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Chair: Econometrics II

Economic Rents, Institutions and Growth

International Aid and Natural Resources: a Comparative Analysis

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Abstract

The aim of this study is to investigate to what extent foreign aid rents and natural resource rents can be compared with respect to their impact on economic growth. For this purpose, the direct impact of both economic rents on GDP growth, as well as their impact conditional on the quality of the institutional environment is assessed in cross-country and panel contexts. A natural resource curse is indeed identified in countries with poor institutional quality, however results regarding the impact of international aid rents are ambiguous.

Key words: Aid, Natural Resources, Institutions, Growth.

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List of acronyms and abbreviations

CIA	Central Intelligence Agency
DAC	Development Assistance Committee
e.g.	exempli gratia
FE	Fixed Effects
FOC	First Order Condition
ICRG	International Country Risk Guide
GDP	Gross Domestic Product
i.e.	id est
IQ	Institucional Quality
IV	Instrumental Variable
NR	Natural Resources
ODA	Official Development Aid
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PRS	Political Risk Service
UN	United Nations
WB	World Bank
2SLS	Two Stage Least Squares

List of exhibits

1 Introduction

1.1 Rationale

Gross Domestic Product (GDP) varies widely across countries.[1] Actually, the highest GDP per capita value achieved by a country in 2010 is more than 500 times the lowest one.[2] This huge gap poses serious concerns bearing in mind that GDP is often seen as the most representative measure of economic development. Particularly, GDP growth is linked to progress and prosperity, while its decline is connected to stagnation and poverty. The study of the roots of economic growth is therefore of utmost importance, and constitutes a classical area of research in economics.

As a result of years of investigation, nowadays institutions are thought to play a crucial role in determining economic growth. They are believed to influence economic outcomes through the structuring of economic incentives in the society.[3] Hence, several areas in economics are taking a political and institutional approach to economic growth. Among them, the natural resource curse and the aid effectiveness topics, that are the focus of this study.

With regards to natural resources, their discovery and exploitation has had perverse effects on the economic growth of several countries worldwide over the past decades. These effects were at first explained relying on an economic resource curse, i.e. the

[1] Refer to Appendix 1 for a graph plotting GDP per capita over the years under study for the various regions in the world.

[2] The data on GDP per capita (expressed in current US$) has been retrieved from the World Bank (WB). The richest country in terms of GDP per capita in 2010 is Luxembourg and the poorest Burundi.

[3] See Acemoglu, Johnson and Robinson (2005)

Dutch Disease.[4] More recently, albeit not rejecting the Dutch Disease hypothesis, there has been a turn to a political resource curse that is in fact supported by evidence, being the two main findings in the literature that resource rich countries on average do tend to grow slower, but this undesired effect can nevertheless be overcome in a good institutional environment.

Actually, the first, and very influential, study concerning the impact of natural resource rents on economic growth, presented in Sachs and Warner (1995), accounted for a negative effect of the former on the later, which the authors explained relying on a Dutch Disease mechanism. Later on though, in Mehlum Moene an Torvik (2006), it was presented compelling evidence of the importance of the institutional environment as a determinant of the effect natural resource rents have on economic growth. Also, along with the empirical analysis, the authors presented a rent-seeking model explaining the dynamics that lay behind their results, approach that opened the way for the appearance of political economy models.

The aid effectiveness literature, in turn, provides less homogeneous results. In fact, decades ago international aid programmes started to be carried out, without any convincing empirical or theoretical foundation and still nowadays, there is no compelling evidence of their growth enhancing potential or traceable benefits.

Nonetheless, the aid effectiveness literature is very vast having gained a new impetus in Boone (1996) with the author documenting that foreign aid inflows had no impact on

[4] The Dutch Disease is a theory that associates negative repercussions to the non-resource sector from a boom in the natural resources sector. It works as follows: a boom in the resource sector leads to the appreciation of the real exchange rate, which in turn causes a loss of competitiveness of the non-resource sector and its shrinkage. This does not simply reflect a shift of a country's comparative advantage due to the fact that the Dutch Disease relies on the assumption that the resource sector lacks the learning-by-doing mechanism existent in the manufacturing sector, resulting no positive externalities therefrom.

economic growth. In support of his findings the author proposed a political economy model where the ineffectiveness of aid rents was explained by its transference to a high-income political elite. Similarly to the path taken in the natural resource curse literature, also the impact of aid inflows conditional on external factors was analysed. First in Burnside and Dollar (2000), and subsequently in Burnside and Dollar (2004), the impact of aid inflows conditional on policy and institutional environment, respectively, was assessed. Both studies presented evidence of a positive impact of aid inflows on economic growth when coupled either with good policies or good institutions. These results were severely criticized and put to tests that often undermined their robustness. The effectiveness of foreign aid inflows is therefore still a topic open to discussion that does not appear that will be settled in the near future, in part due to the huge implications that can be derived, which should not be taken lightly.

Thus, providing either more, or rather less sharp results, the existence of a vast literature on the macroeconomic effects of both economic rents is undeniable. Furthermore, there is the emergence of a literature comparing aid rents to natural resource rents. Notwithstanding the important differences between them, natural resource rents and foreign aid share in fact two crucial aspects; they are both fungible and have a windfall character, i.e. provide extra revenues to an economy. In this study it is hypothesized that whatever negative impact these extra revenues have, it is a result of the interaction between the rents and the local institutional arrangements.[5] Specifically this comparative analysis tries to answer two questions, in light of the evidence supporting the existence of the natural resource curse: what is the impact of aid on economic

[5] Refer to Appendix 3 for two graphs plotting for every country in the analysis the growth rate of GDP versus the percentage of aid rents to GDP as well as versus the percentage of natural resource rents to GDP.

growth and whether this impact depends on the institutional environment. Multiple regression (MR), Fixed Effects (FE) regression, and Instrumental Variable (IV) regression models are the empirical methods employed in order to answer the above questions. For the purpose of these estimations a panel of 88 countries across a 22-year time frame, from 1985 to 2006, will be used.

The MR approach, relying on the Ordinary Least Squares (OLS) estimator, provided evidence of a negative impact of both windfalls on economic growth. When assessing to what extent institutional quality influences this result, the average impact of the rents remained negative, however the impact on economic growth of natural resource rents coupled with good institutions is estimated as significantly positive, despite lacking robustness. The IV regression, relying on the Two Stage Least Squares (2SLS) estimator, reinforces the results obtained by the OLS estimator in the MR context. Using country FE, in turn, provides evidence, in most specifications, of a significant positive impact of aid inflows in good institutional environments.

A theoretical model complements the empirical analysis motivating the importance of institutional quality, within a very simple framework that relies on centralized political economy models.

1.2 Thesis Structure

The remainder of this study is organized into five chapters. Chapter 2 comprises the literature review and is divided into three sections; section 2.1 reviews the literature on the natural resource curse topic while section 2.2 does the same for the aid allocation and effectiveness literature. The last section, 2.3, reconciles both literatures drawing a line between the discussed economic rents and motivating the present study.

In chapter 3 the hypothesis under study are described and subsequently subject to analysis on chapter 4, which deals with the empirics and is divided into four sections. Sections 4.1 and 4.2 introduce the empirical model and the database, respectively. The analytical methods implemented in this study are described in section 4.3 and finally in the last section results are presented.

In chapter 5 a discussion of the findings derived from the empirical research is exposed along with implications the results may have in practice when approaching the international aid topic.

In an attempt to uncover the dynamics behind the hypothesis formulated and the results derived, a theoretical model is developed in chapter 6. Finally chapter 7 concludes and presents suggestions concerning future research.

2 Literature Review

The emergence of a vast literature accounting for the fundamental role of institutions as a determinant of development, shaped economic theory and evidence, with institutions becoming one of the three main factors in explaining cross-country differences in economic performance, along with geography and culture (Acemoglu, Johnson and Robinson 2005). Similarly, European colonization, which shaped the establishment of different types of economic institutions throughout the world, has become an object of study with verified implications for today's patterns of development (Acemoglu, Johnson and Robinson 2001, 2002b).

Ever since, several areas in economics have relied on institutional and political channels when approaching economic growth. The subsequent sections deal with a literature review on two topics that have over the years followed this new institutional approach, beginning with the natural resource curse followed by the aid allocation and effectiveness area.

2.1 The Natural Resource Curse

One of the most counterintuitive concepts, and therefore a vastly analysed and debated topic in Development Economics, is the natural resource curse. Throughout the last decades, several theories were put forward in an attempt to shed some light on the dynamics that may be behind the underperformance exhibited by several resource rich economies.

Early literature focused on an economic resource curse. From the Prebish-Singer hypothesis, concerning the disadvantage natural resource dependent countries would

likely face given a context of deteriorating terms of trade, that dominated the 50's and 60's to the Dutch Disease that had by the 80's become the prevailing theory explaining the impact of natural resource richness on a country's growth performance (Corden and Neary 1982).

It was not until the 90's though, that a worldwide comparative study confirmed the adverse effect of natural resource abundance on GDP growth. Sachs and Warner (1995) documented, based on a cross-country regression model, the adverse effect on GDP growth of a high ratio of natural resource exports to GDP in 1970. Following the contemporaneous economic approach to the theme he authors rely on a Dutch Disease model in order to support their findings.

Notwithstanding the fact that many resource rich economies have performed very poorly in terms of GDP growth, such as Nigeria, Zambia, Sierra Leone, it is undeniable that there are also success cases where the curse is not apparent (e.g. Norway, Botswana, Canada).[6] The rationale behind these diverging experiences was uncovered by the recent institutional approach to the natural resource curse. In Robinson Torvik and Verdier (2006) and Caselli and Cunningham (2009) several channels that link natural resources to economic growth are analysed in political economy frameworks. Furthermore, following a rent-seeking approach both Boschini Pettersson and Roine (2007) and Mehlum Moene and Torvik (2006), provide compelling evidence on the fundamental role of institutions in determining the impact of resource rents on economic growth. While the first argue that not only institutions but also the type of resources is an influential factor, the later reason that the way natural resource abundance affects economic growth is determined by the existence of either producer

[6] For details on Botwana's success refer to Acemoglu, Johnson and Robinson (2002a).

friendly or grabber friendly institutions. Moreover, the later has been extremely influential and resumes the state of the art in the literature, documenting the existence of a natural resource curse exclusively in countries with poor institutions.

Despite the referred prevailing view supporting a natural resource curse in weak institutional environments, there is still extensive debate around fundamental aspects of the empirical and theoretical literature. As a matter of fact, concerns regarding the legitimacy of the commonly used measure of resource abundance, which can be in its essence interpreted as a proxy for resource dependency, are pointed out in Brunnschweiler and Bulte (2008) that argue that natural resources negatively affect growth only if they are excessively relied upon. Furthermore, in Brunnschweiler (2008) the author presents evidence of a natural resource blessing, rather than curse. Following a different approach Gylfason and Zoega (2006) refuse institutions as the only channel through which natural resources affect growth, documenting the importance of two macroeconomics variables through which natural resources have a direct impact, investment and savings.

Finally, more recent literature has tried to move beyond the regular cross-country evidence and has focused on microeconomic data regarding country specific experiences. In Vicente (2010), changes in perceived corruption in Sao Tome and Principe and Cape Verde are compared following the oil discovery in the former, with the results supporting a political resource curse. In the same spirit, Caselli and Michaels (2009) investigate the impact of natural resources through the study of the variations in oil output among Brazilian municipalities, with the results fitting a model of patronage but specially consistent with theories accounting for the easy appropriation of oil resources.

2.2 International Aid: Effectiveness and Allocation

Having as many supporters as opponents, international aid transfers as a way of reducing poverty dates back to the World War II, inspired by the experience of the Marshall Plan.

However, without having so far proved irrefutable results of its benefits, foreign aid is often regarded as the problem rather than the solution. This pessimistic view found its roots in the 70's due to works by Peter Bauer, who believed that aid would more likely be effective in countries that were not in need of it, the Bauer-paradox. More recently, Easterly (2003) is a strong proponent of this view.

Aid optimists on the other hand believe aid inflows are crucial in overcoming major constraints to economic development. This view is expressed in Chenery and Strout (1966), and has been reviewed to include conditionality features, in light of the past decades experience.

Recent literature regarding the effectiveness of international aid is based on two influential studies, which clearly expose both views. While in Boone (1996) it is documented that aid does not affect investment nor growth, neither does it promote development as measured by improvements in human development indicators, in Burnside and Dollar (2000), henceforth BD, the premise is that the impact of aid on growth is conditional on policy. Relying on OLS and 2SLS procedures, the later infer that even though on average aid has little impact on growth, the hypothesis that aid positively influences growth in the presence of growth promoting policies is confirmed and reported as robust. This second work in particular served as a catalyst in the aid

literature, with several authors reacting to the result and conducting new research mainly to test its robustness.

