nature of the heteroskedasticity the OLS-method is superior (Wooldridge, 2015).

Moving beyond the assumptions for fixed effects regression, there error terms do not correlate with each other and they are normally distributed (see appendix 15.3 and 15.4) which results in more reliable data.

In the absence of instruments that fulfill the aforementioned conditions and the fact that OLS and 2SLS generate similar and consistent results in Burnside and Dollar's study as well as other cited growth studies, we will focus on OLS estimation. In addition, the fixed effects regression assumptions hold, thus the OLS regressors are unbiased, consistent and normal.

7.3 Removing Policy

We have chosen to exclude the policy index on basis of its lack of robustness when applying the definition of foreign aid that we have been using for our study. It has been tested and found insignificant for various definitions of foreign aid by Easterly (Easterly, 2003). The Sachs and Warner openness dummy, which is included in the policy index, also received critique for painting a black-and-white picture of what is characterized as an open or a closed economy. It has been criticized for being both subjective and opaque in its definitions (Rodríguez & Rodrik, 2000). Due to the quite extensive criticism that the policy index has received and the fact that it proves insignificant when the ODA definition of foreign aid is being applied, we believe that the choice to exclude the index is justified.

7.4 Missing Data

One of the social variables included in several influential papers on aid effectiveness is ethnolinguistic fractionalization (e.g. (Burnside & Dollar, 2000; Easterly & Levine, 1997)). It aims to capture the adverse effects of ethnic diversity within a country. The data used in the aforementioned papers, even though it was found to be highly statistically significant, has not been updated with more recent observations and the available data sources is limited to the years before 2000. As this does not fit the period of time we study, we are forced to omit the ETHNIC

variable from the regression, acknowledging the fact that this might reduce the explanatory power of the model.

7.5 The Model

We end up testing variations of the following model.

$$g_{it} = y_{it}\beta_y + a_{it}\beta_a + z'_{it}\beta_z + f_{it} + \varepsilon_{it}^{g} \quad (7.1)$$

Where i and t represent country and time respectively. y_{it} is the initial level of GDP per capita. a_{it} is the ODA parameter which will be included with one and four lags in variations of the regression. z'_{it} are exogenous variables that are assumed to affect GDP per capita growth. f_{it} represent the time and country fixed effects which will be included individually and combined in separate regressions. ε_{it}^{f} is the mean-zero error term.

7.6 Data Collection

The approach will be to examine the relationship between aid and growth based on 24 years of the most recent time series available on the LDCs. Hence, we will be using a panel of 47 countries and introduce 4 lags to ODA to capture the long-term effects of aid. The variables included in the model are specified in the variables section. All relevant data will be drawn from the World Bank Databank.

7.7 Countries Omitted

The panel we are using for this study is, as expected, an unbalanced one. The data collection process in many of the least developed countries is complicated as many of these areas have been troubled by wars and lack of stable governments with good routines for collecting data on macroeconomic factors within the country. The result is that some of the countries we aim to study lack large amounts of data on the variables included in the regression. These countries threaten to disturb the results

and the lack of data needs to be managed. It is possible to estimate the missing values applying maximum likelihood or multiple imputation estimation. However, estimating the amount of data that is missing in these cases with no guarantee that one will end up with an estimation close to the true values is risky. The other alternative that emerges is omitting the countries that lack the most data. Omitting countries does however induce risk of sample selection bias where only the most successful countries are included. Nevertheless, we believe that omitting the countries lacking the most data is less likely to weaken the model than trying to estimate the lacking values. Burnside and Dollar proposed the same solution in their widely acknowledged study (Burnside & Dollar, 2000). The countries that have the most missing values, and that we consequently believe would be unreasonable to include, are the following; Afghanistan, Djibouti, Eritrea, Mozambique, Somalia, South-Sudan (new state as of 2011), and Tuvalu. This leaves us with a panel consisting of 40 countries with observations drawn from the period 1994 to 2017.

8. Panel Data

The dataset used in this study is described as a panel. A panel dataset embodies variables that vary across both time and entity. Panel data opens for handling more complex problems and broader analysis's than what is possible with simple cross section data or time-series. Also, by combining cross-sectional data and time-series the models' number of degrees of freedom increases and by that, improving the power of the tests conducted. It also reduces the risk of problems of multicollinearity (Brooks, 2008). There are mainly three ways of conducting a panel data regression analysis. It can be done through an independently pooled OLS regression model, a fixed effects model or a random effects model.

Pooled OLS is useful when the relationship between the dependent variable and at least a few of the independent variables are constant over time. For example, when we are to analyze the impact of certain events. The advantage of using pooled OLS is that it raises only minor statistical complications. However, if we assume that the

time-varying error is uncorrelated with the independent variable, the pooled OLS can still be inconsistent and biased if an unobserved effect and the independent variable is correlated. Thus, this bias occurs when omitting a time-constant variable and a pooled OLS does not solve this problem. (Wooldridge, 2015).

The fixed effects model allows for heterogeneity or individuality among different cross sections allowing them to each have its own intercept. If the panel data consist of many entity observations and thus have too many individual intercepts, this can cause less significant estimators and few degrees of freedom. Moreover, another risk of getting less significant results can occur if too many dummies are included in the regression which can have multicollinearity. Hence, this may lead to higher standard errors. Time fixed effects control for omitted variables that are constant over time but vary across the different entities (countries in the dataset). Entity fixed effects control for omitted variables that are constant across entities but vary over time.

The random effect model or variance component model allows for heterogeneity and is time invariant. The independent variables are uncorrelated with the individual specific effects.

To choose between a fixed effect model or a random effect model a Hausman's test can be conducted on the data. The tests null hypothesis states that there are no systematic differences in the coefficients and if the null is confirmed, the random effects model is the most appropriate. If the null is rejected, i.e. there exists systematic differences in the coefficients, the fixed effect model should be used. The result of the test is that the null is rejected, hence the fixed effect model is the most appropriate for this study. This aligns with what Burnside and Dollar found most appropriate, using a similar dataset to ours. The remaining choice is between time fixed-effects or entity fixed effects model and we will include both in our analysis.

Our panel data set is unbalanced, which means that we have some cross-sectional entities that lack in parts of the observations. The countries that lacked a lot of the

data related to central parts of the regression was removed from the data set as they would not contribute to the quality of the estimation in a positive way. The statistics software we have used, Eviews, takes into account the fact that we have an unbalanced dataset and thus we are still able to use the same estimation techniques as if the panel was balanced.

This specific panel dataset consists of variables observed in 40 countries for the past 24 years (1994-2017).

8.1 Problem of Non-stationarity

A common problem in macroeconomic time-series is non-stationarity. That is, the process has a stochastic trend. For a non-stationary time-series process, shocks will have permanent effects and consequently the regression results will potentially be severely biased. Shocks in the variables should rather have transitory effects that better explains the real-world effects of a shock. Stationarity is also a required assumption for law of large numbers and the central limit theorem to hold (Nielsen, 2005).

