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Natural resources and China's foreign assistance in Africa: a two-sided story

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Abstract

In the context of climate change, countries need natural resources for their development and energy transition process. A large share of these resources is based in emerging and developing countries. Within this framework, we investigate whether natural resources endowment has become a key determinant in the allocation of development aid. We put a specific focus on China, which has started to have a proactive role in international aid to other countries, although it is still an emerging economy. In particular, we analyze whether China is increasingly granting aid to countries well endowed with natural resources and if this official development assistance is motivated by economic interests, mainly those related to natural resources. To do so, we use two sets of data: an original database at the country level, covering the period 2000-2016, and geocoded data on 1650 Chinese development projects across 2969 physical locations in Africa over the period 1999-2013. We built thus our analysis at a macro and microeconomic level. Our results show that the aid granted by China can be linked to access to natural resources.

JEL Codes : F35 , L72 , O13

Keywords : Foreign Aid , Natural Resources , Energy Transition

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1 Introduction

Foreign aid stands as a key vector to finance development strategies in emerging and developing countries [Reilly, 2013, Isaksson and Kotsadam, 2018, Pérez Niño and Le Billon, 2014, Brant, 2013]. Given the existing development gaps between the so-called Southern and Northern countries, the latter have come together in a development assistance committee (DAC) under the aegis of the OECD and have developed aid systems aimed at supporting the least developed economies on their development paths[1], based on specific criteria. This aid, which is most often anchored to well-defined projects, affects all the sectors that drive development in the recipient countries. But this raises other questions: do the donor countries base their aid on humanitarian or development criteria only? or are there other specific interests that could be pursued? Several studies have revealed that donors might pursue, in their decisions to allocate aid, interests that can be political, economic or social.

The leadership of OECD countries in the field of official development assistance (ODA) is being challenged by the emergence of new actors in both the North and the South. The emergence of China as a significant provider of development assistance operating outside the dominant aid system has prompted heightened interest within academic, public, and policymaking circles. China, despite its status as an emerging country, is the largest creditor of African countries and provides foreign aid to the extent of its capacity. According to the UN rules, foreign aid is an obligation and a duty of developed countries. So, the foreign aid provided by China is a mutual aid between developing countries and thus falls under South-South cooperation. The aid provided by China, the world's largest emerging country, to other developing countries, can take several forms as complete projects, goods and materials, technical cooperation and human resources development cooperation, medical teams and volunteers, emergency humanitarian aid, debt relief, construction of infrastructure and implementation of production projects. In this era of climate change, where the world is looking for the natural resources needed in the energy transition process, most of which are located in less developed countries, our research question is: **is China increasingly granting aid to countries endowed with natural resources (e.g. resources needed in the energy transition's context)?**

The next section will be devoted to reviewing the literature on this topic. Section 3 will describe the different datasets used and the empirical methodology used in our study. Section 4 will check the robustness of our results. Section 5 concludes.

[1] Since 1972 OECD DAC has defined ODA for its 24 members as « Those flows to countries and territories on the DAC list of ODA recipients and to multilateral institutions » which are : i. provided by official agencies, including state and local governments, or by their executive agencies; and ii. each transaction of which: a) is administered with the promotion of the economic development and welfare of developing countries as its main objective; and b) is concessional and conveys a grant element of at least 25 percent (calculated at a rate of discount of 10 percent).

2 Literature Review

The literature on the determinants of development aid is extensive [2]. Many studies have focused on the factors that may influence the aid decisions of donor countries and the identities of recipient countries. The results of these studies vary not only according to the donor countries but also according to the studied periods. To our knowledge, we are the first to look at the possible impact of natural resources endowments in the energy transition's context on the flows and destinations of China's development aid.

Dreher et al. [2019] in their work, have sought to know if Chinese public aid is oriented more towards the birth regions of political leaders, which would invalidate the hypothesis of granting this aid for humanitarian purposes. They collected data on the birthplaces of 117 African leaders and geocoded 1,650 Chinese development projects at 2,969 physical locations in Africa from 2000 to 2012. Their econometric results show that the birthplaces of political leaders receive significantly greater financial flows from China during their years in power, compared to what the same region receives at other times. Dreher et al. [2018] argue that much of the controversy of Chinese "aid" stems from a failure to distinguish between China's official development assistance (ODA) and more commercially oriented sources and types of state funding. Using a new database on China's official funding commitments to Africa from 2000 to 2013, they find that Chinese ODA allocation is primarily driven by foreign policy considerations, while economic interests better explain the distribution of less concessional flows. These results underscore the need for better measures of an increasingly diverse set of international financial activities. Furuoka [2017] used the pooled OLS, the one-way fixed effects, and the two-way fixed effects, to examine and compare China's and Japan's foreign aid allocation models in Africa. The main finding is that the provision of foreign aid by China and Japan is mainly driven by the self-interest of the donors. In addition, the size of a recipient country's population was an important factor in determining China's and Japan's aid allocations. The results also suggest that Japan tended to pay more attention to the needs of aid recipient countries and the quality of governance and institutions in these countries. Overall, the results indicate that there is no significant difference in the motives for providing aid between the two donor countries.