In Collier and Dehn (2001), export price shocks were introduced in the analysis of the effectiveness of aid confirming the significance of BD's results. In fact it is documented that aid is likely to be effective when directed to countries experiencing negative shocks. In Collier and Dollar (2002) robustness of the results is also validated, through the use of a different measure of policies, and the extension of the period and countries under study.

Nevertheless there are several studies in the literature that refuse these findings. Using the same econometric technique, specification and data, extended through 1993-97, in Eastely Levine and Roodman (2004), the interaction term between policies and aid ceases to be significant, jeopardizing the robustness of the result. Moreover, in Easterly (2003), the use of alternative definitions of aid, policies and growth, as well as different period averages, leads to statistical insignificance of the interaction term under study. Among others also the results documented in Hansen and Tarp (2001), as well as in Brumm (2003), do not support BD's findings.

Later on, in Burnside and Dollar (2004), the aid-growth relationship is revisited and reviewed. Rather than an index of macroeconomic growth-promoting policies, the interaction term is built using an index of institutional quality. The result is a robust positively significant interaction term, which is strongest in IV regression.

Ambiguity around the relationship between aid and economic growth remains. A recent study describes well where the literature stands: in Rajan and Subramanian (2008), it is found little robust evidence of a positive and negative relation between the two, there is

no evidence that aid works better in healthier policy environments, or that certain forms of aid work better than others.

Behind these non-conclusive results regarding the relation between aid inflows and economic growth, there is little theoretical foundation. Still, some models can be found, suggesting explanations regarding the dynamics of foreign aid. In Boone (1996) the empirical analysis is based on a political economy model distinguishing among three kinds of regimes, with his findings fitting the regime where the welfare of a fixed coalition is maximized with the transference of aid rents to a high-income political elite. A different explanation, which justifies the inefficiency of aid with its positive effect on rent seeking and corruption, is supported in Svensson (2000) and dismissed in Tavares (2003). Furthermore, following a different approach, in Rajan and Subramanian (2005), it is argued that aid may have negative long term effects through a Dutch Disease mechanism.

Besides its effectiveness, another enduring topic in the field of international aid relates to its allocation. In an attempt to explain the pattern of bilateral aid, Dudley and Montmarquette (1976) present one of the first formal models of aid determinants and find that political and economic links to donor countries significantly help explaining aid allocation. While in early literature (McKinley and Little 1979, Mosley 1981), allocation was estimated through two distinct equations, one accounting for the developmental concerns of the donor and the other for its strategic interests, nowadays studies rely on a model including both recipient characteristics as well as donor interest variables. Evidence is consensual and reports that the political and economic interests of donor countries outweigh the need and merits of the recipient. In Alesina and Dollar (2000) it is documented a tendency of major donors to care about historical factors in

what concerns flows to ex-colonies, and also a strong link between UN voting patterns and aid commitments. It is worth noting though, that this trend is changing, as reported in Dollar and Levin (2004), that found, mainly during the 90's, a move towards aid selectivity in what concerns the recipient countries' institutions and policies.

2.3 Natural Resource Rents and Aid: What brings them together?

As shown, there is a vast literature on the macroeconomic effects of natural resources and international aid. Moreover, a closer look at the literature allows recognizing similarities, in what concerns both the empirical and theoretical approaches to the two topics.

Despite their important differences, the characteristics these rents have in common may be the factors offsetting their potential growth enhancing effects. In fact, the current political resource curse approach builds on the assumption that the derived rents are subject to discretionary distribution by the incumbent (Caselli and Cunningham 2009, Robinson, Torvik and Verdier 2006), and this fungible character of natural resource rents is shared by foreign aid rents as documented in Feyzioglu Swaroop and Zhu (1998). To this extent, both rents represent fungible, extra revenues available to the incumbent.

Even though as economic rents they are expected to provide a "big-push", which is regarded as essential for economic progress, or relax capital constraints that are seen as a barrier to economic development, and therefore promote growth, so far this has not been confirmed by evidence. Actually, while in Collier (2006) aid is claimed to be on average considerably more effective in promoting development than oil, leading the

author to encourage an aid scale up, which as he suggests could provide a big push, in Easterly (2006) this theory is strongly rejected.

Ever since Collier first explicitly compared aid and natural resource rents, new studies have taken the same approach. Namely, the effect of both rents on corruption was comparatively studied in Dalgaard and Olsson (2008) that documents a positive impact of aid and a negative impact of natural resources on corruption, in line with Tavares (2003) and Vicente (2010). Moreover, in Morrison (2007) the author presents a model that aims at dealing with the fungibility of both rents by funnelling them to the citizens rather than to the governments.

The literature on the two topics discussed can be summarized in Exhibit 1 that exposes the consensual view on the natural resource curse topic with the impact of these rents being dependent on the local institutional arrangements, whereas the aid effectiveness literature is filled with uncertainties and ambiguity regarding its direct impact on growth as well as the possible conditionality on the quality of the institutions.

Exhibit 1 Economic Rents and GDP growth

	Good Institutions	Bad Institutions
Natural Resources	Positive impact on GDP growth	Negative impact on GDP growth
International Aid	**?**	**?**

3 Hypothesis

Despite the heavy reliance on international development aid as a mean to reduce poverty and enable long-term sustainable growth, these transfers have not proved to be effective so far (section 2.2). In fact, the growth enhancing character that is often attributed to aid and its potential to improve human development indicators has not been robustly demonstrated in empirics, which has led to the appearance of several theories discussing the dynamics that may be offsetting aid effectiveness.

The aid-growth relationship is therefore hereby revisited, in a distinctive framework and relying on the compelling evidence regarding a different source of revenue; natural resource rents, which albeit their intuitive growth promoting potential, actually slow down the pace of development (section 2.1). The change of focus from an economic resource curse to a political resource curse has led as far as proving the importance of the local institutional arrangements in determining the impact of these rents on GDP growth. Thus the aim of this study entails answering two questions: (1) To what extent is aid comparable to natural resources in terms of its impact on GDP growth? and more importantly (2) Is the impact of aid on growth conditional on the local institutional arrangements? In other words it is hypothesized whether aid hinders growth and if this result applies to countries with sound institutions.

In order to test this aid-institutions-growth relationship an empirical model, that includes aid rents as well as natural resource rents in order to explicitly compare their impact on GDP growth, is conceived in the next section and different procedures are implemented in its estimation, relying on a panel of 88 countries and a large time span,

22 years, from 1985 to 2006. Furthermore, the impact of both rents conditional on the quality of local institutions is also assessed.

Similarly to natural resource richness that tends to slow down GDP growth in bad institutional environments, motivating the term curse, it is expected that international aid rents have the same impact given a poor institutional environment. Nevertheless, just as natural resource rents are a blessing when coupled with good institutions, also aid inflows are expected to fulfil their growth enhancing character in the same conditions.

Besides the empirical approach that follows, the theoretical model builds on these same expectations and therefore attempts to uncover the institutional mechanism that are potentially offsetting the beneficial effect these extra rents represent to a country's economic growth.

4 Empirical Analysis

This chapter is divided into four sections, each dealing with specific aspects of the empirical part of this study. The first section introduces the empirical model constructed in order to answer the questions expressed in the previous section. The second and third sections describe the data set and the analytical methods employed. The final section presents the results and discusses the hypothesis previously formulated.

4.1 Empirical Model

In order to test for the aid-institutions-growth relationship different procedures are implemented in estimating departures from the following general equations:

$$g_{it} = y_{it}\beta_y + a_{it}\beta_a + nr_{it}\beta_{nr} + iq_{it}\beta_{iq} + a_{it}iq_{it}\beta_1 + nr_{it}iq_{it}\beta_2 + X_{it}\beta_X + \varepsilon_{it}^g \quad (1)$$

$$a_{it} = Z_{it}\gamma_z + y_{it}\gamma_y + nr_{it}\gamma_{nr} + iq_{it}\gamma_{iq} + X_{it}\gamma_X + \varepsilon_{it}^a \quad (2)$$

where *i* indexes countries, *t* indexes time, g_{it} is annual percentage growth of GDP per capita, y_{it} is the logarithm of initial GDP per capita, a_{it} is the percentage of aid receipts to GDP, nr_{it} is the percentage of natural resource rents to GDP, iq_{it} is a measure of institutional quality, and ε_{it}^g and ε_{it}^a are error terms. Both $a_{it}iq_{it}$ and $nr_{it}iq_{it}$ are interaction terms, the first between aid receipts and institutional quality and the later between natural resource rents and institutional quality. Finally, X_{it} is a vector of other exogenous variables that might affect growth, i.e. control variables.[7]

[7] A control variable is not the object of interest in the study; rather it is a regressor included to hold constant factors that if neglected could lead the estimated causal affect of interest to suffer from omitted variable bias. This study uses the standard control variables employed in the literature.

Additionally, equation (2) includes a vector Z_{it} of instrumental variables, given that this equation is estimated as a 1st stage regression in the IV regression model, which relies on the 2SLS estimator.

It is a common practice in the literature to divide the time frame into sub-periods.[8] This is done for mainly three reasons: it increases the size of the sample; it is useful to explore the time dimension in the data; and it eliminates business cycle factors and measurement error. In this study the 22-years time frame is divided into four sub-periods, of 5 years each with the exception of the last period which averages the last 7 years under analysis, from 2000 to 2006.[9]

The full database includes 88 countries, which are listed in Appendix 2 along with summary statistics of the main variables of interest.

4.1.1 Growth Equation

The variable y_{it}, the logarithm of GDP per capita, is included on the RHS of equation (1) in order to capture convergence effects. Additionally the equation includes the variables nr_{it} and a_{it}, natural resource rents and aid receipts as fractions of GDP to assess the impact of both economic rents on growth.

Institutional quality, in turn, is one of the most important variables in this work and is included not only to control for the institutional environment, which might affect growth, but also in the interaction terms, $nr_{it}iq_{it}$ and $a_{it}iq_{it}$, allowing to infer upon the predicted conditionality.

[8] Burnside and Dollar (2000) uses four-year periods, Boone (1996) both 5-year and decade averaged data, Easterly (2003) 8, 12 and 24 year periods.

[9] Initial GDP per capita is not averaged, but measured at the beginning of the period.

The variable X_{it} is a vector of other exogenous variables that might affect growth; it consists of a measure of the level of investment to control for capital formation, a measure of openness of the economy, which is believed to have a positive impact on growth, and an ethnic tensions index as suggested by Easterly and Levine (1997). All variables included in X_{it} can be found in previous literature on the topics of the natural resource curse and aid effectiveness; a variable controlling for capital formation can be found in Sachs and Warner (1995) and in Mehlum Moene and Torvik (2006); a variable controlling for the openness of the economy can be found in Sachs and Warner (1995) and in Burnside and Dollar (2000); finally ethnic fractionalization is taken into account also in Burnside and Dollar (2000) and in Mehlum Moene and Torvik (2006).

Variants of equation (1) have been estimated previously in the literature, specifically in Burnside and Dollar (2004), where the authors complement their earlier study by reviewing the interaction term used, to incorporate a institutional quality index. Its differentiating feature concerns the link made with the natural resource curse literature, through the inclusion of the terms nr_{it} and $nr_{it}iq_{it}$, that measure natural resource richness and its interaction with institutional quality as in Mehlum Moene and Torvik (2006).

MR, FE and IV procedures are used to estimate equation (1). The first relies on the OLS estimator, which is used as a general technique for estimating linear regression models, however since the introduction in Boone (1996) of the use of instrumental variables, de to concerns about the possible endogeneity of aid inflows, IV regressions have become a standard in the literature, relying on the estimation of variants of equation (2), the aid equation, as 1st stage regression equations.

Regarding the FE regression model, while time fixed effects are widely used in the aid literature, and are employed in this study in every specification for robustness, country fixed effects are seldom used to assess the impact of aid inflows on GDP growth.[10] Nevertheless, this study implements this procedure given its unique feature of controlling for unobserved variables that are intrinsic to the countries and do not vary over time, hence minimizing omitted variable bias.