8.2 Unit Root Test

A unit root process has permanent effects of shocks and is non-stationary. The null hypothesis of the unit root test used in Eviews is the presence of a unit root in the process and the alternate hypothesis is stationarity. The test conducted is an Augmented Dickey-Fuller test (ADF) originating from Dickey and Fullers work on unit root time-series from 1981 (Dickey & Fuller, 1981). We conducted separate unit root tests on all variables likely to have a stochastic trend. The test results show that several variables contain a unit root and this problem of seasonality needed to be addressed. The processes in question was made stationary through differencing. An operation where one computes the difference between consecutive observations. This method helps stabilizing the mean of the time-series and by so, remove trends and seasonality (Athanasopoulos, 2018). We confirmed this by conducting a second

unit root test after differencing and all variables are now stationary (test results are reported in the appendix 15.1).

9. Variables

The World Bank is the largest development institution with the goal of ending extreme poverty within 2030 and is boosting shared prosperity among the poorest by offering loans, knowledge and advice (Worldbank.org). All of our data is collected from the World Bank database known as the World Development Indicators (WDI) which was founded in 1989. For this study we have extracted the following variables from the database: GDP per capita, net ODA per capita, gross domestic savings, broad money, trade intensity, school enrollment, population growth, and gross fixed capital formation. These data are the basis of all variables included in the regression.

9.1 Current to Constant 2010 US Dollar Values

All variables will be measured in constant 2010 USD values. Most of the variables extracted from the World Bank is given in constant 2010 USD terms. If the data is reported in current USD we adjust it to constant values to make it comparable. Moreover, by converting the data to constant USD we adjust for inflation, thus we can measure the true growth of a series. To convert current values to constant values we use the consumer price index (CPI) with 2010 as basis year, multiplying it with the variable nominated in current values and then divide it by the CPI in the given year.

9.2 Gross Domestic Product

Gross Domestic product (GDP) is the monetary value of all goods and services within a country´s borders reported annually. Depreciations of fabricated asset or degradation of natural resources is not taken into account (Bank, 2019). In addition, we use lagged GDP per capita as a measure of initial level of wealth. Furthermore,

the dependent variable GDP per capita growth is defined as GDP divided by midyear population and annual percentage growth rate, respectively. They are both nominated in constant 2010 USD and we treat the variables as mentioned earlier.

9.3 Official Development Assistance

Net official development assistance (ODA) consists of grants or loans to developing countries on the DAC list of aid recipients that are undertaken by the official sector with promotion of economic development and welfare as the main objective and at concessional financial terms.

9.4 Gross Domestic Savings

Gross Domestic Savings (GDS) is calculated as GDP less final consumption expenditures. Burnside and Dollar´ used budget surplus as a variable in their study. We were not able to collect the budget surplus from any of the given countries. Thus, we will use initial GDS as a proxy for budget surplus.

9.5 Gross Fixed Capital Formation

Gross fixed capital formation (GFCF) is formerly the gross domestic fixed investment and it refers to the net increase in physical assets minus disposal. We use initial GFCF as a proxy for government investments.

9.6 Broad Money to GDP (M3)

Broad money is defined by the World Bank as the sum of currency outside banks, demand deposits other than those of the central government, the time, savings and foreign currency deposits of resident sectors other than the central government. The number is given in percentage of GDP. Due to data availability we use broad money over GDP as a proxy for financial development.

9.7 Inflation

The definition of inflation used for this study is the annualized increase in the consumer price index based on the cost to the average consumer of acquiring a basket of goods and services. It is included as it is likely to affect GDP growth. Many countries emphasize price stability. A healthy economy encompasses a low and stable increase in consumer prices. A high level of inflation is costly as it dilutes GDP and reduce the economy's efficiency (R. Barro, Kocherlakota, & Sims, 1996).

9.8 School Enrollment, Secondary (% gross)

The World Bank defines school enrollment as the gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education. School enrollment has a positive effect on economic development in a long-term perspective. Theoretically, school enrollment should affect economic growth in a negative direction as the total available labor force decreases in the short-term.

9.9 Trade (% of GDP)

Trade/GDP, also called trade intensity ratio, is calculated as the sum of exports and imports of goods and services measured as a share of gross domestic product. It is a trivial measure for openness, as it is fairly easy to calculate, and it does not consider non-tariff barriers nor the size of the economy. Moreover, large countries tend to have lower ratio because they undertake a greater share of trade within their borders. Also population and geography may distort trade openness. ("World Bank," 2019).

Warner and Sachs constructed in 1995 a trade-openness index consisting of five factors; the level of tariffs on capital goods and intermediates, the black-market premium, a socialistic government or state monopoly on major export goods. Burnside and Dollar used this index in their regression due to the fact that open economies grow faster than closed economies. Later on, as mention earlier, this

index has been found insignificant by Rodriguez and Rodrik (2000) when separating and testing each of the five factors. In this thesis trade intensity ratio will be used as a measure for trade openness.

9.10 Population Growth

Population growth is the annualized growth rate of the nation's population. The effect of population growth on GDP growth is observable but more difficult to pinpoint as the drivers behind the effects are complex. Population growth affects age structure in the population, migration, economic inequality and the size of the work force. All of which affect GDP growth within the country (Peterson, 2017).

9.11 Worldwide Governance Indicators (WGI)

To capture assumed positive effects of good policies and fewer market distortions, we have chosen to include the World Governance Indicators in the regression. By the neoclassical growth model, this should have positive implications on aid effectiveness. The WGI, which is a quite extensive World Bank project that measures the following six dimensions of governance starting in 1996; voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. These are aggregate measures based on several hundred underlying variables from diverse data sources. The World Bank describes the methodology behind these indicators in the following way;

For each of these clusters we then use a statistical methodology known as an Unobserved Components Model to (i) standardize the data from these very diverse sources into comparable units, (ii) construct an aggregate indicator of governance as a weighted average of the underlying source variables, and (iii) construct margins of error that reflect the unavoidable imprecision in measuring governance. (Mastruzzi, 2010)

To include these measures in the regression we have constructed a variable (WGI) of the average of all estimators to have a general measure of the recipient country's quality of governance. We have included this variable acknowledging the fact that these are mere estimates and not exact measures of the quality of governance in the countries we observe. Nevertheless, it is the most extensive source on governance, and it has been frequently used in recent literature. We believe that they represent the best measure of good governance in the recipient countries.

10. The Model

Table 1 - GDP and ODA summary statistics

Summary Statistics

	GDP per capita growth (percent per annum)	ODA received (percent of GDP)
All observations		
Mean	2.15	8.34
Median	2.21	5.72
Standard deviation	5.53	9.47

Notes: The descriptive statistics are based on 901 observations of the dependent variable GDP per capita growth and all 878 available observations of the endogenous variable ODA received. "All observations" are all available observations from our panel of 40 countries in the years between 1994-2017.

10.1 Multicollinearity

Ideally, we do not want to observe any correlation between the explanatory variables in the regression. This would imply that adding or removing variables would not impact the coefficient estimates of the other included variables. Such an orthogonal relationship, however, is mainly a theoretical one, as most regression analysis in practice have some correlation between the included variables. Smaller levels of correlation are acceptable as it does not lead to a severe loss of precision in the estimates. What is more problematic is when the correlation reaches very

high levels, closing in on the level of near or perfect multicollinearity. The panel structure itself help mitigating some of the problems of multicollinearity, hence it is not given that it is present in the dataset. It does not do so completely and the consequence of including two variables with these levels of correlation is that it is not possible to estimate the remaining parameters (Brooks, 2008).