Kim and Oh [2012] also study the determinants of development aid but unlike the previous study, focused on the case of South Korea. Drawing on a panel of 154 countries over 23 years, they determined whether South Korea's aid met the basic criteria for development aid as defined by the OECD or whether rather South Korea was pursuing selfish interests. The results showed that South Korea's aid goes mainly to developing countries with high incomes and economic growth, implying that South Korea might be pursuing self-interest through its aid. In order to detect a change in aid policy over time, the data was examined by time periods and no significant change was detected either over time or with respect to any regime change. Nevertheless the analysis based on the category of recipient countries in proportion to their income levels indicates a negative correlation between development assistance and recipient

[2] See Carter [2017] for further details on the literature review on China's aid

countries' per capita income for middle- and low-income countries, while this correlation is positive for the other categories of countries. These results suggest that South Korea's aid policy is two-faced, i.e. it pursues selfish interests in high per capita income countries and is based on humanitarian criteria relative to the needs of recipient countries when the latter are low income countries. Dreher and Fuchs [2011] use various data sources covering the period 1956-2012 to empirically determine whether Chinese aid is motivated by political or commercial interests. They estimated the determinants of China's aid allocation by sector from another perspective: project aid, food aid, medical personnel, and total aid to developing countries allocation decisions with traditional and other so-called emerging donors. The results show that political considerations are one of the main motivations for China's aid allocation. However, compared to other donors, China does not pay much more attention to politics. Contrary to widespread perceptions, they find no evidence that China's aid allocation is dominated by natural resource endowments. Moreover, China's aid allocation appears to be largely independent of democracy and governance quality in recipient countries.

Ali and Isse [2006] use a panel approach to assess the determinants of foreign aid. The study focuses on the extent to which variables such as taxes on international trade, the extent of government activity, ethnicity, private credit, and education are key determinants of foreign aid. They specify and estimate a model explaining foreign aid, based on a panel of 151 countries over a 23-year period. The results show that trade, private credit, foreign direct investment, GDP per worker, and government consumption are important determinants of foreign aid. Factors that appear to increase foreign aid are international trade taxes, ethnicity, and public consumption, while those that appear to decrease it are years of schooling, private credit, trade, and GDP per worker. Cooray and Shahiduzzaman [2004] study the determinants of development aid in their paper by focusing on Japan's development aid and using a sample of 96 countries that received development aid from Japan over the period 1981-2001. Their results show that Japan's development aid allocation policies have changed over time and that the main determinants of Japan's development aid are : GDP per capita, demography, trade between Japan and the recipient country, and democratic status. Unfortunately, these results also underline that Japan also pursues its own interests in addition to the needs of its aid recipients. Berthelemy and Tichit [2002] conducted a three-dimensional analysis of aid based on a panel of 22 donors and 137 recipients over a 20-year period (1980-1999) and using a Tobit model to take into account the possible non-observance of the dependent variable "aid" in certain years. The main findings of this study estimate that aid has been on an autonomous downward trend, at a rate of more than 6% per year, in real terms, since the end of the Cold War. Although with decreasing intensity, the best way to attract bilateral aid is to become democratic. This is particularly true for U.S. and Australian aid. Traditional post-colonial ties still have a strong, but diminishing, influence on the aid allocation policies of former colonial countries. Commercial ties, on the other hand, have a growing, though still small, impact. Good economic performance was on average rewarded by donors in the 1990s. Hence, overall, very few studies underline the presence and the exploitation of natural resources as a possible determinant of foreign aid allocation.

3 Methodology and Data

This section highlights the data and empirical strategy adopted to determine the role of natural resources in China's development assistance to African countries. We conduct our analysis at both the macroeconomic and microeconomic levels. Our macroeconomic data covers all African countries from 2000 to 2016 and our microeconomic data covers the Chinese aid projects located in a total of 47 countries, at sub-national level, from 1999 to 2013. For the micro level analysis, sub-national units are thus considered. They are administrative regions (ADM1) and correspond to provinces, states or provinces, states or governorates. The Global Administrative Areas Database (GADM) provides information on subnational administrative areas and their boundaries (Figure 1). There are 709 ADM1 regions in the 47 African countries covered by our sample.

3.1 Empirical strategy

In order to verify whether natural resources play a significant role in China's development assistance to African countries, as announced, we have conducted two types of analysis : one at macro and the other at micro level.

- The macro analysis is defined by equation 1, where ODA_{it} our dependent variable represents the amounts of China's development projects aggregated for each country and year, $Natural\ Resources_{it}$ the natural resource rents of each country at time t as a percentage of GDP and X_{it} a set of control variables which are : GDP per capita, demography, debt service (% of GNI), trade openness, the level of education, life expectancy and a dummy which takes values one if there is a resource discoveries in the country at time t and zero otherwise.

$$\boxed{ODA_{it} = \beta_1\, Natural\ Resources_{it} + \beta_2\, X_{it} + e_{it}} \tag{1}$$

- The analysis conducted at a more disaggregated level, that we call a micro level, is captured by equation 2, where ODA_{rt} is our explained variable. It represents each of China's 1650 development projects geocoded at administrative region level (r). This variable is assumed to be a function of $Mines_{rt}$, which is the number of mines facilities available in each administrative region r for all mineral resources. $Oilgas_{rt}$ is a dummy which takes a value of one if parts of an oil or gas field are within the boundaries of an administrative region, r. X_{rt} is a set of control variables at regional level, which are: night lights, population, capital region, area (in squared km), port presence and road density.