4.1.2 Aid Equation

The move towards IV regression, which relies on the 2SLS estimator, created the need to estimate a new equation relating aid to variables known as instruments and the exogenous variables included in the equation of interest. To that extent, equation (2), the aid equation, is estimated as the 1st stage in the 2SLS estimator approach. Thus it includes not only the exogenous variables in equation (1), namely y_{it}, the logarithm of GDP per capita, the variables nr_{it} and a_{it}, natural resource rents and aid receipts as fractions of GDP and X_{it}, the vector of other exogenous variables, but also in addition a vector of instrumental variables.

The vector Z_{it} of instrumental variables comprises two instruments; the logarithm of population and the colonial links between donor and recipient countries. While the first was already used as an instrument in Boone (1996), the choice of the second was motivated by the literature concerning the allocation of aid that reports evidence of a trend of aid rents flowing from former colonizers to former colonies (Alesina and Dollar 2000, Dudley and Montmarquette 1976).

[10] Time fixed effects were used in Boone (1996), Burnside and Dollar (2000, 2004),Collier and Dehn (2001), Easterly Levine and Roodman (2004) among others. Country fixed effects were used in Hansen and Tarp (2001) and Rajan and Subramanian (2008).

4.2 Variables Definition and Sources

In order to estimate the empirical model, real-world data was collected on the variables included in equation (1) and equation (2). The choice of the sources and indicators used in order to measure the different variables was based on the literature on the two topics addressed by this study, the natural resource curse and the allocation and effectiveness of international aid.

Exhibit 2 Overview of the Variables

Variable Name	Measurement	Indicator Name	Source
Dependent			
GDP pc growth (1)	interval	GDP per capita growth (annual %)	WB
Aid (2)	interval	ODA total; GDP (Current USD)	DAC-OECD; WB
Independent			
NR	interval	Total natural resource rents (%GDP)	WB
Aid	interval	ODA total; GDP (Current USD)	DAC-OECD; WB
IQ	index	Investment Profile	ICRG-PRS
	index	Law and Order	ICRG-PRS
	index	Corruption	ICRG-PRS
	index	Bureaucracy Quality	ICRG-PRS
Controls			
Initial GDP pc	interval	GDP (Current USD)	WB
Investments	interval	Gross capital formation (%GDP)	WB
Openness	interval	Trade (%GDP)	WB
Ethnic Tensions	index	Ethnic Tensions	ICRG-PRS
Instruments			
Colonies	binary	Independence	CIA
Population	interval	Population, total	WB

Note: The dependente variables are classified as (1) and (2), indicating in which equation they perform such role.

For a more comprehensive description the variables are divided into the four types according to their role in this study; they are classified as either dependent, independent, control or instrumental variables (Exhibit 2).

4.2.1 Dependent variables

GDP per capita growth

The dependent variable in equation (1) is the WB series entitled GDP per capita growth (annual %), and defined as the annual percentage growth rate of GDP per capita based on constant local currency.

Aid

In equation (2) the dependent variable is the net disbursements of Official Development Assistance (ODA) available from the Development Assistance Committee (DAC-OECD) as in Boone (1996), Easterly (2003), Burnside and Dollar (2004). It is expressed in current US$ and defined as flows that are concessional in character and convey a grant element of at least 25%. For the purpose of this work it is divided by the WB series GDP (current US$).

4.2.2 Independent Variables

Natural Resources (NR)

Following Sachs and Warner (1995), the WB series total resource rents to GDP is used as the measure of natural resource abundance. It is defined as the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.

Aid

The variable aid included as an independent variable in equation (1) is the same as the one included as a dependent variable in equation equation (2). Is the fear of endogeneity regarding this variable that leads to the estimation of equation (2) as a first-stage regression in an IV regression model using a 2SLS estimator.

Institutional Quality (IQ)

Two different measures are used to capture this variable throughout the empirical analysis, based on data from the International Country Risk Guide (ICRG-PRS), the most widely used source of information on institutions in the literature.[11] The first, used as the prime measure of institutional quality in this study, consists of an unweighted average of four indices: Law and Order that are assessed separately with the Law sub-component assessing the strength and impartiality of the legal system and the Order sub-component assessing the popular observance of the law; Investment Profile that consists of an assessment of factors affecting the risk to investment that are not covered by other political, economic and financial risk components; Bureaucratic Quality that measures the institutional strength and quality of the bureaucracy by its capacity to minimize revisions of policy when governments change; and Corruption that measures the corruption within the political system that is a threat to foreign investment for several reasons.[12] The resulting index is believed to capture the essence of the degree of property rights protection and rule of law prevalence.

The second measure is used in order to test for robustness and consists solely of the Law and Order index from the same source.[13]

The institutional quality variable, whose measure in not provided for several developing countries, is the major source of constraint in terms of data availability.

[11] ICRG-PRS constitutes the source of information regarding institutional quality in Sachs and Warner (1995),Burnside and Dollar (2000, 2004), Easterly Ross and Levine (2004), Tavares (2003), Mehlum, Moene and Torvik (2006), among others.

[12] The index is based on the analysis of Knack and Keefer (1995).

[13] Approach followed in Mehlum, Moene and Torvik (2006).

4.2.3 Control Variables

Openness

This variable is included in order to control for the openness of the economy, which is believed to positively influence growth. It is measured by the WB series named Trade (%GDP), and defined as the sum of exports and imports of goods and services measured as a share of gross domestic product. Similar measures are used as control variables in Sachs and Warner (1995) and Burnside and Dollar (2000, 2004) among others.

Investments

In order to control for capital formation, investments is another control variable included in the regression. It is measured by the WB series entitled Gross Capital Formation (%GDP), which consists of a measurement of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements; plant, machinery, and equipment purchases; and the construction of roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. This control variable has been included in the regression estimated in both Sachs and Warner (1995) and Mehlum Moene and Torvik (2006)

Ethnic Tensions

To account for ethnic fractionalization, procedure suggested by Easterly and Levine (1997), the index Ethnic Tensions from the PRS group included in the ICRG is also used as a control variable. This index consists of an assessment of the degree of tension within a country attributable to racial, nationality, or language divisions.

4.2.4 Instrumental Variables

Colonies

As discussed historical and political links appear to better explain patterns of aid rather than either merit or need of the recipient country. Many developing countries have a colonial past, which links them to current major donor countries. Evidence shows a trend of aid rents flowing from former colonizers to former colonies, documented in both, Dudley and Montmarquette (1976) and Alesina and Dollar (2000). Given this, a dummy variable is constructed, equal to one if a country is a former colony of either France, United Kingdom, The Netherlands or Belgium, and taken as an instrumental variable in this study (Appendix 4). The information regarding the colonial past of the countries included in this study was retrieved from the CIA World Fact Book.

Population

Along with colonial links also logarithm of population is used as an instrument, as in Boone (1996), motivated by the fact that small economies receive more aid than large economies. The series Population (total), from the WB was used in order to measure this variable. This series counts all residents regardless of legal status or citizenship, except for refugees not permanently settled in the country of asylum, which are generally considered part of the population of their country of origin. The values reported and hereby used are midyear estimates.

4.3 Analytical Methods

As discussed this study attempts to find the causal relation between foreign aid receipts and GDP growth, as well as the role played by institutional quality in determining this

relation. The analysis relies upon the use of observational data, rather than experimental data from ideal randomized controlled experiments, which consequently entails several difficulties when estimating causal effects. This arises from the fact that in the real world, levels of treatment are not assigned randomly and it is therefore difficult to sort out the effect of the treatment from other relevant factors. Nevertheless, these ideal experiments are uncommon, hence different econometric tools were developed and are here addressed in order to tackle the major challenges posed by the use of observational data.

Furthermore, two types of data sets are used in this study, cross-sectional data and panel data. Data on different entities for a single time period is called cross-sectional data, and is useful to uncover the relationships among variables by studying differences across countries during a single time period. Panel data are data for multiple entities in which each entity is observed at two or more time periods. The number of entities in a panel data set is denoted n, and the number of time periods in denoted T. In the present study, there are $n = 88$ countries and $T = 22$ years. Panel data can be used to learn about economic relationships from the experiences of many different entities in the data set and from the evolution over time of the variables of each entity.

Cross-sectional data is employed in both MR and IV regression models while panel data is required for the FE regression model.

4.3.1 Multiple Regression Model

The cross-sectional multiple regression approach relying on the OLS estimator is the mainstream method used in practice. The equation estimated employing this method is the following:

$$g_i = y_i\beta_y + a_i\beta_a + nr_i\beta_{nr} + iq_i\beta_{iq} + a_i iq_i\beta_1 + nr_i iq_i\beta_2 + X_i\beta_X + \varepsilon_i^g \quad (3)$$

which differs from equation (1) by not indexing time, only countries.

The OLS estimators are characterized by having desirable properties provided that four assumptions on the regression model and sampling scheme are met (Exhibit 3).

Under LSA1 to LSA4, OLS estimators are unbiased, consistent and normally distributed in large samples. LSA1, also known as the conditional mean assumption, is the key assumption that ensures the OLS estimators are unbiased through implying that the regressors and the error term are uncorrelated, and it is the most important to consider in practice. Moreover, LSA3 deserves attention given the fact that OLS estimators are not reliable in case the data set contains large outliers. Through out the analysis presented in this study the full sample is used given that the exclusion of outliers does not significantly change the obtained results.

Exhibit 3 Least Squares Assumptions

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + u_i, i = 1, \ldots, n$$

ASSUMPTION 1.	$E(u_i \mid X_{1i}, X_{2i}, \ldots, X_{ki}) = 0.$
ASSUMPTION 2.	$(X_{1i}, X_{2i}, \ldots, X_{ki}, Y_i), i = 1, \ldots, n$ are i.i.d.
ASSUMPTION 3.	Large outliers are unlikely.
ASSUMPTION 4.	No perfect multicollinearity.

Source: adapted from Stock and Watson (2012)

If, in addition to meeting the four least squares assumptions described above, the error term is homoskedastic, the OLS estimator is the most efficient linear conditionally unbiased estimator. Nonetheless, often the error term is heteroskedastic and there is the

need to employ heteroskedasticity-robust standard errors so that inference is still realiable. In fact unless there is a convincing reason to believe otherwise, it is prudent to assume heteroskedasticity of the error term. Hence, all results on section 4.4 are computed relying on robust standard errors.

Despite being very useful in uncovering the patterns in the data, the OLS estimator does not address several issues that might undermine the validity of the estimated regression coefficients. In particular, omitted variable bias, sample selection and simultaneous causality are three relevant threats in the present analysis that pose major challenges in determining the causal relation under study. All the three mentioned sources of bias arise due to correlation between a regressor and the error term, violating LSA1.

Omitted Variable Bias

Omitted variable bias refers to the bias in OLS estimator that arises when the following two conditions are verified: at least one of the included regressors is correlated with an omitted variable, and the omitted variable is a determinant of the dependent variable.

When the two conditions are satisfied, the result is a violation of LSA1, meaning that the conditional expectation of the error given the regressors is different from zero, i.e. $E\left(\varepsilon_i^g \middle| y_i, a_i, nr_i, iq_i, a_i iq_i, nr_i iq_i, X_i\right) \neq 0$. As a result the omitted variable bias persists even if the sample size is large, and results in inconsistency of the OLS estimator.

There are numerous solutions that can minimize this bias, some involving more complex econometric techniques, depending on the availability or not of a variable that can adequately control for the omitted variable.

When the variable is observable or there are adequate control variables, the best strategy involves including it or them in the multiple regression, thereby addressing the problem by eliminating the potential bias in the coefficient of interest. Should be noted however,

that adding variables to multiple regressions comes with costs as well as benefits. Whilst omitting the variable could result in omitted variable bias, including it when it does not belong reduces the precision of the estimators of the other regression coefficients.

In case the variable is not observable and there are no adequate control variables available, there are three solutions, which entail the use of different types of data. The first is to use IV regression, which relies on the use of a new variable called instrumental variable. The second solution is to use panel data and FE regression. The third is to use a study design in which the effect of interest is studied using a randomized controlled experiment

Simultaneous causality

As discussed this study attempts to uncover the causal relation between foreign aid rents and GDP growth. The multiple regression approach relying on the OLS estimator implies the assumption that the causality runs from the regressor, aid rents, to the dependent variable, GDP growth, however this may not be the case. The aid-growth relation may be more complex than the one assumed and causality might run also from the dependent variable to the regressor, resulting in simultaneous causality. If so, given that simultaneous causality leads to correlation between the error and the regressor, violating LSA1, the OLs regression is biased and inconsistent given that it picks up both effects.

There are two ways in which simultaneous causality bias can be mitigated. One is to use instrumental variables regression, while the other consists in designing and implementing a randomized controlled experiment.