Consequently, we constructed a correlation matrix (table 2) of all the data included in the model to look for potential problems related to multicollinearity.

Table 2 – Variable correlation matrix

Correlation Matrix	GDP Per Capita Growth	Log Initial GDP	Initial Gross Fix.Cap.Form.	Lag ODA (-4)	Lag Gross Dom.Sav.
GDP Per Capita Growth	1				
Log Initial GDP	0,181	1			
Initial Gross Fix.Cap.Form.	0,216	0,132	1		
Lag ODA (-4)	0,107	0,062	-0,026	1	
Lag Gross Dom.Sav.	-0,057	0,033	0,113	0,215	1
Inflation	-0,009	0,091	0,053	0,050	-0,160
M3	0,095	-0,043	0,079	0,006	0,021
Log Trade	0,219	-0,027	0,104	-0,131	-0,002
WGI	0,060	0,088	-0,130	-0,010	-0,035
School Enrollment	-0,048	-0,045	-0,054	0,031	0,141
Population Growth	-0,231	-0,219	-0,247	-0,009	-0,049

Correlation Matrix	Inflation	M3	Log Trade	WGI	School Enrollment	Population Growth
GDP Per Capita Growth						
Log Initial GDP						
Initial Gross Fix.Cap.Form.						
Lag ODA (-4)						
Lag Gross Dom.Sav.						
Inflation	1					
M3	-0,055	1				
Log Trade	0,074	-0,040	1			
WGI	-0,194	0,003	-0,036	1		
School Enrollment	-0,096	-0,030	0,041	0,154	1	
Population Growth	-0,084	-0,152	0,055	-0,048	-0,068	1

Notes: Correlation matrix for all variables included in the regression. Correlation levels exceeding 0.7 implies multicollinearity. (Data source: World Bank Databank)

A general rule of thumb for at what levels of correlation multicollinearity starts to severely distort the model estimates is at 0.7 and above (Dormann et al., 2013). It becomes evident from the correlation matrix in table 2 that there are no severe problems of multicollinearity in the data set. Correlations of 0.215 like the one between gross domestic savings and ODA is not one that needs to be addressed from a multicollinearity perspective. We can acknowledge the fact that ODA increase savings in the recipient country, which seems to be a natural assumption and it should not distort the model estimates in a dramatic way. One potential problem of multicollinearity that we encountered was from the six world governance indicators whose correlation matrix (table 3) is enclosed below.

Table 3: World Governance Indicators correlation matrix

WGI Correlation Matrix	Control of Corruption	Government Effectiveness	Political Stability	Regulatory Quality	Rule of Law	Voice and Accountability
Control of Corruption	1					
Government Effectiveness	0,770	1				
Political Stability	0,000	0,621	1			
Regulatory Quality	0,000	0,742	0,522	1		
Rule of Law	0,000	0,797	0,803	0,679	1	
Voice and Accountability	0,000	0,493	0,680	0,530	0,744	1

Notes: Correlation matrix for all World Governance Indicators. Correlation levels exceeding 0.7 imply multicollinearity. (Data source: World Bank Databank)

Several of the indicators exceed the recommended threshold of 0.7 and the lowest correlation is 0.493 which in itself is not an insignificantly low correlation seen from a multicollinearity point of view. To include these variables individually in the regression would distort the estimation results to the uninterpretable. One way of handling this issue is to create a ratio of the combined variables. This is unproblematic as long as financial theory suggests that the independent variable only lead to changes in the dependent variable individually (Brooks, 2008). We believe that a combined measure of quality of governance should work well in relation to GDP growth as the six measure are so closely related. The result is that the combined WGI indicator can be included in the regressions without the risk of multicollinearity.

10.2 Wald Test

The Hausman test concluded that a fixed effects model was most appropriate for the data set, however it only tests a fixed effect model vs. random effects model. A pooled OLS model is still an alternative that might fit the data better. Furthermore, we conducted a Wald test to conclude which model is the optimal one. The null hypothesis is that pooled OLS is appropriate and the alternative hypothesis suggesting a fixed effects specification. The test rejects H_0 and fixed effects should be used. However, we include pooled OLS as basis for comparison between models.

11. Regression Results

11.1 Long-term Effects of Aid

The results of the regressions with four lags in ODA are summarized in the table 4. All regressions are estimated using the ordinary least squared method with GDP per capita growth as the dependent variable.

Table 4 – Long-term growth regressions, 1994-2017

Estimation Method Fixed Effects	OLS(1) None	OLS(2) None	OLS(3) Time	OLS(4) Time and Country
Log intial GDP per capita	0.6043**	0.2730**	0.2758**	-0.0458
	(-3.85)	(2.05)	(2.19)	(-0.13)
Initial Gross Fix.Cap.Form.	1.09E-11**	8.35E-12**	8.00E-12**	1.23E-11**
	(-2.27)	(2.42)	(2.19)	(3.38)
Initial Gross Dom.Sav.	-0.0007**	-0.0003**	-0.0003**	-0.0009*
	(-3.61)	(-2.06)	(-2.01)	(-1.73)
Inflation	0.000284	-0.0004	-0.0007**	-0.014*
	(0.66)	(-1.33)	(-2.53)	(-1.89)
M3	0.00089	0.0009	0.0006	0.0004
	(0.86)	(1.12)	(1.37)	(0.73)
Log Trade	-0.00056	0.0013**	0.0013**	0.0009**
	(-1.44)	(4.26)	(4.14)	(2.39)
WGI	0.005225	0.005	0.0045	-0.013
	(0.73)	(0.97)	(0.0.59)	(-1.26)
School Enrollment	0.002649	-0.0012	-0.0012	-0.0012
	(1.58)	(-0.99)	(-0.82)	(-0.85)
Population Growth	-0.000918	-0.0097**	0.0099**	-0.006
	(-0.20)	(-2.95)	(-2.74)	(-0.95)
Lag ODA (-4)		0.0023**	0.0023**	0.0021**
		(2.78)	(2.86)	(2.61)
# of observations	960	960	960	960
Periods	24	24	24	24
R^2	13.8%	19.15%	26.7%	48.9%
** Significant at 5%				
* Significant at 10%				

Notes: Regressions with 4 lags in ODA. The dependent variable is real GDP growth for all regressions. Data is extracted from all 40 included countries from 1994-2017. Variable estimates are reported first and the values below in parenthesis are the t-values for significance testing. In OLS(1) ODA is excluded to control for the improvement of the model *when including it in OLS(2). Exogenous variables: Initial gross fixed capital formation and gross domestic savings serve as proxy for government investments and budget surplus respectively. Inflation is the annual increase in the country's CPI. M3 is the broad money to GDP, a measure of money supply within an economy. WGI is an index comprised of the average score on the World Bank's World Governance Indicators that works as a measure of quality of governance. School enrollment is the percentage of the population in the age group corresponding to the level of education that are currently enrolled to that level. Population growth measures the percentage rate of population growth. White's heteroscedasticity robust standard errors are applied for the estimation.*

The first model we constructed, OLS (1), is estimated using pooled OLS with no fixed effects. ODA is excluded from the initial regression to see whether the inclusion of it improves the model. The result of the Hausmans' test, as previously reported (section 8), was that a fixed effect was preferable over random effects model. We include a pooled regression as a benchmark for the fixed effects models.