$$\boxed{ODA_{rt} = f(Mines_{rt}\ , Oilgas_{rt}\ , X_{rt})} \tag{2}$$

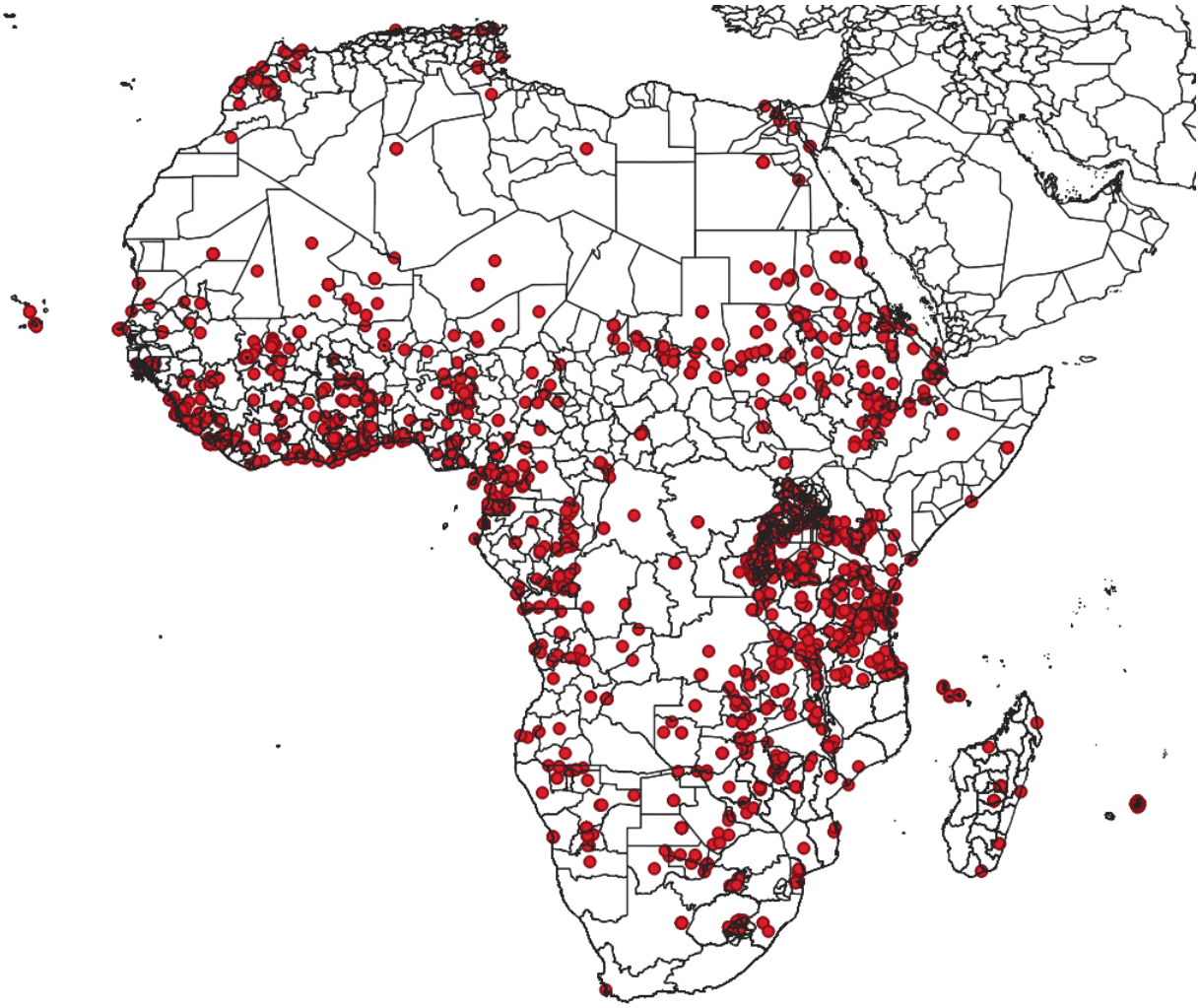
Both equations have been estimated by Ordinary Least Square, Least Square Dummy Variable and Poisson Pseudo Maximum Likelihood. Silva and Tenreyro [2006] show that PPML outperforms simple OLS and Tobit approaches with heteroskedasticity and many zero observations in the data.

3.2 Data

Various data sources were used to conduct our study at the macro and micro levels. In the macro analysis, Aid Data provided us with data on the amount of development projects financed by China in African countries over a 17 year period (2000 to 2016), data which were then aggregated by country and year. All other variables come from the WDI database of the World Bank. Our variable measuring the natural resource wealth of the recipient country is the total natural resource rent expressed as a percentage of GDP. The latter was then decomposed by type of resource (Mineral, Oil and Natural gas) in order to perform a more detailed analysis. Population is the logarithm of the total population in each country i at time t, GDP/head the logarithm of per capita GDP. The debt variable translates the debt service of each country expressed in percentage of Gross National Income (GNI). Trade openness is the sum of exports and imports of goods and services measured as a share of gross domestic product. The education variable captures the level of tertiary education. Life expectancy is the average time men and women in each country i are expected to live at birth. The resources discoveries variable is a dummy taking a value of 1 if there is a resource discoveries in the country at time t and 0 otherwise.

In the dissagregated (micro) analysis, we used data stemming from Dreher et al. [2019]. A total of 1650 Chinese development projects have been geocoded across 2969 physical locations in Africa from 1999 to 2013 at administrative region level (ADM1) for our ODA variable. Night light intensity is a variable defining the night time light intensity at regional level from the National Oceanic and Atmospheric Administration (NOAA, 2014). This variable was preferred over GDP per capita as a proxy of the level of development of each administrative region due to its high granularity. Indeed, income data at the regional level is difficult to obtain, especially in African countries. Area, expressed in squared kilometers, is the regional area directly calculated from the shapefile of subnational boundaries. Our population variable represents an estimate of the population at regional level based on high-resolution data on the spatial distribution of the world population in 2000 by the Center for International Earth Science Information Network (CIESIN). Road density is computed as the total length of road per km^2 at regional level using geographic data from CIESIN (2013). Capital Region is a dummy which takes a value of 1 if the capital city is located in the administrative region. $Port_{rt}$ is also a binary variable that is equal to 1 if a port is located in region r and zero otherwise according to data from the World Port Index (NGA, 2011). To test the possibility that Chinese aid is motivated by a desire for access to natural resources, $Mines_{rt}$ variable is calculated, and it is defined as the logarithm of the sum of mining facilities in each subnational region r according to the mineral resource data system United States Geological Survey (USGS, 2005).