Sample selection

Missing data is common in economic datasets and does not always pose a threat to the validity of the regression coefficients. There are three forms of missing data and whether they are a source of bias or not depends on the way data is missing. If data are missing completely at random or based on the value of a regressor, there is a reduction of the sample size but there is no bias. However, if data are missing because of a selection process that is related to the dependent variable beyond depending on the regressors, then this selection process might introduce correlation between the regressors and the error term, which results in bias generally known as sample selection bias. Albeit its relevance, the issue of sample selection is not address in this study.

4.3.2 Instrumental Variable Regression Model

As stated above one of the solutions suggested to overcome the bias introduced by omitted variables and simultaneous causality is the use of the IV regression. Indeed it consists of a general way to obtain a consistent estimator of the unknown coefficients of the population regression line whenever the LSA1 is violated, i.e. $E(u_i | X_{1i}, X_{2i}, \dots, X_{ki}) \neq 0$, which means that one or more regressors is correlated with the error term. The variables that are correlated with the error term are referred to as endogenous, and denoted by W_i, while the variables that are uncorrelated with the error term are called exogenous. In what concerns the present study, the variable a_i, that measures foreign aid rents to GDP, is considered endogenous.

Any endogenous variable can be thought of as having two parts: one part that is uncorrelated with the error term and a second part that is correlated with the error term introducing bias. IV regression allows isolating the first part so that the focus is upon the variations of the endogenous variable that are uncorrelated with the error term,

while the variations that bias the OLS estimates can be disregarded. In order to implement such procedure there is the need to introduce additional variables known as instrumental variables or simply instruments. These additional variables are used as tools to isolate the variations of interest of the endogenous variable so that consistent estimation of the regression coefficients is possible.

As long as there exists a valid instrument, the effect on the dependent variable of a unit change of the endogenous variable can be estimated using instrumental variables estimator. In order for an instrument to be valid, it must satisfy two conditions: the instrument relevance condition and the instrument exogeneity condition (Exhibit 4).

Exhibit 4 Conditions for a Valid Instrument

1. Instrument Relevance Condition	$corr(Z_i, W_i) \neq 0$
2. Instrument Exogeneity Condition	$corr(Z_i, u_i) = 0$

Source: adapted from Stock and Watson (2012)

Provided an instrument Z_i is valid, variation in the instrument is related to variation in W_i, the endogenous variable. Additionally if an instrument is exogenous, then the part of W_i captured by the instrument is exogenous. As a result, when both conditions are satisfied the instrument is capable of capturing the variation in W_i that is exogenous, and can in turn be used to estimate the coefficient of the endogenous regressor using an IV estimator called 2SLS.

Basically, the 2SLS estimator is calculated as the name suggests in two stages: the first stage which decomposes the endogenous variable into two components, the problematic one that is correlated with the error term and a problem-free component that is

uncorrelated with the error, and the second stage that uses the later to estimate the regression coefficients.

All in all, the IV regression model has four types of variables: the dependent variable, the endogenous regressor(s), additional regressors known as included exogenous variables and instrumental variables.

In general there can be multiple endogenous regressors, multiple instrumental variables and multiple included exogenous regressors. However, for IV regression to be possible there must be at least as many instruments as endogenous variables otherwise it is not feasible to compute the first stage regression in 2SLS. Hence, regression coefficients must be either exactly identified, number of instruments equals number of endogenous variables, or overidentified where the number of instruments exceeds the number of endogenous variables. This study relies on overidentification of the coefficients given that in order to overcome the bias introduced by the single endogenous variable a_i, it is used two instrumental variables.

The equation of interest in this study that includes a single endogenous variable and the remaining exogenous variables is, as in the MR context

$$g_{it} = y_i\beta_y + a_i\beta_a + nr_i\beta_{nr} + iq_i\beta_{iq} + a_iiq_i\beta_1 + nr_iiq_i\beta_2 + X_i\beta_X + \varepsilon_i^g \quad (4)$$

but where a_i is correlated with the error term but the remaining variables are not.

The first-stage regression of 2SLS in turn relates the endogenous variable, a_i, to both the exogenous variables included in equation (4) as well as the instruments

$$a_i = Z_i + y_i\gamma_y + nr_i\gamma_{nr} + iq_i\gamma_{iq} + X_i\gamma_X + \varepsilon_i^a \quad (5)$$

where the unknown regression coefficients are estimated by OLS and the predicted values from this regression are $\hat{a}_1, \ldots \hat{a}_n$.

The second stage of 2SLS consists in estimating equation (5) by OLS after replacing a_i by its predicted value from the first-stage. The resulting estimator of the coefficients in equation (5) is the 2SLS estimator.

In order for the 2SLS estimator to be consistent and to have a sampling distribution that, in large samples, is approximately normal four assumptions must hold (Exhibit 5); the IV regression assumptions that consist of modifications of the least squares assumptions for the MR model presented in the previous section (Exhibit 3).

The IVA1 differs from the LSA1 to the extent that it applies only to the included exogenous variables leaving out the endogenous regressors, $W_{1i}, \dots, W_{ri}$, which in the present study is simply the variable a_i. Moreover IVA4 implies that the two conditions for instrument validity must hold so that the instrumental variables must be both relevant and exogenous. The instrument relevance condition plays the role of the LSA4 by assuming that the regressors in the second-stage regression are not perfectly multicollinear.

Exhibit 5 The IV Regression Assumptions

$$Y_i = \beta_0 + \beta_1 X_{1i} + \cdots + \beta_k X_{ki} + \beta_{k+1} W_{1i} + \cdots + \beta_{k+r} W_{ri} + u_i, i = 1, \dots, n$$

ASSUMPTION 1.	$E(u_i \mid X_{1i}, \dots, X_{ki}) = 0$;
ASSUMPTION 2.	$(X_{1i}, \dots, X_{ki}, W_{1i}, \dots, W_{ri}, Z_{1i}, \dots, Z_{mi}, Y_i), i = 1, \dots, n$ are i.i.d.;
ASSUMPTION 3.	Large outliers are unlikely;
ASSUMPTION 4.	The two conditions for a valid instrument in Exhibit 4 hold.

Source: adapted from Stock and Watson (2012)

Checking whether the instrumental variables are valid becomes imperative and is a common procedure whenever possible, given that the reliance on invalid instruments violates IVA4 and hence the use of 2SLS estimator produces meaningless results.

On the one hand, if the instruments are weak, barely satisfying the instrument relevance condition, 2SLS is no longer reliable, given that the normal distribution provides a poor approximation to the sampling distribution of the estimator, even if the sample size is large. In order to check for weak instruments given the context of a single endogenous regressor, which is the case in the present study, the computation of the F-statistic testing the hypothesis that the coefficients on the instruments are all zero in the first-stage regression of 2SLS is required. The first-stage F-statistic provides a measure of the information contained in the instruments and in case it exceeds 10 there is no need for further worries regarding the relevance of the instrumental variables.

On the other hand, if the instruments are not exogenous then 2SLS is inconsistent. Testing the instrumental variables exogeneity is only possible in the case of overidentification, and therefore can be applied to this study given that two instrumental variables are used and there is only one endogenous regressor. Exogeneity of the instruments is checked relying on the test of overidentifying restrictions. Along with the IV regression estimation in section 4.4.2, the two conditions for the validity of the used instruments are checked and all results reported.

4.3.3 Fixed Effects Regression Model

FE regressions are very useful in controlling for some types of omitted variable bias without actually observing the omitted variables. Unlike MR and IV regression that rely on cross-sectional data, FE regressions require a different type of data, panel data in

which each entity, is observed at two or more time periods. In the current study, there are 88 different entities, i.e. countries, that are observed in $T = 22$ time periods, i.e. years.

There are two kinds of fixed effects, entity fixed effects that control for variables that are constant over time but differ across entities, and time fixed effects that control for variables that are constant across entities but evolve over time. Both are considered and applied in this study.

4.3.3.1 Entity Fixed Effects

Entity FE regression is a method for controlling for omitted variable bias in panel data when the omitted variable is constant over time but varies across entities. This is done through the estimation of n different intercepts, one for every country, that can be represented by a set of binary or indicator variables that absorb the influence of all omitted variables that are constant over time but differ from one country to the other.

According to the FE regression model the following equation is estimated

$$g_{it} = y_{it}\beta_y + a_{it}\beta_a + nr_{it}\beta_{nr} + iq_{it}\beta_{iq} + a_{it}iq_{it}\beta_1 + nr_{it}iq_{it}\beta_2 + X_{it}\beta_X + \propto_i + \varepsilon_{it}^g \qquad (6)$$

where $\propto_i = \beta_0 + \beta_z K_i$ are terms known as entity fixed effects that are treated as unknown intercepts to be estimated, one for each entity, and K_i is an unobserved variable that varies from one state to the next but does not change over time. The variation in the entity fixed effects comes from omitted variables represented by K_i that vary across countries but not over time.

4.3.3.2 Time Fixed Effects

Time FE regressions in turn control for variables that evolve over time but are constant across entities, i.e. variables that are constant from one country to another yet change over the years.

According to the FE regression model the estimated equation is now

$$g_{it} = y_{it}\beta_y + a_{it}\beta_a + nr_{it}\beta_{nr} + iq_{it}\beta_{iq} + a_{it}iq_{it}\beta_1 + nr_{it}iq_{it}\beta_2 + X_{it}\beta_X + \lambda_t + \varepsilon_{it}^g \quad (7)$$

where $\lambda_t = \beta_0 + \beta_s S_t$ are terms known as time fixed effects allowing the model to have a different intercept for each time period, and S_t is unobserved and changes over time but is constant across countries. Similarly to what happens with entity fixed effects, the influence of the variable S_t, just like the influence of the variable Z_i, can be eliminated. The variation in the time fixed effects comes from omitted variables represented by S_i that evolve along the years but not across countries.

4.3.3.3 Entity and Time Fixed Effects

Given the fact that some omitted variables are constant over the years but vary across countries while others evolve over the time but are constant from one country to the other, it is appropriate to include both country and time fixed effect in the FE regression model estimated and whose results are presented in section 4.4.3.

The combined entity and time effects regression model is

$$g_{it} = y_{it}\beta_y + a_{it}\beta_a + nr_{it}\beta_{nr} + iq_{it}\beta_{iq} + a_{it}iq_{it}\beta_1 + nr_{it}iq_{it}\beta_2 + X_{it}\beta_X + \lambda_t + \alpha_i + \varepsilon_{it}^g \quad (8)$$

and eliminates the omitted variable bias arising from unobserved and not included variables that are either constant over the years or across countries.

The FE regression models here presented are variants of the MR model in section 4.3.1 and their coefficients are also estimated by OLS. Similarly to the case of MR and the IV regression, also in FE regression there is a set of assumptions under which the sampling distribution of the fixed effects OLS estimator is normal in large samples therefore allowing for inference to be made.

Exhibit 6 The Fixed Effects Regression Assumptions

$$Y_{it} = \beta_1 X_{it} + \propto_i + u_i, i = 1, \dots, n, t = 1, \dots, T$$

ASSUMPTION 1.	$E(u_{it} \mid X_{i1}, X_{i2}, \dots, X_{iT}, \propto_i) = 0$.
ASSUMPTION 2.	$(X_{i1}, X_{i2}, \dots, X_{iT}, u_{i1}, u_{i2}, \dots, u_{iT}), i = 1, \dots, n$ are i.i.d.
ASSUMPTION 3.	Large outliers are unlikely.
ASSUMPTION 4.	No perfect multicollinearity.

Source: adapted from Stock and Watson (2012)

Under the FE regression assumptions exposed in Exhibit 6 the fixed effects estimator is consistent and normally distributed when n is large.

The FEA1 plays the same role as LSA1 (Exhibit 3) and implies that there is no omitted variable bias. It goes beyond LSA1 though, by requiring that the conditional mean of the error does not depend on any of values of the regressors for that entity, so that this assumption is violated if current error is correlated with past, present or future values of the regressors.

Regarding FEA2, while its cross section counterpart holds that each observation is independent, which arises under simple random sampling, here it holds that the

variables are independent across entities but makes no such restriction within an entity, so that a regressor can be correlated over time within an entity, know as autocorrelation.

Moreover in panel data the regression error can be correlated over time within an entity. Like heteroskedasticity, this correlation does not introduce bias into the fixed effects estimator and can be overcome so that inference is possible through the employment of clustered standard errors, which are robust to both heteroskedasticity and to correlation over time within an entity. These clustered standard errors are employed when obtaining the results for the FE regression in section 4.4.3.