Introducing ODA to the Regressions

What becomes clear from OLS(1) and OLS(2) is that the inclusion of the ODA parameter improves the model, ceteris paribus. The model R^2 increase from 0.138 to 0.1915 and ODAs' coefficient estimate is significantly positive at a 5% level.

Results From OLS(2)

For OLS(2) we observe that a country's initial level of GDP has a quite substantial positive effect on growth, significant at a 5% level. This would imply that a high level of GDP should be positively correlated with GDP growth, which is inconsistent with the convergence theory of the neoclassical growth model that states that lower income countries will have higher growth rates as they are farther off from the steady state level. One explanation is that all countries included in this regression, being on the list of LDCs, have a low initial GDP levels and there might be individual differences in growth rates. This model, without trying to, does not capture the long-term effects of income levels on growth.

Gross fixed capital formation is positive and significant at a 5% level. Gross domestic savings is found to be negative at a 5% level. The two work as proxies for investments and budget surplus respectively. These results fit economic theory in that investments should induce growth directly. Government savings increase capital availability for firms and lead to GDP growth through increased value creation at a firm level, however the effect on GDP is more of a long-term issue and we would not expect to see positive short-term effects of savings.

The trade intensity ratio is also positive and significant at a 5% level which is not surprising as an open economy has access to and make use of the international markets. Population growth has a significant positive effect on the dependent variable which can be related to the positive effects of an increased active workforce.

The expectations for the remaining variables was that inflation would have a negative impact as a GDP deflator, money supply (M3) to be positive as an enabler for investment, WGI should be positive as good governance could lead to more effective use of money and finally school enrollment to have a short-term negative impact of people taken out of the workforce. None of these variables however, were significant at any level in this initial pooled OLS regression.

Finally, ODA with four lags is found to have a positive effect on economic growth and the result is statistically significant at a 5% level. The R^2 of the OLS(2) is 0.1915.

Results From OLS(3)

For OLS(3) we introduced time fixed effects as suggested by the Hausmans' test. The coefficient estimates remain close to identical to those of OLS(2) and all variables, including ODA, that were statistically significant in the first regression remain at the same significance levels. However, the inflation estimate is negative and now significant at a 5% level. This is the expected effect from inflation on GDP as it can be described as a GDP deflator. The R^2 of this third model is 0.267 which may imply that introducing fixed time effects to the model has improved its goodness of fit.

Results From OLS(4)

In OLS(4) fixed country effects were included alongside the fixed time effects in OLS(3). When controlling for both these effects, the regression results deviate more from what we previously observed. Initial GDP is no longer significant at any level,

neither is population growth. Money supply, WGI and school enrollment remain insignificant as in the previous models. Gross fixed capital formation and trade intensity ratio have similar coefficients as before and remain significant at a 5% level. Gross domestic savings and inflation are still negative at a 10% level. ODA remains significant at a 5% level and it seems we are able to observe a consistent pattern of a positive relationship between ODA and GDP growth across variations of model specifications. The R^2 of OLS(4) is 0.489 which may seem like a drastic improvement up from OLS(3). R^2 increases with the number of independent variables. Consequently, adding country fixed effects will lead to a drastic increase in R^2 regardless of the model improvement.

11.2 Short-term Effects of Aid

To confirm the assumptions of aid having a positive long-term impact and to also analyze the short-term effects of aid on economic growth we have conducted the same regressions as before substituting ODA with four-time lags with a one lag ODA parameter. We will focus on the ODA parameter in these regressions as well as the quality of the model compared to the long-term effect models reported earlier. The results of said regressions are summarized in table 5.

Table 5 – Short-term growth regressions, 1994-2017

Estimation Method Fixed Effects	OLS(5) None	OLS(6) Time	OLS(7) Time and Country
Log intial GDP per capita	0.5476**	0.5213**	0.4175**
	(3.42)	(2.91)	(2.05)
Initial Gross Fix.Cap.Form.	1.13E-11**	1.13E-11**	1.11E-11**
	(2.38)	(2.74)	(3.32)
Initial Gross Dom.Sav.	-0.0008**	-0.0008*	-0.0040**
	(-3.94)	(-1.67)	(-5.53)
Inflation	0.0003	-2.42E-05	-0.0010**
	(0.75)	(-0.05)	(-2.12)
M3	0.0009	0.0008	-0.0007
	(0.88)	(1.11)	(-0.88)
Log Trade	-0.0005	-0.0005	0.0005
	(-1.23)	(-0.64)	(1.01)
WGI	0.005	0.0055	0.0108
	(0.69)	(0.73)	(0.74)
School Enrollment	0.0026	0.0028	-0.0012
	(1.54)	(0.86)	(-0.68)
Population Growth	-0.001	-0.0013	0.0176*
	(-0.22)	(-0.21)	(-1.68)
Lag ODA (-1)	-0.0021*	-0.0019	0.0002
	(-1.75)	(-1.54)	(0.22)
# of observations	960	960	960
Periods	24	24	24
R^2	14.9%	21.3%	61.5%
** Significant at 5%			
* Significant at 10%			

Notes: Regressions with 1 lag in ODA. The dependent variable is real GDP growth for all regressions. Data is extracted from all 40 included countries from 1994-2017. Variable estimates are reported first and the values below in parenthesis are the t-values for significance testing.). Exogenous variables: Initial gross fixed capital formation and gross domestic savings serve as proxy for government investments and budget surplus respectively. Inflation is the annual increase in the country's CPI. M3 is the broad money to GDP, a measure of money supply within an economy. WGI is an index comprised of the average score on the World Bank's World Governance Indicators that works as a measure of quality of governance. School enrollment is the percentage of the population in the age group corresponding to the level of education that are currently enrolled to that level. Population growth measures the percentage rate of population growth. White's heteroscedasticity robust standard errors are applied for the estimation.

Results From OLS(5)

OLS(5) is the exact same model as OLS(2) except for the ODA parameter which now is lagged only one period. For the short-term aid parameter, we now observe a negative relationship with GDP growth, and it is significant at a 10% level.

Results From OLS(6)

The ODA estimate remains negative in in OLS(6) as fixed time effects are added. However, the result is only significant at a 15% level which is rather weak. The R^2 is 0.213. Higher than OLS(5), but lower than the corresponding regression with 4 lags in ODA, OLS(3).

Results From OLS(7)

For the time and country fixed effects model, ODA ends up not being statistically significant at any level. Population growth become positive and significant at a 10% level and inflation is negative and significant at a 5% level. The model R^2 is 0.615.

12. Interpretation of Results

The results of OLS (2-4) indicate long-term positive effects of aid on GDP growth that are robust for various model specifications. There are logical explanations for why the effects of aid are realized over a longer time period . The DAC presented statistics on "AID by Major Purposes" in 2017 (OECD, 2017) and it provides intuition on why the observable effects are positive in the long-term. The three areas that received the largest piece of all ODA in 2017 were social and administrative, economic infrastructure and humanitarian aid. Accumulated, these three purposes received 64.5% of all ODA allocated that year. All of these and several of the others on the list, which is enclosed in its full extent in appendix section 15.2, are more likely to have long-term effects on growth rather than instant impact. Hence, the

allocation of ODA seems to be aimed at sustaining long-term growth which again aligns with the goals of the UN.