Figure 1: **China's aid project in Africa geocoded at ADM1 level**



The new geo referenced data on China's foreign aid activities have been obtained by building on the Strange et al. [2017] and Dreher et al. [2019] dataset, which provides project-level information on Chinese government-funded activities in African countries (see Strange et al. [2014] for methodological details). These data on Chinese official funding were assembled using AidData's Tracking Underreported Financial Flows (TUFF) method, which synthesises and standardises a large amount of unstructured information in the public domain. In total, they cover 1650 projects committed in 49 African countries, representing approximately $83.3 billion in official funding over the period 1999-2013. Despite the short time since the dataset was published, it has already been used in a number of publications at the country level.[3]

[3] See : Hendrix and Noland [2014], Dreher and Fuchs [2015], Hernandez [2017], Li [2017], Eichenauer et al. [2018] In order to bring the data to the sub-national level, the project-level data have been geo-referenced from AidData's Chinese Official Finance to Africa dataset version 1.1 using the method described in Strandow et al. [2011] This method is based on a double-blind system, in which two coders use a defined hierarchy of geographic terms and independently assign uniform latitude and longitude coordinates, data accuracy information and standardised names to projects.

4 Results

4.1 Macroeconomic level Analysis

In order to address our research question at the macroeconomic level, we estimate equation 1 using the PPML and LSDV estimation techniques. The latter are robust estimation approaches as they not only overcome the endogeneity problems (LSDV) but also solve the problems of heteroskedasticity and zero observations in the data. Table 1 and table 2 shows the results of the estimations of equation 1. These results confirm the conclusions of several studies and underline some interesting facts related to Chinese aid, especially in the current context of energy transition in recent years, which has triggered a race for critical metals.[4]

Table 1 : Regression with resources at aggregated level

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	3.425	0.194	3.583	0.204	3.570	0.203
	(1.49)	(1.52)	(1.59)	(1.63)	(1.57)	(1.62)
GDP per head	4.660***	0.271***	4.669***	0.272***	4.669***	0.272***
	(4.00)	(4.27)	(4.00)	(4.28)	(4.00)	(4.28)
Debt	0.0542*	0.00327*	0.0560*	0.00338*	0.0560*	0.00337*
	(1.73)	(1.90)	(1.78)	(1.95)	(1.77)	(1.94)
Trade	-0.0786	-0.00315	-0.118	-0.00556	-0.120	-0.00565
	(-0.48)	(-0.34)	(-0.71)	(-0.59)	(-0.71)	(-0.60)
Education	-0.543*	-0.0315*	-0.548*	-0.0319*	-0.546*	-0.0318*
	(-1.77)	(-1.85)	(-1.78)	(-1.88)	(-1.77)	(-1.87)
Life expectancy	-6.535**	-0.399**	-6.122*	-0.374**	-6.089*	-0.372**
	(-2.07)	(-2.25)	(-1.85)	(-2.01)	(-1.82)	(-1.98)
Resources rents			0.201	0.0123	0.203	0.0124
			(0.69)	(0.76)	(0.69)	(0.76)
Resource discoveries					0.119	0.00486
					(0.13)	(0.10)
N	442	442	442	442	442	442
R^2	0.280		0.280		0.280	
pseudo R^2		0.013		0.013		0.013

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

[4] Bonnet et al. [2022] : Essential to low-carbon technologies, strategic minerals and metals are at the heart of considerable economic and geopolitical stakes and geopolitical issues. China is already a major producer, and is increasing its direct investment abroad and is developing its refining capacity to consolidate its dominant position. Western economies are planning to diversify their supplies, build up strategic stocks, promote the exploitation of resources at home, develop recycling policies and strengthen their investments abroad. These are all challenges to be met in order to reduce their dependence on China

Our results show that the variables that positively impact Chinese aid are GDP per capita and debt service (in percentage of GNI). The level of education (mainly tertiary) and life expectancy are variables negatively correlated with Chinese foreign aid. Our measure of natural resource wealth, represented by the annual natural resource rents of the countries in our sample, when taken at an aggregate level is not significant (Table 1). We therefore decomposed it by resource type and the results show that only mineral and oil resources play a key role in explaining China's foreign assistance. The positive correlation between aid with oil revenues can be explained by China's new status as the world's leading economic power. Faced with huge needs in energy resources for its development, it has to diversify its imports to stabilize its supplies and reduce its dependency on Middle East. Hence a new strategic partnership with many oil-producing African countries such as Algeria, Sudan, Cameroon, Nigeria, Gabon, Congo and Angola, since 2006, within the 3rd China-Africa summit. Mineral rents are also positively correlated to Chinese aid and are defined as the difference between the production value of a mineral stock at world prices and its total production costs. The minerals included in the calculation are tin, gold, silver, lead, zinc, iron, copper, nickel, bauxite and phosphate [5]

Table 2 : Regression with resources at disaggregated level

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	3.425	0.194	3.753*	0.218*	3.731	0.217*
	(1.49)	(1.52)	(1.65)	(1.74)	(1.63)	(1.72)
GDP per head	4.660***	0.271***	4.444***	0.260***	4.443***	0.260***
	(4.00)	(4.27)	(3.78)	(4.07)	(3.77)	(4.07)
Debt	0.0542*	0.00327*	0.0612**	0.00366**	0.0611*	0.00366**
	(1.73)	(1.90)	(1.97)	(2.15)	(1.96)	(2.15)
Trade	-0.0786	-0.00315	-0.250	-0.0134	-0.254	-0.0135
	(-0.48)	(-0.34)	(-1.49)	(-1.42)	(-1.49)	(-1.42)
Education	-0.543*	-0.0315*	-0.405	-0.0238	-0.403	-0.0237
	(-1.77)	(-1.85)	(-1.29)	(-1.37)	(-1.27)	(-1.36)
Life expectancy	-6.535**	-0.399**	-5.010	-0.313*	-4.954	-0.310
	(-2.07)	(-2.25)	(-1.48)	(-1.66)	(-1.45)	(-1.63)
Mineral rents			0.481*	0.0269*	0.482*	0.0269*
			(1.87)	(1.90)	(1.87)	(1.90)
Oil rents			0.445**	0.0277**	0.448**	0.0278**
			(2.03)	(2.26)	(2.01)	(2.25)
Natural gas rents			-0.190	-0.0123	-0.180	-0.0119
			(-0.34)	(-0.41)	(-0.32)	(-0.39)
Resource discoveries					0.181	0.00740
					(0.18)	(0.14)
N	442	442	441	441	441	441
R^2	0.280		0.290		0.290	
pseudo R^2		0.013		0.013		0.013

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

[5] Some metals in this list such as lead, zinc, iron, copper, nickel, bauxite and phosphate are energy transition metals and are essential in the energy transition process.