4.4 Research Results

The evidence presented in this section results from the estimation of the equations described above using a panel of 88 countries with data across four five-years periods from 1985 to 2006.

Descriptive statistics of the main variables across the 22-year timeframe are reported in Exhibit 7.

Exhibit 7 Descriptive Statistics

	Average	Std. Dev.	Min	Max
GDP per capita growth (% annual)	1,42	1,92	-4,28	8,79
GDP per capita (current US$)	3318,09	5462,37	169,47	30627,82
Natural Resource Rents (%GDP)	0,12	0,15	0,00	0,68
Foreign Aid (%GDP)	0,06	0,08	0,00	0,42
Institutional Quality Index	3,49	0,78	1,37	5,63
Investments (%GDP)	0,21	0,06	0,09	0,39
Openness (%GDP)	0,73	0,44	0,20	3,50
Ethnic Tensions Index	0,61	0,22	0,09	1,00

Note: The Institutional Quality Index varies from 0 to 6. The Ethnic Tensions Index varies from 0 to 1.

As mentioned in the introduction, the range within which the variable GDP per capita takes values is enormous, with minimum and maximum values being 169,47 and 30627,82 dollars per person, respectively.

Concerning the economic rents, the average percentage of natural resource rents to GDP is two times the average percentage of foreign aid rents to GDP. Moreover, dependence on natural resource rents appears greater than dependence on foreign aid rents as suggested by the maximum value of the two. In fact while the top ten countries in terms of their aid receipts show figures of aid as a percentage of GDP between 17% and 42%, in the top ten natural resource rich countries the figures translating natural resource rents as a percentage of GDP range between 37% and 68% (Exhibit 8).[14]

Exhibit 8 Top 10 Countries

Panel A. International Aid

	Aid (%GDP)
Gambia	0.216
Guinea-Bissau	0.422
Guyana	0.173
Liberia	0.340
Malawi	0.234
Mali	0.174
Mozambique	0.326
Nicaragua	0.196
Sierra Leone	0.215
Zambia	0.207

Panel B. Natural Resources

	NR (%GDP)
Angola	0.423
Brunei	0.441
Congo, Rep.	0.520
Gabon	0.387
Iraq	0.677
Kuwait	0.414
Nigeria	0.382
Oman	0.384
Qatar	0.383
Saudi Arabia	0.374

Furthermore it is interesting to notice that none of the top ten aid receivers is also one of the resource rich economies.

[14] In Appendix 5 two graphs can be found plotting the aid and natural resource dependency of the 20 countries above against their GDP growth.

4.4.1 Multiple Regression Results

To start with, equation (3) is regressed excluding the interaction terms. The results are presented in Exhibit 9 and provide evidence of a significant negative impact of natural resources and foreign aid on GDP per capita growth, robust to the inclusion of controls and to some extent to the use of the second measure of institutional quality.

Exhibit 9 Multiple Regression Model - No interaction terms

Estimation Method	OLS				
	(1)	(2)	(3)	(4)	(5)
Initial GDP per capita	-0.369*	-0.206	-0.323	-0.372*	-0.153
	(0.204)	(0.166)	(0.209)	(0.214)	(0.191)
Natural Resources	**-3.280****	-3.568**	**-3.024***	**-2.873***	**-3.336****
	(1.613)	(1.526)	(1.602)	(1.592)	(1.504)
Aid	**-4.217****	-3.272*	**-3.664***	**-3.841***	**-2.683**
	(1.976)	(1.966)	(2.084)	(2.076)	(2.096)
Institutional Quality	1.595***	3.217***	1.643***	1.609***	3.340***
	(0.542)	(0.934)	(0.554)	(0.557)	(0.972)
Investments	17.60***	17.99***	18.31***	18.15***	18.72***
	(2.724)	(2.774)	(2.870)	(2.869)	(2.919)
Openness			-0.415	-0.386	-0.410
			(0.416)	(0.412)	(0.388)
Ethnic Tensions				0.0963	-0.00782
				(0.126)	(0.131)
R-squared	0.292	0.297	0.299	0.300	0.294
Observations	313	313	313	313	313

Note: The dependent variable is GDP per capita growth. IQ stands for Institutional Quality. Variables are described in more detail in the text. In regressions (2) and (5) it is used the second measure of IQ for robustness. Further details on the IQ variables are presented in the text. All regressions include time dummies and a constant, which coefficients are not reported. Robust standard erros in parentheses. Full sample. *significant at 10%, **significant at 5%, ***significant at 1%.

Exhibit 10, in turn, presents the results of the OLS estimation of equation (3) including the interaction terms. Albeit the lack of robustness to a different measure of institutional quality in column (5), and the statistical insignificance of the interaction term involving aid receipts, results are in line with the hypothesis previously described; both economic rents present negative coefficients while both interaction terms present positives ones.

Even though it is useful to start with an OLS regression in order to understand the patterns in the data, no major conclusions should be taken from this first method. The

consistency of its results depends on key assumptions that do not hold in case of endogeneity or omitted variables, two real threats to the validity of the OLS results in the present study. In fact, performing an Omitted Variable Test, results in the rejection, at a 1% significance level, of the hypothesis that there exists no omitted variable.

Exhibit 10 Multiple Regression Model – With interaction terms

Estimation Method	OLS				
	(6)	(7)	(8)	(9)	(10)
Initial GDP pc	-0.547	-0.425*	-0.377*	-0.400*	-0.204
	(0.368)	(0.218)	(0.227)	(0.242)	(0.222)
Natural Resources	**-0.633**	**10.47*****	**-9.923****	**-9.749****	**-8.767****
	(8.587)	(3.893)	(3.919)	(3.926)	(4.371)
Aid	**-6.766**	**-5.317****	**-5.219****	**-5.128****	**-3.608**
	(12.49)	(2.073)	(2.090)	(2.110)	(2.505)
NR* IQ	**0.0150**	**0.138****	**0.132****	**0.130****	**0.103**
	(0.120)	(0.0588)	(0.0595)	(0.0596)	(0.0713)
Aid*IQ	**6.117**	**2.910**	**3.996**	**3.499**	**1.545**
	(17.37)	(6.804)	(7.019)	(7.259)	(8.230)
IQ	2.778**	1.274**	1.309**	1.307**	2.233
	(1.178)	(0.595)	(0.604)	(0.606)	(1.441)
Investments		18.13***	18.72***	18.63***	19.09***
		(2.725)	(2.848)	(2.866)	(3.079)
Openness			-0.343	-0.328	-0.306
			(0.428)	(0.427)	(0.406)
Ethnic Tensions				0.0408	-0.00381
				(0.131)	(0.133)
R-squared	0.114	0.311	0.313	0.313	0.300
Observations	326	313	313	313	313

Note: The dependent variable is GDP per capita growth. IQ stands for Institutional Quality. Variables are described in more detail in the text. In regression (10) it is used the second measure of IQ for robustness.. Further details on the IQ variables are presented in the text. All regressions include time dummies and a constant, which coefficients are not reported. Robust standard errors in parentheses. Full sample. *significant at 10%, **significant at 5%, ***significant at 1%.

4.4.2 Instrumental Variable Results

The use of IV regression is the most standard approach in the aid literature to overcome the problems of endogeneity and omitted variable bias not addressed by OLS. It involves the use of instruments, which ideally capture the movements in the aid variable that are uncorrelated to the error term in equation (4), allowing for a consistent

estimation of its coefficients. A 2SLS estimation strategy fitting equations (4) and (5) is used for this purpose.

Exhibit 11 presents the IV regression results. Before proceeding to the analysis of the relationship of interest present in the 2nd stage regression results, there is the need to confirm the validity of the instruments, given that unless the two conditions for a valid instrument are fulfilled the resulting estimates are meaningless.

The relevance of the instrumental variables is confirmed through the performance of a F-statistic testing the hypothesis that the coefficients of the instruments in the 1st stage regression are zero, which provides a result well above 10, the standard rule of thumb approach.

Furthermore, given that this study relies on two instruments and there is only one endogenous regressor, it is possible to perform a test of overidentifying restrictions and assess whether the instruments are exogenous. In fact there is a non-rejection of the null hypothesis that the instruments are exogenous at 5% significance level, which fulfils the remaining condition confirming the validity of the instruments.

Focusing on the results from the 2nd stage regression, there is evidence of a natural resource curse as documented in Mehlum, Moene and Torvik (2006), with a negative impact of natural resources on GDP growth unless the environment is characterized by good institutions where evidence shows a positive impact of natural resources on the dependent variable. This result is robust to the inclusion of all controls and the use of the second measure of institutional quality.

Furthermore, the interaction term involving aid has a positive coefficient as in Burnside and Dollar (2004) but it is not significant as in Rajan and Subramanian (2008).

Exhibit 11 Instrumental Variable Regression Model

Estimation Method	2SLS			
	(11)	(12)	(13)	(14)
Initial GDP pc	-0.750***	-0.748**	-0.808**	-0.542*
	(0.266)	(0.298)	(0.333)	(0.307)
Natural Resources	**-10.53*** **	**-10.52*** **	**-10.23*** **	**-10.18** **
	(3.937)	(3.942)	(3.935)	(4.399)
Aid	**-11.46*** **	**-11.46*** **	**-11.21*** **	**-11.70** **
	(3.726)	(3.806)	(3.759)	(4.721)
NR*IQ	**0.142** **	**0.142** **	**0.139** **	**0.130** *
	(0.0599)	(0.0605)	(0.0604)	(0.0725)
Aid*IQ	**3.053**	**3.124**	**1.462**	**5.862**
	(9.506)	(9.953)	(10.53)	(13.26)
IQ	1.383**	1.382**	1.386**	1.445
	(0.619)	(0.623)	(0.627)	(1.589)
Investments	18.18***	18.19***	17.98***	18.83***
	(2.781)	(3.002)	(3.043)	(3.333)
Openness		-0.00342	0.0386	0.0551
		(0.451)	(0.456)	(0.446)
Ethnic Tensions			0.0835	0.0450
			(0.138)	(0.137)
R-squared	0.292	0.292	0.292	0.279
Observations	313	313	313	313
	1st Stage			
	(15)	(16)	(17)	(18)
Initial GDP pc	-0.294***	-0.294***	-0.295***	-0.301***
	(0.0477)	(0.0478)	(0.0475)	(0.0482)
Initial GDP pc ^2	0.0162***	0.0162***	0.0162***	0.0168***
	(0.00313)	(0.00314)	(0.00312)	(0.00318)
Population	**-0.0264*** **	**-0.0263*** **	**-0.0262*** **	**-0.0257*** **
	(0.00284)	(0.00347)	(0.00356)	(0.00343)
Colonies	**-0.0340*** **	**-0.0341*** **	**-0.0336*** **	**-0.0314*** **
	(0.00861)	(0.00812)	(0.00871)	(0.00820)
Natural Resources	-0.0496***	-0.0498***	-0.0487***	-0.0516***
	(0.0187)	(0.0181)	(0.0187)	(0.0181)
IQ	0.00645	0.00640	0.00599	-0.0158
	(0.00833)	(0.00833)	(0.00807)	(0.0215)
Investmets	0.136**	0.135*	0.134	0.143*
	(0.0665)	(0.0803)	(0.0811)	(0.0830)
Openness		0.000654	0.000791	0.00236
		(0.0103)	(0.0104)	(0.0102)
Ethnic Tensions			0.000767	0.00195
			(0.00234)	(0.00228)
R-squared	0.679	0.679	0.679	0.679
Observations	317	317	317	317
	Significance of instruments test			
F (2, .)	43.78	28.95	27.01	28.30
	Overidentification test			
$\chi^2(1)$	2.51809	2.72585	2.01601	2.33746
	(p = 0.1125)	(p = 0.0987)	(p = 0.1556)	(p = 0.1263)

Notes: The dependent variable is GDP per capita growth in columns (11), (12), (13) and (14), and Aid in columns (15), (16), (17) and (18). IQ stands for Institutional Quality. Variables are described in more detail in the text. Variables Colonies and Population are used as instruments for 2SLS. In columns (14) and (18) it is used the second measure of IQ for robustness. All regressions include time dummies and a constant, which coefficients are not reported. Robust standard errors in parentheses. Full sample. *significant at 10%, **significant at 5%, ***significant at 1%.

The unconditional impact of aid rents, in turn, is negative, significant and robust. The growth deterrent character of aid rents has been documented previously though as a non-robust result (Brumm 2003, Easterly 2003, Easterly, Levine and Roodman 2004, Rajan and Subramanian 2008).