However, we should be careful drawing conclusions from this. As mentioned previously, being forced to omit seven countries incurs the risk of sample selection bias. Whereas only the most successful countries are included in the study, this may lead to overoptimistic estimates for ODA. We will not discuss this issue further, but it is necessary to acknowledge the fact that it might affect the results.

The results of ODA (5-7) concerning the short-term effect of aid. The negative short-term effect can be related to the real exchange rate problem commonly known as the Dutch Disease of aid inflows (Rajan, 2005b). The theory states that the vast amount of money being poured into the economy at once, drive up the nominal interest rate which leads to a loss of competitiveness in the country's' traded goods sector.

Another interpretation of the negative short-term effects is the timing of aid. Foreign aid in the ODA definition includes aid in times of crisis and not only aid for development. Many of the countries in this study has over the time period we observe been subject to humanitarian and environmental crises, resulting in a vast increase in aid allocated that year but at the same time causing GDP growth to stagnate. One example is the earthquake that hit Haiti in 2010 causing over 200 000 deaths and severe destruction of the country's infrastructure. That year net ODA (% of GDP) went from 15% in 2009 to 46.4% in 2010. GDP per capita growth on the other hand was negative 6.9%. Hence, the regression model may give negative estimates of the effect of aid, when it in fact is due to circumstances like a natural disaster.

Furthermore, ODA does not incorporate Foreign Direct Investments (FDI) which by definition is a form of aid that lead to a faster increase in GDP through creation of jobs, development of technology and increase in the nations' productivity. Hence, it is important to emphasize that this study does not draw conclusions on all of development aid, merely one definition of it. Again, it confirms that ODA is

aimed at sustained long-term economic growth and crisis management rather than short-term GDP growth.

13. Conclusion

To conclude this master thesis, we will respond to the question that provide the basis of our research. Can foreign aid (ODA) effectively contribute to the UNs sustainable development goal for economic growth in the least developed countries? The answer that emerges from this study is yes. The 8th goal of sustainable development aims at achieving sustained economic growth in the least developed countries. With long-term growth in mind, we find that ODA give highly significant positive contributions. The short-term negative effects can be explained logically and the do not offset the positive effects that we observe over a four-year time period.

We believe that the unambiguous results from the long-term analysis may indicate that the ODA is more effectively distributed now than it has been in the previous decades. We believe that years of research on how aid is most effectively used from a growth perspective has led to it becoming a more effective tool in sustaining economic growth.

The effectiveness of foreign aid can be measured through many different metrics and the results depend on the measure and how one defines foreign aid. In addition, there are other non-economic arguments in favor of ODA such as solidarity, inequality and the fact that ODA can enhance human freedom.

Although aid undisputedly works at a micro-level and in times of immediate crisis, its ability to contribute to sustained economic growth still is a question without a definite answer. The findings in this study are encouraging, and aid seems to work in the current macroeconomic landscape. We believe that more emphasis should be

put on finding the most effective use of foreign aid to support the UNs SDGs for economic growth and we encourage further research into this question.

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15. Appendix

15.1 *Test Results – Augmented Dickey-Fuller Unit Root Tests*

ADF - Fisher Chi-square				
	Statistic	Prob.	Cross-sections	Observations
GDPPCG	237.998	0.0000	40	821
ODA	48.2141	0.9981*	40	796
GFC Formation	22.7327	1.0000*	30	544
Log Initial GDP	54.9421	0.9855*	40	821
Trade	78.6935	0.3936	38	774
M3	58.0036	0.9562*	39	758
School Enrollment	24.1666	0.9997*	26	339
Inflation	327.139	0.0000	40	858
GDS	113.755	0.0021	37	696
WGI	952.214	0.0000	40	880
Population Growth	575.159	0.0000	40	880

* Non-stationary series

Notes: ADF tests under the null hypothesis that there is no unit root in the data series. Prob. close to 1 implies a unit root present and non-stationarity.

15.2 DAC List of Aid by Major Purposes in 2017

Aid by Major Purposes in 2017

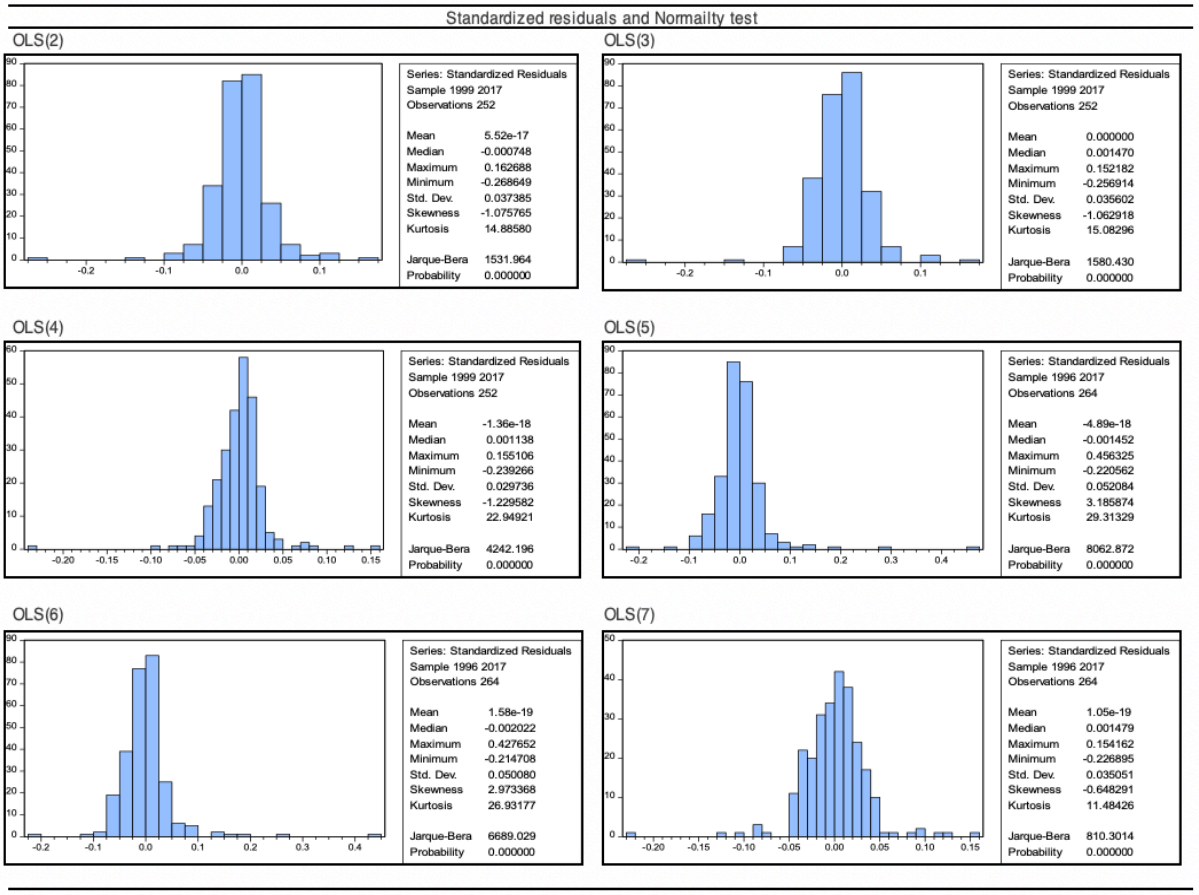
Purpose	ODA % of Total
Action relating to debt c	0,33
Other and unspecified	0,54
Trade and tourism	0,67
Industry, mining and construction	1,07
Other social infrastructure	1,83
of which: Basic education	1,84
Other	2,79
Programme assistance	2,89
of which: Basic health	3,06
Water supply and sanitation	4,17
Health	4,77
Agriculture, forestry and fishing	5,11
Energy	5,92
Administrative expenses	5,96
Population b	6,18
Production	6,85
Education a	7,19
Multisector	7,93
Transport and communications	8,39
Government and civil society	9,97
Refugees in donor countries	10,98
Humanitarian aid	13,31
Economic infrastructure	17,09
Social and administrative infrastructure	34,12
TOTAL	**100,00**