4.2 Crowding-in or crowding-out effect analysis of Chinese Aid ?

Within this section, an analysis was conducted to ascertain whether aid provided by other leading donor nations has a crowding-in or crowding-out effect on China's aid. To enhance the robustness of our analysis, we incorporated aid contributions from USA , Germany and Japan as control variables and conducted a comprehensive evaluation of our equation 1, examining natural resource rents at both aggregated and disaggregated levels. Our results show no significant effect for the United States and Germany. However, when examining natural resource rents at the aggregate and disaggregated levels, our analysis indicates a crowding-in effect of China aid by Japan's one. Chinese development aid is then attracted by Japanese aid , in other words, China grants aid in the same areas as Japan.

Table 3 : Crowding in/out effect with resources at aggregated level

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	2.274	0.127	2.492	0.140	2.473	0.139
	(1.00)	(1.02)	(1.11)	(1.14)	(1.09)	(1.12)
GDP	4.374***	0.253***	4.438***	0.257***	4.439***	0.257***
	(3.29)	(3.53)	(3.31)	(3.57)	(3.31)	(3.57)
Debt	0.0536	0.00313*	0.0541	0.00316*	0.0541	0.00316*
	(1.56)	(1.65)	(1.56)	(1.65)	(1.55)	(1.65)
Trade	-0.114	-0.00532	-0.171	-0.00882	-0.172	-0.00885
	(-0.67)	(-0.55)	(-0.96)	(-0.88)	(-0.96)	(-0.88)
Education	-0.549	-0.0316	-0.561	-0.0324*	-0.559	-0.0323*
	(-1.54)	(-1.63)	(-1.56)	(-1.67)	(-1.55)	(-1.66)
Life expectancy	-4.400	-0.281	-3.762	-0.242	-3.744	-0.241
	(-1.27)	(-1.47)	(-1.04)	(-1.21)	(-1.03)	(-1.20)
ODA USA	0.0408	0.00305	0.0288	0.00234	0.0288	0.00234
	(0.35)	(0.47)	(0.24)	(0.35)	(0.24)	(0.35)
ODA GERMANY	0.0438	0.00240	0.0316	0.00168	0.0326	0.00173
	(0.34)	(0.34)	(0.25)	(0.24)	(0.26)	(0.25)
ODA JAPAN	0.175**	0.0107**	0.176**	0.0107**	0.177**	0.0107**
	(2.17)	(2.39)	(2.19)	(2.40)	(2.18)	(2.40)
Resources rents			0.283	0.0172	0.281	0.0171
			(0.82)	(0.91)	(0.81)	(0.90)
Resources discoveries					0.118	0.00532
					(0.13)	(0.12)
N	410	410	410	410	410	410
R^2	0.285		0.286		0.286	
pseudo R^2		0.014		0.014		0.014

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 4 : Crowding in/out effect analysis with resources at disaggregated level

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	2.274	0.127	2.754	0.160	2.754	0.161
	(1.00)	(1.02)	(1.26)	(1.34)	(1.24)	(1.33)
GDP	4.374***	0.253***	4.255***	0.246***	4.255***	0.246***
	(3.29)	(3.53)	(3.23)	(3.49)	(3.23)	(3.49)
Debt	0.0536	0.00313*	0.0602*	0.00349*	0.0602*	0.00349*
	(1.56)	(1.65)	(1.74)	(1.84)	(1.74)	(1.84)
Trade	-0.114	-0.00532	-0.345*	-0.0191*	-0.345*	-0.0191*
	(-0.67)	(-0.55)	(-1.91)	(-1.90)	(-1.90)	(-1.90)
Education	-0.549	-0.0316	-0.397	-0.0227	-0.397	-0.0227
	(-1.54)	(-1.63)	(-1.09)	(-1.15)	(-1.08)	(-1.15)
Life expectancy	-4.400	-0.281	-2.327	-0.161	-2.328	-0.161
	(-1.27)	(-1.47)	(-0.64)	(-0.81)	(-0.64)	(-0.81)
ODA USA	0.0408	0.00305	0.0206	0.00181	0.0206	0.00181
	(0.35)	(0.47)	(0.18)	(0.29)	(0.18)	(0.29)
ODA GERMANY	0.0438	0.00240	0.00498	0.000205	0.00496	0.000187
	(0.34)	(0.34)	(0.04)	(0.03)	(0.04)	(0.03)
ODA JAPAN	0.175**	0.0107**	0.176**	0.0106**	0.176**	0.0106**
	(2.17)	(2.39)	(2.12)	(2.33)	(2.12)	(2.32)
Mineral rents			0.794**	0.0445***	0.794**	0.0445***
			(2.55)	(2.61)	(2.56)	(2.63)
Oil rents			0.462**	0.0288**	0.462**	0.0289**
			(2.06)	(2.34)	(2.06)	(2.34)
Natural gas rents			-0.310	-0.0191	-0.310	-0.0192
			(-0.46)	(-0.54)	(-0.46)	(-0.54)
Resource discoveries					-0.00307	-0.00186
					(-0.00)	(-0.04)
N	410	410	409	409	409	409
R^2	0.285		0.302		0.302	
pseudo R^2		0.014		0.015		0.015

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

4.3 Disaggregated level analysis

At this disaggregated (micro) level, we analyse China's aid allocation at administrative regions level (such as provinces). The countries analyzed in the macroeconomic analysis were therefore subdivided into administrative regions using the GADM[6] map data. The OLS and PPML[7] estimation methods with region and country-year fixed effect were used to estimate equation 2, Table 3 and table 4 contain the results of these analyses. The results show us that the control variables explaining the allocation of Chinese aid at this dissagregated level are all positively correlated with our dependent variable ODA. According to the results, Chinese aid goes more towards fairly developed regions, fact which is not in line with the logic of aid since it is supposed to go to the most needy regions, which could suggest a negative relationship between aid and the level of development of the regions. Chinese aid is also targeted not only at regions with a large population but also at the regions where the country capitals in our sample are located in and at regions having a larger size (in squared km). The correlation between our variable of interest Mine, which is a proxy used to quantify the natural resource wealth of each administrative region and our dependent variable ODA is positive and significant. These results confirm the results of our macroeconomic level analysis and suggest that access to natural resources is a key determinant in China's development aid allocation.