4.4.3 Fixed Effects Results

A way of controlling for omitted variables is the use of FE regression, the main tool of regression analysis of panel data. As described data have been divided into sub-periods resulting in four observations per country, however to maximize the advantages of this method the whole panel data including every year from 1985 to 2006 is also used in estimating equation (8).

Exhibit 12 Fixed Effects Regression Model - Averaged Data

Estimation method	OLS			
	(18)	(19)	(20)	(21)
Initial GDP per capita	-0.570	-0.965	-0.960	-0.960
	(1.978)	(0.704)	(0.714)	(0.716)
Natural Resources	**-28.22**	**2.187**	**2.500**	**2.647**
	(22.53)	(7.506)	(7.664)	(8.150)
Aid	**-2.002**	**-6.833**	**-6.828**	**-6.761**
	(17.89)	(5.450)	(5.447)	(5.548)
Natural Resources*IQ	**0.416***	**0.143**	**0.141**	**0.139**
	(0.250)	(0.129)	(0.129)	(0.136)
Aid*IQ	**36.88**	**37.95*****	**38.45*****	**38.37*****
	(22.63)	(12.40)	(12.68)	(12.72)
Institutional Quality	1.985**	1.109*	1.100*	1.089*
	(0.928)	(0.624)	(0.620)	(0.614)
Investments		16.30***	16.64***	16.64***
		(3.807)	(3.921)	(3.928)
Openness			-0.383	-0.387
			(1.457)	(1.482)
Ethnic Tensions				0.0255
				(0.259)
R-squared	0.150	0.308	0.308	0.308
Number of country	87	84	84	84

Note: The dependent variable is GDP per capita growth. IQ stands for Institutional Quality. Variables are described in more detail in the text. All regressions include time dummies and a constant, which coefficients are not reported. Robust standard errors in parentheses. Full sample. *significant at 10%, **significant at 5%, ***significant at 1%.

The FE regression estimates show interesting results in what concerns the impact of aid rents on GDP growth. Exhibit 12, which contains the results derived from the use of the averaged data, provides evidence of the positive effect of foreign aid rents on GDP growth in the context of high quality institutions, while not implying any relation between the two otherwise.

Exhibit 13 Fixed Effects Regression Model - Full Panel Data

Estimation method	OLS			
	(22)	(23)	(24)	(25)
Natural Resources	**-9.202**	**0.970**	**0.791**	**0.484**
	(6.278)	(5.164)	(5.356)	(5.492)
Aid	**-14.99*****	**-9.223****	**-9.156****	**-9.393****
	(5.524)	(4.599)	(4.636)	(4.668)
Natural Resources*IQ	**2.281**	**1.488**	**1.562**	**1.656**
	(1.562)	(1.463)	(1.468)	(1.504)
Aid*IQ	**6.969*****	**5.477*****	**5.437*****	**5.495*****
	(1.840)	(1.650)	(1.651)	(1.664)
Institutional Quality	2.291	0.288	0.298	0.568
	(2.183)	(1.726)	(1.724)	(1.620)
Investments		17.55***	17.61***	17.57***
		(2.641)	(2.837)	(2.853)
Openness			0.0865	0.0929
			(1.013)	(1.014)
Ethnic Tensions				-0.108
				(0.198)
R-squared	0.091	0.130	0.131	0.131
Number of country	88	85	85	85

Note: The dependent variable is GDP per capita growth. IQ stands for Institutional Quality. Variables are described in more detail in the text. All regressions include time dummies and a constant, which coefficients are not reported. Robust standard errors in parentheses. Full sample. *significant at 10%, **significant at 5%, ***significant at 1%.

When using the full panel data, consisting of observations for every country over every year between 1985 and 2006, the results are the ones hypothesised, with aid rents hindering growth unless in the presence of good institutions (Exhibit 13). In fact aid rents are shown to have adverse effects on GDP growth with 5% level of confidence, whereas aid rents coupled with good institutions have, at a 1% significance level, a positive impact on GDP growth across all specifications.

The use of the second measure of IQ across all specifications does not significantly alter the results; these estimates are presented in Appendix 6 and Appendix 7.

In comparison with other studies that have also employed country fixed effect, the results hereby presented, unlike the ones exposed in Hansen and Tarp (2001) where aid rents are reported to increase the GDP growth rate in any event, i.e. given good or bad institutions, are less encouraging with respect to aid effectiveness given the underlying conditionality.

Nevertheless, in Rajan and Subramanian (Rajan and Subramanian 2008), the robustness of the unconditional growth enhancing impact of aid rents had been already tested and rejected in a panel context. The results in the referred study are reported as lacking robustness concerning both the impact of aid rents on GDP growth, as well as this impact conditional on policy.

5 Discussion and Implications

Using a broad dataset and an extended time span, this study attempted to uncover the causal relation between foreign aid rents and GDP growth. Specifically a panel of 88 countries and a 22-year framework, from 1985 to 2006, was used to answer two question put forward at first which guided the research throughout the entire work. These two questions regarded the direct impact of aid rents on GDP growth, and its conditionality on the quality of local institutional arrangements.

The empirical model conceived in order to test the aid-institutions-growth relation was based on previous literature on the effectiveness and allocation of aid as well as on the natural resource curse literature. In fact was building upon the later topic that the hypothesis regarding the nature of the impact of aid rents on economic growth were formulated.

Given the challenges intrinsic to working with observational data, different regression models were addressed to tackle the threats to the validity of the results provided by simple MR using the OLS estimator. Both, the IV regression model and the FE regression model, were used, approaches that find their motivation in the vast literature on aid effectiveness.

While the IV regression model was used in order to overcome the endogeneity problem that is thought to exist regarding the variable measuring aid rents, the FE regression model was employed in order to minimize the omitted variable bias through controlling for variable that are constant over time but change across countries, as well as variables that are constant across countries but vary over time.

Throughout the empirical research all specifications use the full sample, given that excluding outliers does not significantly change the results, and robust standard errors, clustered standard errors in case of the FE regression model.

Furthermore, the inclusion of control variables was done in accordance to the previous literature, to control for omitted variable bias, and time fixed effects were employed across all specifications for robustness. These proceedings can be found in earlier literature on both the aid effectiveness and natural resource curse literature.

The use of two instrumental variables in the IV regression model allowed for a more comprehensive study of the validity of the instruments given that it was possible to perform an overidentifying restrictions test in order to assess exogeneity besides the F-statistic used to assess the instrument's relevance.

The use of the full panel data besides the average data in the FE regression model context provided interesting insights on the causal relation under study.

Nevertheless, results regarding the aid-institutions-growth relation remain unclear. Even though the OLS and 2SLS results similar results, providing evidence of an adverse effect of aid rents on GDP growth and no significance of the interaction term between aid and institutions, the results of the FE regression model are in some aspects not in line with the ones just described.

Using averaged data as well as the full panel data results in compelling evidence of the beneficial effect of aid rents on GDP growth in a high institutional quality context. However only the employment of the full panel data provides evidence of a deterrent character of foreign aid on GDP growth given poor local institutional arrangements.

It is not the first study encountering evidence of a negative impact of aid rents on economic growth; nonetheless this result has always been reported as a non-robust finding.

Contrary to what is documented in Collier (2006) this study is not able to robustly qualify aid rents as superior to natural resource rents, nor to provide robust evidence of the growth enhancing character of aid conditional on institutional quality as suggested in Burnside and Dollar (2004).

Far from trying to prove that aid is ineffective, this study, like many others, attempts to understand the dynamics that lie behind the relation between aid and growth, in this case through an institutional channel. Further empirical as well as theoretical insights are needed if cross-country studies are to be employed for policy purposes.

The fact that there exists no compelling evidence relating aid rents to increasing economic growth, should be an alert that there are factors offsetting what is undeniably a potential growth enhancing revenue, which is in fact transferred for the purpose of reducing poverty and increasing life standards. The quality rather than the quantity of aid should become the focus and a less general approach should be taken given that the developing world under study consists of extremely different cultures and economies around the globe.

6 Theoretical Model

The theoretical model hereby developed attempts to predict the impact of international aid and natural resource rents on growth through an institutional channel, and is adapted from the workhorse model in Besley and Persson (2010). It is a centralized political economy model, which along with the rent seeking approach and the Dutch Disease models are representative of the main theories in the aid effectiveness and natural resource literature.[15]

This model relies on the assumption that aid rents, as well as natural resource rents accrue entirely to the political elite and are thus subject to the leader's discretionary behaviour.[16] The leader's budget consists therefore of both aid and natural resource rents, which will be collectively referred to as windfalls, denoted by W and normalized to one.

The economy is characterized by a non-booming, yet productive, tradable sector. Formally, the tradable sector GDP depends on the share of W invested in the economy (x), according to the following production function

$$f(x) = x^{1/2}. \tag{9}$$

that is increasing in the share x but characterized by diminishing returns ($f' > 0; f'' < 0$).

[15] This model is characterized as a centralized political economy model due to its focus on the incentives and constraints faced by a political elite. Decentralized models, i.e. rente seeking, focus on the incentives faced by private individuals.

[16] Aid and resource rents are assumed to accrue to the incumbente in Morrison (2007) and in Dalgaard and Olsson (2008).

As in all political economy models, there is state intervention that in this case is modelled as a decision making process by a political elite, represented by a pro-active, self-interested utility maximizing individual, henceforth the leader. The leader's decision entails allocating W across his own consumption of political valuable goods, which can be thought of as distributions across the elite that are unproductive from an economic point of view, or in investments in the economy. However the freedom the leader enjoys in allocating W across the two ends is constrained by an exogenous variable α that captures the quality of the local institutional environment and assumes values from 0 to 1, i.e. $\alpha \in [0,1]$, with high values indicating high institutional quality. For simplicity the computations rely on the use of the parameter $\theta = (1 - \alpha)$, that varies inversely to α though also between 0 and 1. All in all, the leader maximizes the following utility function

$$U^l = (1 - x)\,\theta + tf(x) \tag{10}$$

where t is an exogenous tax rate. Hence, the share the leader directs to his own consumption of politically valuable goods, $(1 - x)$, enters his utility function directly, while the share devoted to investments in the economy enters through the taxation levied on the productive tradable sector. The leader cannot capture the entire tradable sector GDP due to the distortionary effects of taxation.

The focus should lie on the parameter θ, that enters the utility function creating a mechanism that refrains the leader from appropriating W for consumption scaling downwards the derived utility in accordance to the quality of the institutional environment. If institutional quality is very high, the incentive to appropriate W is minimized. This mechanism can be though of as representing the higher enforcement of rule of law and protection of property rights in better institutional environments leave

less room for the leader to not honour his commitments with the aid agencies, or the closer link between citizens and government in better institutional environments that promote transparency and government accountability. On the other hand if the institutional quality is very poor, it does not play a significant role in influencing the allocation of W.

Plugging equation (3) into equation (4) and taking the first order condition (FOC) with respect to the variable of choice, x, yields

$$\frac{t}{2x^{1/2}} = \theta \Leftrightarrow x = \frac{1}{4}\left(\frac{t}{\theta}\right)^2 \tag{11}$$

which shows the allocation of aid rents and natural resource rents to investments in the economy depends positively on the tax rate and institutional quality. Given that t is exogenous the focus is on the parameter θ, whose interpretation is summarized in Proposition1.

Proposition 1. *The higher the institutional quality, the higher is the share of aid and natural resource rents allocated to investments in the economy.*

Finally an adaptation of the Solow model relates the allocation decision made by the leader and GDP growth.[17] Assuming the share x of the aid and natural resource rents allocated to investments in the economy has an impact on long-term growth through the accumulation of capital, the dynamics between the windfall and GDP growth can be derived. Starting with a standard production function

$$Y = AK^{\beta}L^{1-\beta} \xrightarrow{intensive\ form} y = Ak^{\beta} \tag{12}$$

[17] The full derivation of the Solow model approach can be found in Appendix 8.

where A represents technology, the parameter β is the share of capital in income, $y = Y/L$ and $k = K/L$. And relying on the following capital accumulation equation

$$\dot{K} = I - \delta K \tag{13}$$

where δ refers to the depreciation rate and I corresponds to investment and therefore to the share x of the windfall allocated to the tradable sector, the relevant equation becomes

$$\dot{K} = xW - \delta K \xrightarrow{intensive\ form} \dot{k} = \frac{xW}{L} - (n + \delta)k \tag{14}$$

with n being population growth rate, and from where it is possible to derive the following conditions

$$xW/L < (n + \delta)k \Rightarrow \dot{k} < 0; xW/L > (n + \delta)k \Rightarrow \dot{k} > 0; xW/L = (n + \delta)k \Rightarrow \dot{k} = 0.$$

The implications coming from the above conditions lead to the following proposition

Proposition 2. *There is capital accumulation only if the magnitude of the investment in the economy exceeds the depreciation of capital coupled with the growth rate of the population.*

Furthermore GDP growth can be written relying on equations (12) and (14) as

$$g_y = \frac{\dot{y}}{y} = \beta\left(\frac{\dot{k}}{k} + \frac{\dot{A}}{A}\right) = \beta\left(\frac{xW}{K} - (n + \delta) + \frac{\dot{A}}{A}\right) \tag{15}$$

and given the fact that both rents have been considered in the empirical model as shares of GDP it is more consistent to write the above equation as

$$g_y = \beta\left(\frac{xW}{Y}\frac{Y}{K} - (n + \delta) + \frac{\dot{A}}{A}\right) \tag{16}$$

and derive the FOC w.r.t. the share of aid and natural resource rents to GDP

$$\frac{\partial g_y}{\partial\left(\frac{xW}{Y}\right)} = x\beta\frac{Y}{K} \tag{17}$$

whose intuitive result is expressed in Proposition 3.