15.3 Test Results – Durbin-Watson Autocorrelation Test

Autocorrelation - Durbin-Watson test	
	DW Value
OLS(2)	2.006
OLS(3)	1.937
OLS(4)	2.283
OLS(5)	1.485
OLS(6)	1.491
OLS(7)	2.263

Notes: DW value around 2 implies no residual autocorrelation.
Values between approximately 1.5 and 2.5 is acceptable.

15.4 Standardized Residual Histogram, Descriptive Statistics and Normality Tests



Notes: Residual histogram and normality test. Prob. of 0 indicates normally distributed standard errors.

15.5 White's Heteroscedasticity Test

OLS(2)

Dependent Variable: RESID^2
Method: Panel Least Squares
Date: 06/04/19 Time: 11:06
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000799	0.000693	-1.152918	0.2501
DLOGINITIALGDP^2	1.069668	0.196387	5.446729	0.0000
LGDS^2	3.25E-06	3.67E-07	8.837843	0.0000
DGFCFORMATION^2	-4.97E-23	1.10E-22	-0.451012	0.6524
INFLATION^2	-1.14E-06	1.54E-06	-0.743203	0.4581
DM3^2	-4.31E-06	6.83E-06	-0.631986	0.5280
L4DODA^2	-1.13E-05	4.12E-06	-2.751347	0.0064
POPULATIONGROWTH^2	0.000128	7.36E-05	1.734788	0.0841
DSCHOOLENROLLMENT^2	-3.40E-05	2.80E-05	-1.212646	0.2265
DLTRADE^2	-2.84E-06	2.15E-06	-1.319070	0.1884
WGI^2	0.000224	0.000386	0.579080	0.5631

R-squared	0.360632	Mean dependent var	0.001393
Adjusted R-squared	0.334102	S.D. dependent var	0.005207
S.E. of regression	0.004249	Akaike info criterion	-8.041461
Sum squared resid	0.004352	Schwarz criterion	-7.887399
Log likelihood	1024.224	Hannan-Quinn criter.	-7.979470
F-statistic	13.59346	Durbin-Watson stat	2.090365
Prob(F-statistic)	0.000000		

OLS(3)

Dependent Variable: RESID^2
Method: Panel Least Squares
Date: 06/04/19 Time: 10:58
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000861	0.027939	0.030825	0.9754
DLOGINITIALGDP^2	1.016869	0.185747	5.474473	0.0000
LGDS^2	3.00E-06	3.44E-07	8.719764	0.0000
DGFCFORMATION^2	-1.08E-23	1.05E-22	-0.102884	0.9181
INFLATION^2	-1.01E-06	1.44E-06	-0.700457	0.4844
DM3^2	-4.14E-06	6.39E-06	-0.647678	0.5179
L4DODA^2	-9.95E-06	3.90E-06	-2.549900	0.0114
POPULATIONGROWTH^2	9.77E-05	6.91E-05	1.414345	0.1587
DSCHOOLENROLLMENT^2	-3.99E-05	2.65E-05	-1.505491	0.1336
DLTRADE^2	-2.25E-06	2.05E-06	-1.102048	0.2716
WGI^2	0.000154	0.000362	0.423707	0.6722
YR2-24	6.12E-05	0.001165	0.052489	0.9582

Effects Specification

Period fixed (dummy variables)

R-squared	0.405944	Mean dependent var	0.001262
Adjusted R-squared	0.328342	S.D. dependent var	0.004747
S.E. of regression	0.003890	Akaike info criterion	-8.149249
Sum squared resid	0.003360	Schwarz criterion	-7.729079
Log likelihood	1056.805	Hannan-Quinn criter.	-7.980181
F-statistic	5.231100	Durbin-Watson stat	2.119138
Prob(F-statistic)	0.000000		

OLS(4)

Dependent Variable: RESID^2
Method: Panel Least Squares
Date: 06/04/19 Time: 11:04
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009339	0.024812	0.376383	0.7070
DLOGINITIALGDP^2	0.450541	0.180669	2.493734	0.0135
LGDS^2	1.82E-06	9.13E-07	1.996401	0.0473
DGFCFORMATION^2	8.46E-23	1.14E-22	0.740936	0.4596
INFLATION^2	-8.12E-07	1.48E-06	-0.548635	0.5839
DM3^2	-2.11E-07	5.91E-06	-0.035694	0.9716
L4DODA^2	1.36E-06	5.00E-06	0.272430	0.7856
POPULATIONGROWTH^2	9.09E-05	0.000130	0.701290	0.4840
DSCHOOLENROLLMENT^2	-8.21E-05	2.46E-05	-3.339513	0.0010
DLTRADE^2	-6.63E-06	2.19E-06	-3.027237	0.0028
WGI^2	-0.000339	0.001113	-0.305032	0.7607
YR2-24	0.000369	0.001036	0.356316	0.7220

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.483385	Mean dependent var	0.000881
Adjusted R-squared	0.338417	S.D. dependent var	0.004134
S.E. of regression	0.003363	Akaike info criterion	-8.358964
Sum squared resid	0.002216	Schwarz criterion	-7.574647
Log likelihood	1109.230	Hannan-Quinn criter.	-8.043371
F-statistic	3.334415	Durbin-Watson stat	2.538876
Prob(F-statistic)	0.000000		

OLS(5)

Dependent Variable: RESID^2
Method: Panel Least Squares
Date: 06/04/19 Time: 11:10
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000799	0.000693	-1.152918	0.2501
DLOGINITIALGDP^2	1.069668	0.196387	5.446729	0.0000
LGDS^2	3.25E-06	3.67E-07	8.837843	0.0000
DGFCFORMATION^2	-4.97E-23	1.10E-22	-0.451012	0.6524
INFLATION^2	-1.14E-06	1.54E-06	-0.743203	0.4581
DM3^2	-4.31E-06	6.83E-06	-0.631986	0.5280
L4DODA^2	-1.13E-05	4.12E-06	-2.751347	0.0064
POPULATIONGROWTH^2	0.000128	7.36E-05	1.734788	0.0841
DSCHOOLENROLLMENT^2	-3.40E-05	2.80E-05	-1.212646	0.2265
DLTRADE^2	-2.84E-06	2.15E-06	-1.319070	0.1884
WGI^2	0.000224	0.000386	0.579080	0.5631