Table 5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	PPML	OLS	PPML	OLS	PPML	OLS	PPML
Mine	0.177**	0.150***	0.112*	0.0841*	0.115*	0.0843*	0.121*	0.0952**
	(2.50)	(3.67)	(1.70)	(1.84)	(1.71)	(1.85)	(1.78)	(2.09)
Night light	0.157**	0.138***	0.310***	0.254***	0.316***	0.252***	0.306***	0.237***
	(2.02)	(5.21)	(2.94)	(5.94)	(2.87)	(5.78)	(2.73)	(5.35)
Population	0.185*	0.283***	0.0989	0.197***	0.0975	0.197***	0.0907	0.195***
	(2.01)	(7.33)	(1.07)	(4.53)	(1.05)	(4.53)	(0.97)	(4.43)
Capital region	4.319***	1.162***	4.255***	1.125***	4.248***	1.127***	4.174***	1.116***
	(7.80)	(9.16)	(7.71)	(8.86)	(7.72)	(8.88)	(7.68)	(8.77)
Oil & gas	0.202	-0.0381	0.0747	-0.0985	0.0914	-0.104	0.0555	-0.125
	(1.23)	(-0.29)	(0.49)	(-0.74)	(0.60)	(-0.76)	(0.36)	(-0.92)
Area (in km)			0.241***	0.194***	0.240***	0.194***	0.252***	0.188***
			(2.78)	(3.54)	(2.80)	(3.51)	(2.95)	(3.40)
Port					-0.0811	0.0154	-0.0637	0.0244
					(-0.43)	(0.14)	(-0.34)	(0.23)
Road density							1.498	0.712**
							(1.18)	(2.26)
N	8327	3806	8327	3806	8327	3806	8327	3806
R^2	0.394		0.395		0.395		0.396	
pseudo R^2		0.380		0.383		0.383		0.385

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

[6] GADM is defined as the Database of Global Administrative Areas

[7] Stata command "Poi2hdfe" were used to estimate the Poisson regression model with high dimensional fixed effects

Table 6 : Micro analysis with China's aid total flows

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML
Mine	0.119***	0.214***	0.127***	0.151***	0.150***	0.0841*	0.0843*	0.0952**	0.101**	0.106**
	(3.35)	(5.47)	(3.19)	(3.69)	(3.67)	(1.84)	(1.85)	(2.09)	(2.14)	(2.24)
Night light		0.313***	0.315***	0.137***	0.138***	0.254***	0.252***	0.237***	0.208***	0.206***
		(19.22)	(19.17)	(5.24)	(5.21)	(5.94)	(5.78)	(5.35)	(4.33)	(4.28)
Population			0.332***	0.283***	0.283***	0.197***	0.197***	0.195***	0.136***	0.147***
			(8.29)	(7.31)	(7.33)	(4.53)	(4.53)	(4.43)	(3.04)	(3.28)
Capital region				1.165***	1.162***	1.125***	1.127***	1.116***	1.174***	1.161***
				(9.23)	(9.16)	(8.86)	(8.88)	(8.77)	(8.87)	(8.76)
Oil & gas					-0.0381	-0.0985	-0.104	-0.125	-0.179	-0.176
					(-0.29)	(-0.74)	(-0.76)	(-0.92)	(-1.20)	(-1.19)
Area (in km)						0.194***	0.194***	0.188***	0.164***	0.147**
						(3.54)	(3.51)	(3.40)	(2.70)	(2.40)
Port							0.0154	0.0244	0.0802	0.0360
							(0.14)	(0.23)	(0.72)	(0.32)
Road density								0.712**	0.685**	0.716**
								(2.26)	(2.17)	(2.17)
Precipitation									0.0282	0.0195
									(0.80)	(0.56)
Temperature										0.273**
										(2.31)
N	3806	3806	3806	3806	3806	3806	3806	3806	2858	2843

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

New : Robustness test with the net ODA received (constant 2020 US$)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML
Mines	0.0788**	0.201***	0.106***	0.121***	0.121***	0.0338	0.0299	0.0464	0.0569	0.0622
	(2.42)	(5.26)	(2.74)	(2.99)	(3.00)	(0.76)	(0.67)	(1.04)	(1.25)	(1.37)
Distance	0.000806***	0.000883***	0.000834***	0.000777***	0.000777***	0.000793***	0.000799***	0.000805***	0.000652***	0.000645***
	(10.74)	(11.46)	(10.79)	(10.10)	(10.11)	(10.35)	(10.42)	(10.47)	(7.63)	(7.49)
Night light		0.318***	0.318***	0.160***	0.161***	0.317***	0.329***	0.313***	0.272***	0.273***
		(19.92)	(19.91)	(6.77)	(6.68)	(7.94)	(8.03)	(7.55)	(5.80)	(5.79)
Population			0.340***	0.303***	0.303***	0.185***	0.186***	0.184***	0.145***	0.155***
			(8.52)	(7.80)	(7.84)	(4.37)	(4.38)	(4.29)	(3.28)	(3.49)
Capital region				1.017***	1.014***	0.961***	0.950***	0.929***	1.011***	1.003***
				(8.75)	(8.74)	(8.30)	(8.19)	(7.98)	(8.16)	(8.14)
Oil & gas					-0.0239	-0.0953	-0.0606	-0.103	-0.260**	-0.252**
					(-0.18)	(-0.73)	(-0.45)	(-0.78)	(-2.02)	(-1.97)
Area (in km)						0.259***	0.266***	0.259***	0.307***	0.281***
						(4.89)	(4.97)	(4.84)	(4.73)	(4.28)
Port							-0.116	-0.104	-0.0491	-0.0974
							(-1.14)	(-1.01)	(-0.47)	(-0.89)
Road density								0.923***	0.805**	0.816**
								(2.81)	(2.47)	(2.42)
Precipitation									0.814***	0.705**
									(2.60)	(2.23)
Temperature										0.248**
										(2.03)
N	4357	4357	4357	4357	4357	4357	4357	4357	3299	3284
pseudo R^2	0.329	0.430	0.446	0.463	0.463	0.467	0.468	0.470	0.442	0.443