Proposition 3. *The impact of aid and natural resources on economic growth if fundamentally positive and depends on the share allocated to investments in the economy.*

This model therefore uncovers the growth enhancing potential of both economic rents that is offset by poor institutions that do not enforce the allocation of a share of the revenues high enough to overcome the depreciation of capital and the growth rate of the population allowing for capital accumulation and long-term growth.

7 Conclusion

In this study aid effectiveness was analysed in light of the documented results on the impact of natural resource rents on GDP growth. The aim was to assess to what extent both revenues are comparable. To this end two questions were addressed, namely what is the impact of aid on GDP growth and if this impact is linked with the local institutional environment.

Using the standard measures of aid, natural resources, institutional quality and growth, and relying on controls previously used in the literature, the results were not encouraging with respect to foreign aid inflows. While the results regarding the impact of natural resource rents were consistent with previous literature, reinforcing the acknowledged conditionality on institutions, aid inflows' positive impact on growth in a good institutional environment was left to prove given the lack of robustness of the results.

Once again the aid-growth relationship has been revisited, both in cross-country and panel contexts, without providing any conclusive results. Further research should aim at going beyond cross-country analysis, and uncover what lies behind the impact of aid on economic growth. Analysing through what channels aid may be either promoting or hindering growth and understanding the different successful or rather unsuccessful experiences is imperative in order to promote aid effectiveness. Also, to bear in mind that every case is unique is very important in a developing world that comprises a vast and dissimilar amount of countries.

Aid by itself appears to lack the capability of financing growth; therefore the lasting focus on the magnitude of the transfers should not distract aid agencies from their

primary objective of reaching the most in need and provide means for the improvement of life standards. Careful evaluation of on-going and complete projects, as well as population involvement can only benefit both sides of the donor-recipient relationship and should consist of a standard procedure.

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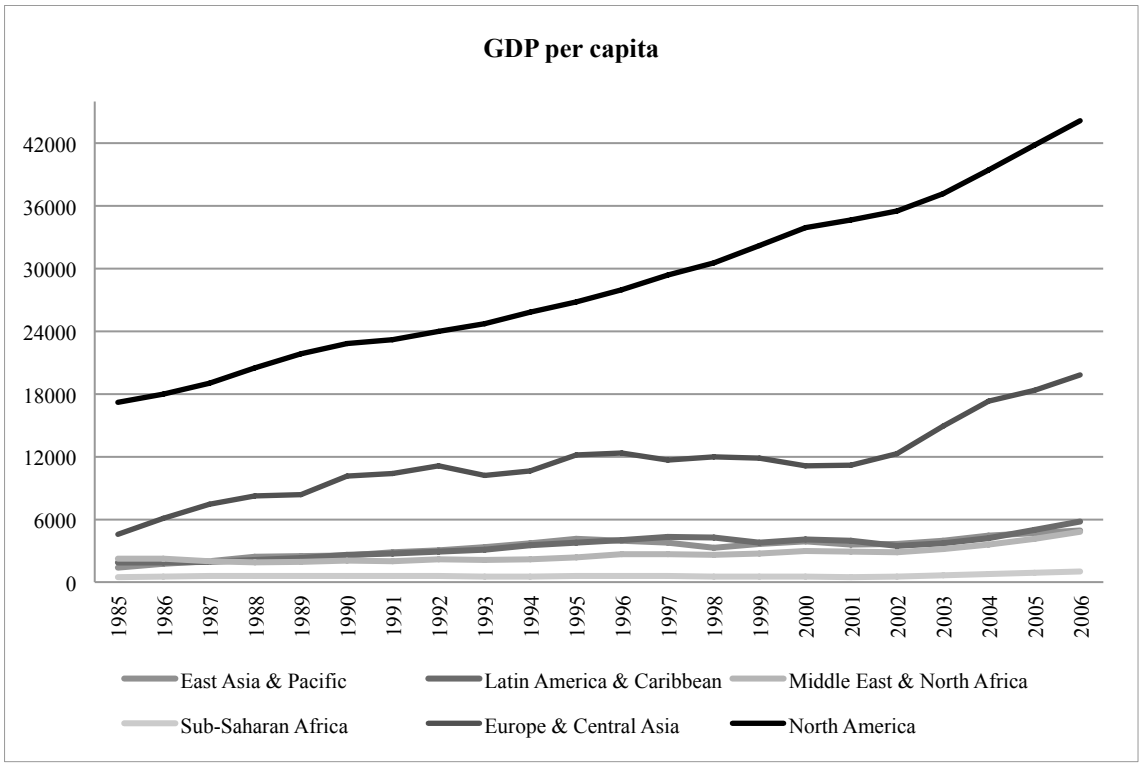
Appendix

Appendix 1 GDP per capita



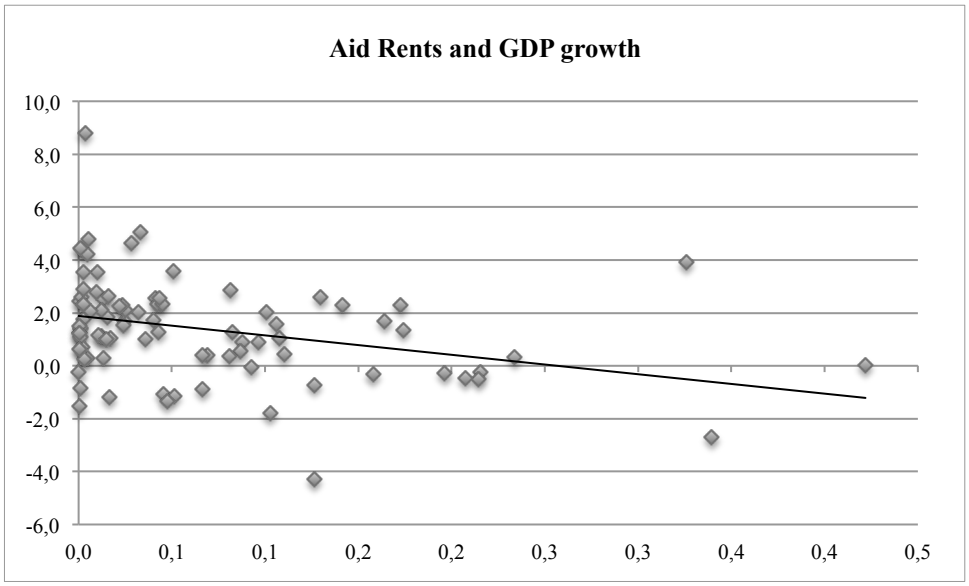
Appendix 2 Country-Specific Summary Statistics

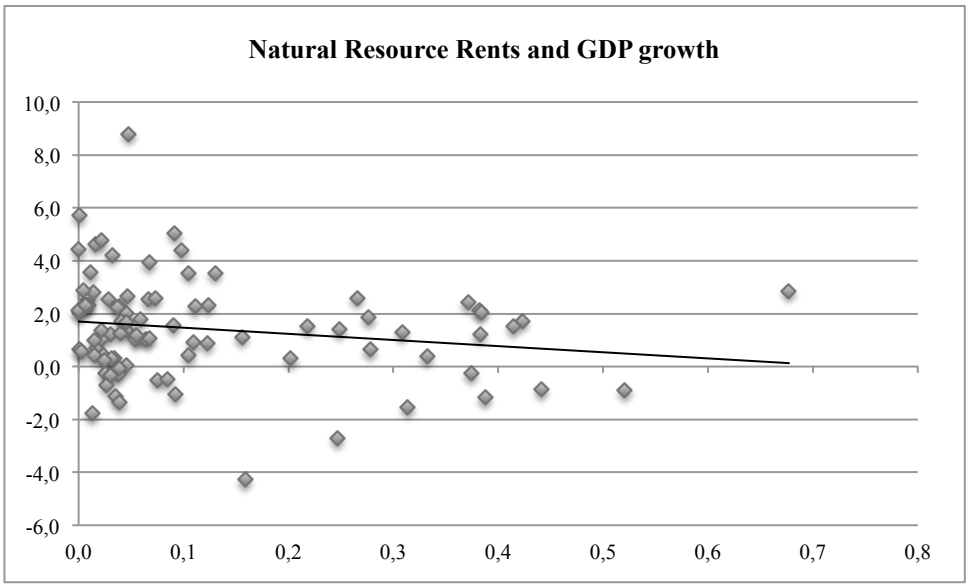
Country	GDP pc growth	NR Rents (%GDP)	Aid (% GDP)	IQ Index
Algeria	0,295	0,202	0,005	3,379
Angola	1,714	0,423	0,040	2,948
Argentina	1,394	0,046	0,001	3,728
Bahamas, The	0,621	0,001	0,001	4,615
Bahrain	1,832	0,277	0,015	4,510
Bangladesh	2,551	0,029	0,041	2,362
Bolivia	0,907	0,109	0,088	3,044
Botswana	4,624	0,016	0,028	4,811
Brazil	1,224	0,030	0,000	3,775
Brunei Darussalam	-0,871	0,441	0,001	5,633
Burkina Faso	2,278	0,038	0,142	3,562
Cameroon	-1,053	0,092	0,045	3,371
Chile	4,404	0,098	0,002	4,680
China	8,794	0,048	0,003	3,932
Colombia	1,764	0,059	0,003	3,238
Congo, Dem. Rep.	-4,282	0,159	0,126	3,238
Congo, Rep.	-0,892	0,520	0,067	1,549
Costa Rica	2,506	0,009	0,013	4,426
Cote d'Ivoire	-1,141	0,036	0,051	3,492
Cuba	0,695	0,017	0,002	3,455
Dominican Rep.	2,794	0,014	0,009	3,632
Ecuador	1,109	0,156	0,012	3,465
Egypt, Arab Rep.	2,339	0,123	0,042	3,480
El Salvador	2,337	0,009	0,045	2,980
Ethiopia	1,042	0,064	0,108	2,924
Gabon	-1,177	0,387	0,017	3,258
Gambia, The	-0,256	0,025	0,216	3,942
Ghana	2,010	0,046	0,100	3,507
Guatemala	1,035	0,021	0,017	3,035
Guinea	0,866	0,123	0,096	3,315
Guinea-Bissau	0,039	0,046	0,422	2,574
Guyana	2,285	0,111	0,173	3,115
Haiti	-1,787	0,013	0,103	1,597
Honduras	1,274	0,040	0,083	3,012
India	4,221	0,032	0,005	3,848
Indonesia	3,534	0,105	0,010	2,982
Iran, Islamic Rep.	1,397	0,249	0,001	3,450
Iraq	2,849	0,677	0,081	2,031
Israel	2,038	0,000	0,032	4,780
Jamaica	1,688	0,040	0,025	3,589
Jordan	0,563	0,002	0,087	3,987
Kenya	0,405	0,023	0,069	3,779
Korea, Rep.	5,709	0,000	0,000	3,163
Kuwait	1,503	0,414	0,000	4,133
Lebanon	2,121	0,000	0,025	2,902
Liberia	-2,699	0,247	0,340	1,368
Libya	2,431	0,371	0,000	4,509
Madagascar	-0,715	0,027	0,126	3,664
Malawi	0,308	0,034	0,234	3,596
Malaysia	3,531	0,130	0,003	4,378
Mali	1,355	0,021	0,174	2,653
Mexico	1,071	0,067	0,001	3,944
Mongolia	1,543	0,090	0,106	3,649
Morocco	2,308	0,008	0,023	4,089
Mozambique	3,921	0,067	0,326	3,268
Namibia	1,029	0,054	0,036	4,700
Nicaragua	-0,294	0,038	0,196	3,393
Niger	-0,347	0,031	0,158	2,982
Nigeria	2,099	0,382	0,012	2,616
Oman	2,050	0,384	0,006	4,441
Pakistan	2,249	0,037	0,022	2,880
Papua New Guinea	0,361	0,332	0,081	3,548
Paraguay	0,301	0,031	0,013	3,117
Peru	1,171	0,055	0,011	3,221
Philippines	1,002	0,016	0,015	3,233
Qatar	1,219	0,383	0,000	4,509
Saudi Arabia	-0,257	0,374	0,000	4,256