R-squared	0.360632	Mean dependent var	0.001393
Adjusted R-squared	0.334102	S.D. dependent var	0.005207
S.E. of regression	0.004249	Akaike info criterion	-8.041461
Sum squared resid	0.004352	Schwarz criterion	-7.887399
Log likelihood	1024.224	Hannan-Quinn criter.	-7.979470
F-statistic	13.59346	Durbin-Watson stat	2.090365
Prob(F-statistic)	0.000000		

OLS(6)

Dependent Variable: RESID^2
Method: Panel Least Squares
Date: 06/04/19 Time: 11:12
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000861	0.027939	0.030825	0.9754
DLOGINITIALGDP^2	1.016869	0.185747	5.474473	0.0000
LGDS^2	3.00E-06	3.44E-07	8.719764	0.0000
DGFCFORMATION^2	-1.08E-23	1.05E-22	-0.102884	0.9181
INFLATION^2	-1.01E-06	1.44E-06	-0.700457	0.4844
DM3^2	-4.14E-06	6.39E-06	-0.647678	0.5179
L4DODA^2	-9.95E-06	3.90E-06	-2.549900	0.0114
POPULATIONGROWTH^2	9.77E-05	6.91E-05	1.414345	0.1587
DSCHOOLENROLLMENT^2	-3.99E-05	2.65E-05	-1.505491	0.1336
DLTRADE^2	-2.25E-06	2.05E-06	-1.102048	0.2716
WGI^2	0.000154	0.000362	0.423707	0.6722
YR2-24	6.12E-05	0.001165	0.052489	0.9582

Effects Specification

Period fixed (dummy variables)

R-squared	0.405944	Mean dependent var	0.001262
Adjusted R-squared	0.328342	S.D. dependent var	0.004747
S.E. of regression	0.003890	Akaike info criterion	-8.149249
Sum squared resid	0.003360	Schwarz criterion	-7.729079
Log likelihood	1056.805	Hannan-Quinn criter.	-7.980181
F-statistic	5.231100	Durbin-Watson stat	2.119138
Prob(F-statistic)	0.000000		

OLS(7)

Dependent Variable: RESID^2
Method: Panel Least Squares
Date: 06/04/19 Time: 11:13
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009339	0.024812	0.376383	0.7070
DLOGINITIALGDP^2	0.450541	0.180669	2.493734	0.0135
LGDS^2	1.82E-06	9.13E-07	1.996401	0.0473
DGFCFORMATION^2	8.46E-23	1.14E-22	0.740936	0.4596
INFLATION^2	-8.12E-07	1.48E-06	-0.548635	0.5839
DM3^2	-2.11E-07	5.91E-06	-0.035694	0.9716
L4DODA^2	1.36E-06	5.00E-06	0.272430	0.7856
POPULATIONGROWTH^2	9.09E-05	0.000130	0.701290	0.4840
DSCHOOLENROLLMENT^2	-8.21E-05	2.46E-05	-3.339513	0.0010
DLTRADE^2	-6.63E-06	2.19E-06	-3.027237	0.0028
WGI^2	-0.000339	0.001113	-0.305032	0.7607
YR2-24	0.000369	0.001036	0.356316	0.7220

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.483385	Mean dependent var	0.000881
Adjusted R-squared	0.338417	S.D. dependent var	0.004134
S.E. of regression	0.003363	Akaike info criterion	-8.358964
Sum squared resid	0.002216	Schwarz criterion	-7.574647
Log likelihood	1109.230	Hannan-Quinn criter.	-8.043371
F-statistic	3.334415	Durbin-Watson stat	2.538876
Prob(F-statistic)	0.000000		

Notes: White's test conducted using the squared residuals of each regression as dependent variable. Level of significance exceeding 0.05 implies heteroscedastic standard errors.

15.6 Residual Endogeneity Test and Wald's Test for Residual Coefficients = 0

OLS1
Dependent Variable: GDPPCG
Method: Panel Least Squares
Date: 06/04/19 Time: 15:48
Sample (adjusted): 1996 2017
Periods included: 22
Cross-sections included: 28
Total panel (unbalanced) observations: 265

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.012542	0.367837	0.034096	0.9728
DLOGINITIALGDP	0.604343	0.157088	3.847159	0.0002
LGDS	-0.000725	0.000201	-3.613076	0.0004
DGFCFORMATION	1.09E-11	4.80E-12	2.274246	0.0238
INFLATION	0.000284	0.000430	0.660169	0.5097
DM3	0.000890	0.001040	0.855572	0.3930
POPULATIONGROWTH	-0.000909	0.004518	-0.201238	0.8407
DSCHOOLENROLLMENT	0.002649	0.001684	1.572986	0.1170
DLTRADE	-0.000560	0.000389	-1.441553	0.1507
WGI	0.005226	0.007151	0.730759	0.4656
YR2-24	-0.000593	0.015313	-0.038702	0.9692

R-squared	0.138145	Mean dependent var	0.028933
Adjusted R-squared	0.104214	S.D. dependent var	0.056346
S.E. of regression	0.053330	Akaike info criterion	-2.984024
Sum squared resid	0.722390	Schwarz criterion	-2.835431
Log likelihood	406.3832	Hannan-Quinn criter.	-2.924322
F-statistic	4.071309	Durbin-Watson stat	1.476071
Prob(F-statistic)	0.000033		

OLS2
Dependent Variable: GDPPCG
Method: Panel Least Squares
Date: 06/04/19 Time: 15:50
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.053869	0.010521	5.120231	0.0000
DLOGINITIALGDP	0.273007	0.133091	2.051284	0.0413
LGDS	-0.000317	0.000154	-2.064295	0.0401
DGFCFORMATION	8.35E-12	3.44E-12	2.427800	0.0159
INFLATION	-0.000423	0.000318	-1.330520	0.1846
DM3	0.000852	0.000758	1.124999	0.2617
L4DODA	0.002343	0.000841	2.785165	0.0058
POPULATIONGROWTH	-0.009669	0.003287	-2.941267	0.0036
DSCHOOLENROLLMENT	-0.001247	0.001265	-0.985926	0.3252
DLTRADE	0.001316	0.000309	4.256890	0.0000
WGI	0.005043	0.005180	0.973464	0.3313

R-squared	0.191488	Mean dependent var	0.025511
Adjusted R-squared	0.157940	S.D. dependent var	0.041589
S.E. of regression	0.038164	Akaike info criterion	-3.651204
Sum squared resid	0.351005	Schwarz criterion	-3.497142
Log likelihood	471.0517	Hannan-Quinn criter.	-3.589213
F-statistic	5.707854	Durbin-Watson stat	2.009257
Prob(F-statistic)	0.000000		

OLS3
Dependent Variable: GDPPCG
Method: Panel Least Squares
Date: 06/04/19 Time: 15:51
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252
White period standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.187991	0.221593	0.848363	0.3971
DLOGINITIALGDP	0.275818	0.125920	2.190427	0.0295
LGDS	-0.000357	0.000359	-0.995143	0.3208
DGFCFORMATION	8.00E-12	3.66E-12	2.187590	0.0297
INFLATION	-0.000764	0.000301	-2.538639	0.0118
DM3	0.000611	0.000446	1.370766	0.1718
L4DODA	0.002319	0.000810	2.863215	0.0046
POPULATIONGROWTH	-0.009900	0.003614	-2.739119	0.0067
DSCHOOLENROLLMENT	-0.001204	0.001461	-0.824264	0.4107
DLTRADE	0.001325	0.000320	4.139821	0.0000
WGI	0.004545	0.007644	0.594636	0.5527
YR2-24	0.005472	0.009138	0.598852	0.5499