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

4.4 Robustness check

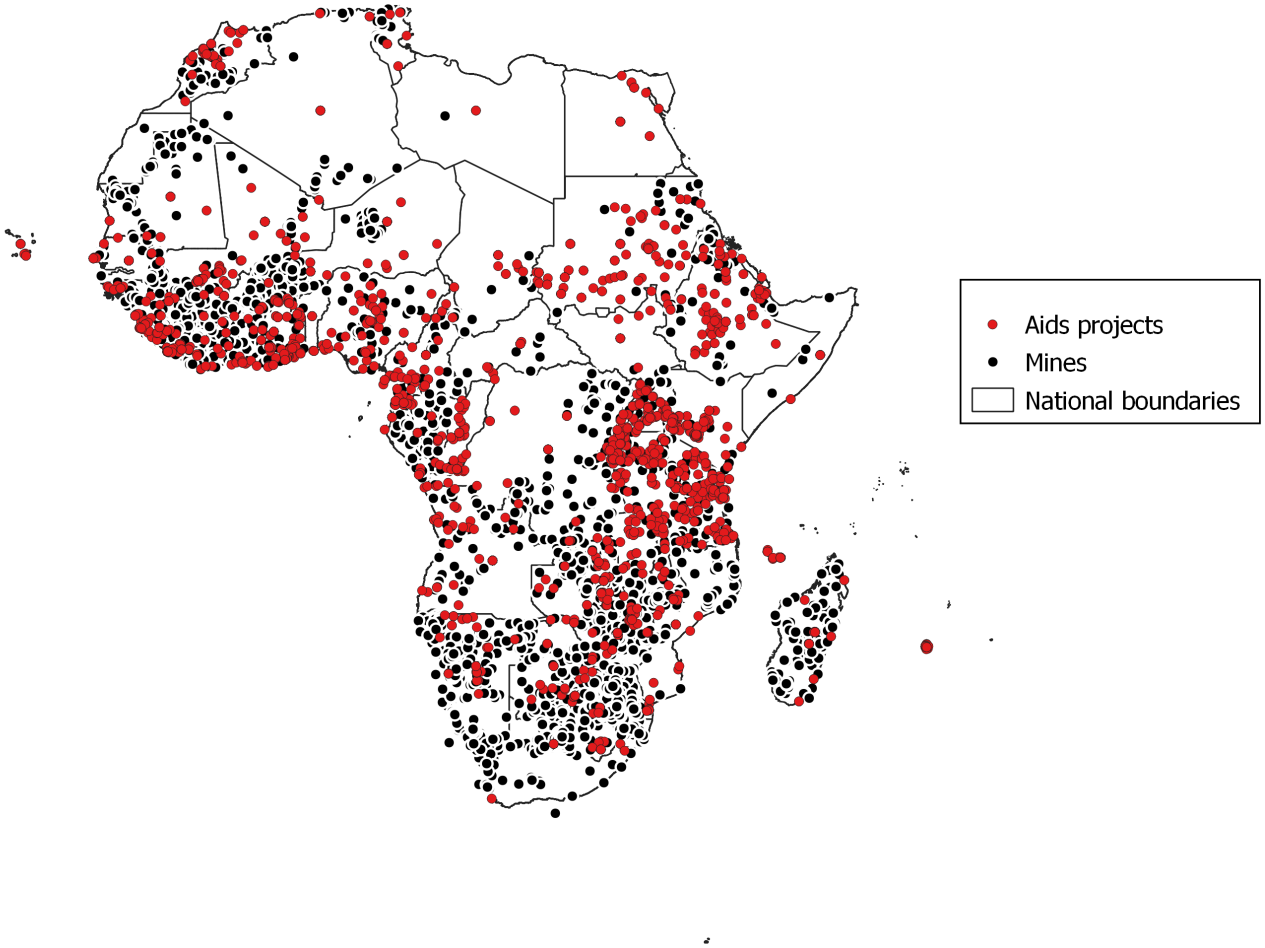
In order to test the robustness of our results obtained at dissagregated level, we have sorted China's development aid projects to African countries over the period studied and kept only those that meet the criteria characterizing ODA as defined by the OECD. We re-estimated equation 2 using the same estimation techniques (OLS and PPML) with administrative region and country-year fixed effects. The results are almost identical to the analysis carried out previously at the dissagregated level and are reported in Table 4. The control variables explaining the allocation of Chinese aid at dissagregated level are the same and are positively correlated with our dependent variable, ODA. Nevertheless only the PPML gives significant results. This can be explained by the fact that this method can be considered as more appropriate to our specific case given the sorting carried out in the aid projects of China to African countries to keep only those that meet the criteria of ODA as defined by the OECD. Indeed, this sorting forced us to consider some regions as having received no aid, which introduces zero values in the database. In such a situation, the literature suggests that simple OLS produce biased results, so the best estimation for this case is therefore the PPML technique. [8]

We also tested the robustness of our results obtained at macroeconomic level. To do so, we took as dependent variable the total net amount of ODA in constant US$ 2020 , the total net ODA and official aid received in current US$. These variable are defined by the World Bank as disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients. It includes loans with a grant element of at least 25 percent (calculated at a rate of discount of 10%). The results reported in tables [5:9] confirm the determining role of natural resources in development aid allocation decisions. We notice that mineral resources are the resources that impact development aid when we analyze the total amount of aid received by African countries from the donors. Further robustness tests were also run, by taking the net of bilateral aid from 3 of the largest OECD DAC donors: the USA, Germany and Japan. The results reported in table 11, show once again the key role of natural resources in development aid allocation decisions by USA and Germany. For Japan, we did not find any significant correlation justifying Japan's desire to have access to natural resources through its aid policy.