Senegal	0,446	0,015	0,110	3,476
Sierra Leone	-0,493	0,075	0,215	2,392
Singapore	4,434	0,000	0,001	5,627
South Africa	0,236	0,024	0,003	4,509
Sri Lanka	3,571	0,012	0,051	3,495
Sudan	2,555	0,067	0,043	2,163
Suriname	0,405	0,105	0,067	2,832
Syria	1,525	0,218	0,024	3,318
Tanzania	1,673	0,046	0,164	3,566
Thailand	4,764	0,021	0,005	4,107
Togo	-0,072	0,038	0,093	2,830
T. and Tobago	2,586	0,265	0,002	4,155
Tunisia	2,642	0,046	0,016	3,949
Turkey	2,879	0,005	0,002	3,779
Uganda	2,593	0,073	0,130	3,241
UAE	-1,555	0,314	0,000	3,159
Uruguay	2,333	0,006	0,003	3,831
Venezuela, RB	0,634	0,278	0,001	3,241
Vietnam	5,029	0,091	0,033	3,473
Yemen, Rep.	1,287	0,308	0,043	3,371
Zambia	-0,486	0,084	0,207	3,261
Zimbabwe	-1,357	0,039	0,047	2,838

Note: NR stands for Natural Resourses. IQ stands for Institutional Quality. Variables described in the text.

Appendix 3 Economic rents and growth



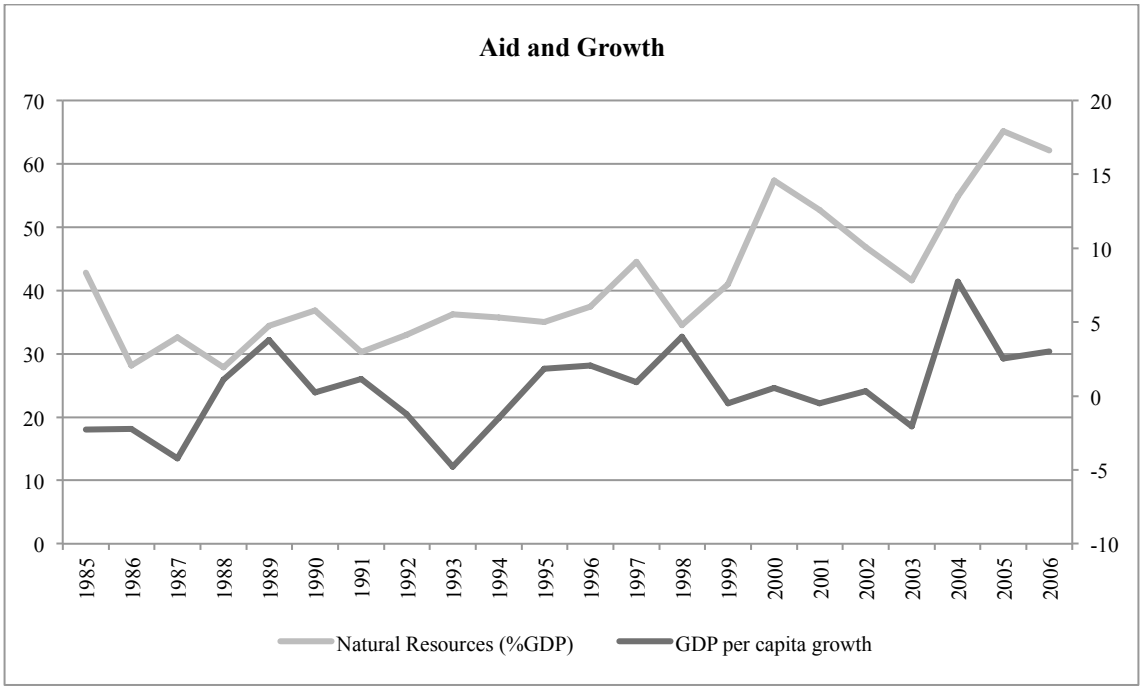


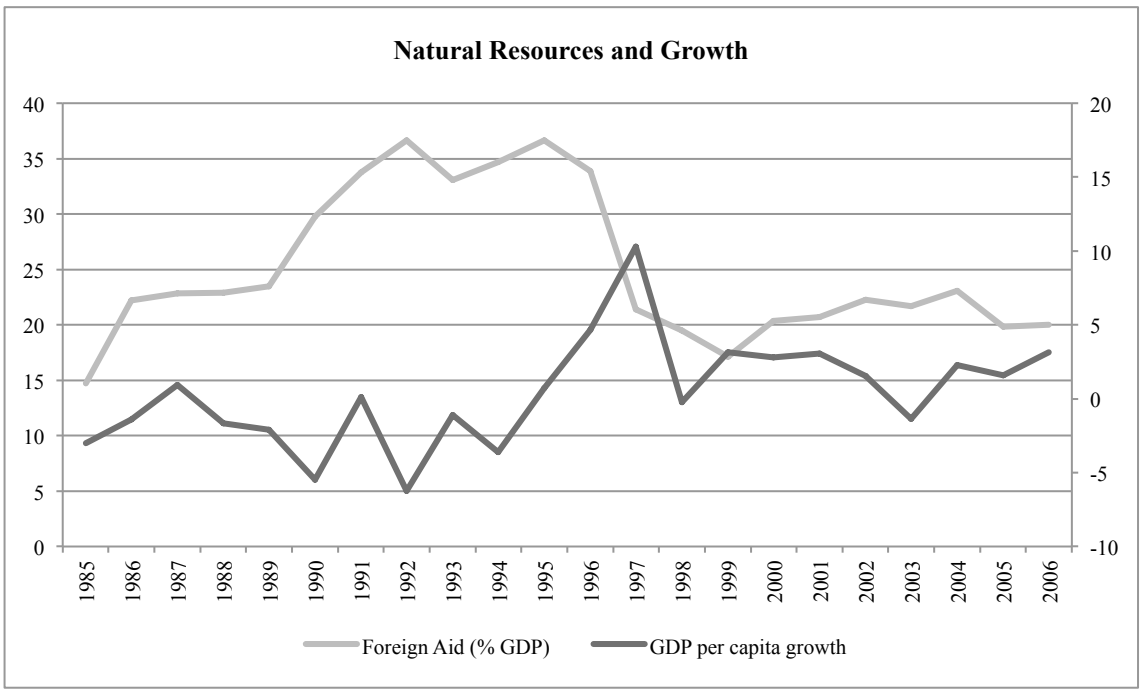
Appendix 4 Colonies – Dummy Variable

UK	France	Netherlands	Belgium
Bahamas, The	Algeria	Indonesia	Congo, Dem. Rep.
Bahrain	Burkina Faso	Suriname	
Botswana	Cameoon		
Brunei	Congo, Rep.		
Gambia, The	Cote d'Ivoire		
Ghana	Gabon		
Guyana	Guinea		
India	Madagascar		
Jamaica	Mali		
Kenya	Morocco		
Kuwait	Niger		
Malawi	Senegal		
Malaysia	Togo		
Nigeria	Tunisia		
Qatar	Vietnam		
Sierra Leone			
Sri Lanka			
Sudan			
Tanzania			
Trinidad and Tobago			
Uganda			
UAE			
Zambia			
Zimbabwe			

Note: Countries that are classified as colonies of UK, France, Netherland or Belgium have value 1 while the remaining countries assume value 0.

Appendix 5 Graphs: Aid and Natural Resources Dependency





Appendix 6 FE – Averaged Data – Alternative IQ Variable

Estimation method	OLS			
	(1)	(2)	(3)	(4)
Initial GDP per capita	0.192	-0.511	-0.506	-0.511
	(1.890)	(0.728)	(0.736)	(0.740)
Natural Resources	**-30.13**	**-0.424**	**-0.0169**	**0.505**
	(26.16)	(8.313)	(8.409)	(8.605)
Aid	**-5.796**	**-9.812**	**-9.837**	**-9.752**
	(19.13)	(6.128)	(6.100)	(6.052)
Natural Resources*IQ	**0.475**	**0.203**	**0.202**	**0.195**
	(0.350)	(0.146)	(0.146)	(0.148)
Aid*IQ	**52.22***	**48.79*****	**49.59*****	**50.13*****
	(29.12)	(14.81)	(15.08)	(15.14)
Institutional Quality	-1.011	-1.305	-1.347	-1.799
	(5.606)	(1.910)	(1.916)	(2.010)
Investments		17.75***	18.25***	18.30***
		(3.832)	(3.994)	(3.985)
Openness			-0.561	-0.604
			(1.447)	(1.480)
Ethnic Tensions				0.192
				(0.276)
R-squared	0.138	0.297	0.298	0.300
Number of country	87	84	84	84

Note: The dependent variable is GDP per capita growth. IQ stands for Institutional Quality. Variables are described in more detail in the text. All regressions include time dummies and a constant, which coefficients are not reported. Robust standard errors in parentheses. Full sample. *significant at 10%, **significant at 5%, ***significant at 1%.

Appendix 7 FE – Full Panel Data – Alternative IQ Variable

Estimation method	OLS			
	(5)	(6)	(7)	(8)
Natural Resources	-11.24	0.331	0.0803	-0.0171
	(6.859)	(5.469)	(5.635)	(5.692)
Aid	-17.11***	-9.861**	-9.867**	-9.935**
	(5.777)	(4.805)	(4.826)	(4.842)
Natural Resources*IQ	2.982*	1.695	1.795	1.814
	(1.794)	(1.588)	(1.588)	(1.597)
Aid*IQ	8.000***	5.731***	5.723***	5.720***
	(2.020)	(1.770)	(1.770)	(1.769)
Institutional Quality	-0.968	-0.334	-0.387	-0.187
	(1.819)	(1.352)	(1.336)	(1.248)
Investments		17.71***	17.79***	17.77***
		(2.660)	(2.879)	(2.895)
Openness			0.0734	0.0841
			(1.003)	(1.010)
Ethnic Tensions				-0.0848
				(0.198)
R-squared	0.090	0.130	0.131	0.131
Number of country	88	85	85	85

Note: The dependent variable is GDP per capita growth. IQ stands for Institutional Quality. Variables are described in more detail in the text. All regressions include time dummies and a constant, which coefficients are not reported. Robust standard errors in parentheses. Full sample. *significant at 10%, **significant at 5%, ***significant at 1%.

Appendix 8 Theoretical Model Derivations

$$Y = AK^{\beta}L^{1-\beta}$$

$$y = Ak^{\beta}$$

$$\ln y = \beta(\ln A + \ln k)$$

$$\dot{K} = I - \delta K$$

$$\dot{K} = xW - \delta K$$

$$k = \frac{K}{L} \Rightarrow \ln k = \ln K - \ln L$$

$$\frac{\dot{k}}{k} = \frac{\dot{K}}{K} - \frac{\dot{L}}{L}$$

$$\frac{\dot{k}}{k} = \frac{xW - \delta K}{K} - n$$

$$\frac{\dot{k}}{k} = \frac{xW}{K} - \delta - n$$

$$\dot{k} = \frac{K}{L}\frac{xW}{K} - (\delta - n)k$$

$$\dot{k} = \frac{xW}{L} - (\delta + n)k$$

$$\frac{\dot{y}}{y} = \beta\left(\frac{\dot{k}}{k} + \frac{\dot{A}}{A}\right)$$

$$\frac{\dot{y}}{y} = \beta\left(\frac{xW}{Lk} - (\delta + n) + \frac{\dot{A}}{A}\right)$$

$$\frac{\dot{y}}{y} = \beta\left(\frac{xW}{K}\frac{Y}{Y} - (\delta + n) + \frac{\dot{A}}{A}\right)$$

$$\frac{\dot{y}}{y} = \beta\left(\frac{xW}{Y}\frac{Y}{K} - (\delta + n) + \frac{\dot{A}}{A}\right)$$