Effects Specification

Period fixed (dummy variables)

R-squared	0.267198	Mean dependent var	0.025511
Adjusted R-squared	0.171472	S.D. dependent var	0.041589
S.E. of regression	0.037856	Akaike info criterion	-3.598731
Sum squared resid	0.318137	Schwarz criterion	-3.178561
Log likelihood	483.4401	Hannan-Quinn criter.	-3.429663
F-statistic	2.791273	Durbin-Watson stat	1.936895
Prob(F-statistic)	0.000011		

OLS4
Dependent Variable: GDPPCG
Method: Panel Least Squares
Date: 06/04/19 Time: 15:52
Sample (adjusted): 1999 2017
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 252
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.172374	0.208968	0.824885	0.4104
DLOGINITIALGDP	-0.045778	0.361191	-0.126742	0.8993
LGDS	-0.000875	0.000631	-1.386807	0.1671
DGFCFORMATION	1.23E-11	3.63E-12	3.386058	0.0009
INFLATION	-0.001376	0.000728	-1.890547	0.0602
DM3	0.000445	0.000607	0.732613	0.4647
L4DODA	0.002080	0.000796	2.614816	0.0096
POPULATIONGROWTH	-0.005981	0.006244	-0.957933	0.3393
DSCHOOLENROLLMENT	-0.001172	0.001383	-0.847073	0.3980
DLTRADE	0.000888	0.000370	2.397776	0.0174
WGI	-0.013019	0.010361	-1.256553	0.2104
YR2-24	0.005218	0.008739	0.597121	0.5511

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.488781	Mean dependent var	0.025511
Adjusted R-squared	0.345327	S.D. dependent var	0.041589
S.E. of regression	0.033650	Akaike info criterion	-3.752458
Sum squared resid	0.221939	Schwarz criterion	-2.968141
Log likelihood	528.8097	Hannan-Quinn criter.	-3.436865
F-statistic	3.407223	Durbin-Watson stat	2.282976
Prob(F-statistic)	0.000000		

OLS5

Dependent Variable: GDPPCG
Method: Panel Least Squares
Date: 06/04/19 Time: 15:54
Sample (adjusted): 1996 2017
Periods included: 22
Cross-sections included: 28
Total panel (unbalanced) observations: 264

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.029014	0.014262	2.034369	0.0430
DLOGINITIALGDP	0.546763	0.159917	3.419052	0.0007
LGDS	-0.000811	0.000206	-3.940329	0.0001
DGFCFORMATION	1.13E-11	4.76E-12	2.384716	0.0178
INFLATION	0.000322	0.000430	0.749525	0.4542
DM3	0.000916	0.001038	0.881979	0.3786
L1DODA	-0.002080	0.001186	-1.753503	0.0807
POPULATIONGROWTH	-0.001009	0.004521	-0.223136	0.8236
DSCHOOLENROLLMENT	0.002584	0.001678	1.539421	0.1250
DLTRADE	-0.000480	0.000390	-1.230914	0.2195
WGI	0.004976	0.007188	0.692318	0.4894

R-squared	0.148601	Mean dependent var	0.028934
Adjusted R-squared	0.114949	S.D. dependent var	0.056453
S.E. of regression	0.053110	Akaike info criterion	-2.992135
Sum squared resid	0.713626	Schwarz criterion	-2.843137
Log likelihood	405.9618	Hannan-Quinn criter.	-2.932263
F-statistic	4.415792	Durbin-Watson stat	1.482917
Prob(F-statistic)	0.000010		

OLS6

Dependent Variable: GDPPCG
Method: Panel Least Squares
Date: 06/04/19 Time: 15:53
Sample (adjusted): 1996 2017
Periods included: 22
Cross-sections included: 28
Total panel (unbalanced) observations: 264
White period standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.055028	0.252569	0.217873	0.8277
DLOGINITIALGDP	0.521315	0.179230	2.908640	0.0040
LGDS	-0.000796	0.000517	-1.541497	0.1246
DGFCFORMATION	1.13E-11	4.14E-12	2.740056	0.0066
INFLATION	-2.42E-05	0.000547	-0.044253	0.9647
DM3	0.000834	0.000749	1.113799	0.2665
L1DODA	-0.001902	0.001642	-1.158582	0.2478
POPULATIONGROWTH	-0.001309	0.006107	-0.214267	0.8305
DSCHOOLENROLLMENT	0.002766	0.003199	0.864495	0.3882
DLTRADE	-0.000524	0.000827	-0.633875	0.5268
WGI	0.005548	0.009811	0.565471	0.5723
YR2-24	0.000954	0.010483	0.090959	0.9276

Effects Specification

Period fixed (dummy variables)

R-squared	0.213043	Mean dependent var	0.028934
Adjusted R-squared	0.104027	S.D. dependent var	0.056453
S.E. of regression	0.053437	Akaike info criterion	-2.904176
Sum squared resid	0.659612	Schwarz criterion	-2.457182
Log likelihood	416.3512	Hannan-Quinn criter.	-2.724560
F-statistic	1.954239	Durbin-Watson stat	1.490684
Prob(F-statistic)	0.002649		

OLS7

Dependent Variable: GDPPCG
Method: Panel Least Squares
Date: 06/04/19 Time: 15:54
Sample (adjusted): 1996 2017
Periods included: 22
Cross-sections included: 28
Total panel (unbalanced) observations: 264
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.190196	0.241248	0.788384	0.4314
DLOGINITIALGDP	0.417578	0.360621	1.157941	0.2482
LGDS	-0.003987	0.000721	-5.530192	0.0000
DGFCFORMATION	1.11E-11	3.35E-12	3.319443	0.0011
INFLATION	-0.000968	0.000760	-1.273120	0.2044
DM3	-0.000672	0.000764	-0.879942	0.3799
L1DODA	0.000229	0.001036	0.221281	0.8251
POPULATIONGROWTH	0.017597	0.010448	1.684222	0.0937
DSCHOOLENROLLMENT	-0.001169	0.001719	-0.680347	0.4971
DLTRADE	0.000457	0.000452	1.011099	0.3132
WGI	0.010819	0.014556	0.743263	0.4582
YR2-24	0.006294	0.010119	0.621944	0.5347

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.614515	Mean dependent var	0.028934
Adjusted R-squared	0.503026	S.D. dependent var	0.056453
S.E. of regression	0.039798	Akaike info criterion	-3.413301
Sum squared resid	0.323106	Schwarz criterion	-2.600585
Log likelihood	510.5557	Hannan-Quinn criter.	-3.086727
F-statistic	5.511918	Durbin-Watson stat	2.262794
Prob(F-statistic)	0.000000		

Notes: Residual endogeneity test conducted by including variable residuals as independent variable. Prob. levels below 0.05 implies variable endogeneity. Results confirmed with Wald's test of residual estimator = 0. F-test prob. below 0.05 implies variable endogeneity.