All these robustness tests confirm the results of our previous analyses, both at the macro and micro level. The aid strategies of some donor countries, such as China, which is at the heart of our study, might be linked to the access to natural resources, especially minerals and oil.

[8] Silva and Tenreyro [2006] shows that PPML outperfoms simple OLS with Tobit approaches with heteroskedasticity and many zero observations in the data.

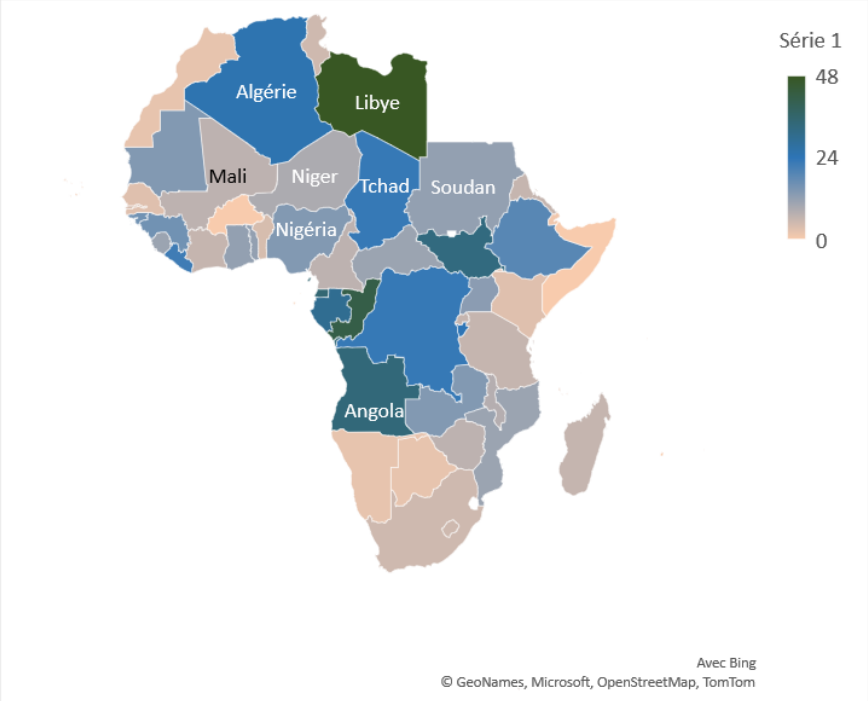
Figure 2: **Average natural resource rents in percentage of GDP from 2000 to 2017**



4.5 Heterogeneity's test

Based on the fact that countries are characterized by different structural parameters, we further take into account countries' heterogeneity. We rank countries into two categories : rich resource economies and less rich resources countries. The purpose of this ranking is to see whether our results still hold when we take these structural parameters into account. To do so, we used the method developed by the IMF to classify countries according to their level of natural resource wealth in Lundgren et al. [2013]. We considered a country to be resource-rich when its total resource rents as a percentage of GDP, averaged over the study period, exceeded 20% and less resource-rich when its total resource rents as a percentage of GDP, averaged over the study period, was below 20%. The results are presented in Table 12 and 13. The results show no significant correlation between Chinese aid and natural resources for our two groups when resource rents are taken as a whole [Table 13]. These results are consistent with those we found in our macro-level analysis when resource rents were taken at an aggregate level. When analysed at a disaggregated level, by type of resource, the results become more interesting. In the group of less resource-rich countries, only mineral resources seem to impact aid since its coefficient is positive and significant. In the other country group, that of resource-rich countries, we note that the types of resources impacting aid are oil and mining related [Table 12]. We also highlight the fact that our coefficients are higher in the group of resource-rich countries. This therefore reflects a stronger effect in this group. These results also support our macroeconomic results that link China's development aid to African countries to access to natural resources.

Figure 3: **Average natural resource rents in percentage of GDP from 2000 to 2017**



5 Conclusion

Within the energy transition framework and the race for critical metals needed in this respect, we have examined Chinese aid in order to determine its main determinants and to verify whether the natural resource wealth of the recipient countries is one of the main criteria for this aid allocation.

To conduct our analysis, we use two sets of data (e.g. a more aggregated one, available at country level; and a geo-referenced dataset of officially funded Chinese development projects in Africa) during the period 1999-2013. We conducted a macroeconomic and a micro (disagregated) analysis. The results of both analyses are convergent. They suggest a certain commercial nature of part of the development aid granted by China to African countries. The endowment of natural resources is found to be a key factor in the allocation decisions of Chinese development aid. Nevertheless, China remains attentive to the needs of beneficiaries in the areas of education and public debt issues as it also grants aid to countries with deficient health or education systems.

Further research avenues are considered. In this line, a specific analysis will be carried out on each of the critical metals, the most important of which are : aluminium, copper, iron ore, nickel, lithium and steel, as well as certain essential rare earth metals, such as molybdenum, neodymium and indium, in order to determine the place of each of these metals in the international policies adopted by China (and other major powers). Indeed, the energy transition and the fight against global warming will shift the demand from fossil fuels to metals that are essential for the growing production of electric vehicles and their batteries, wind turbines, especially marine ones, solar panels and kilometers of electrical networks. As a result, the demand for metals is expected to highly increase in the coming decades. This research will be used to analyze the policies adopted by countries at the international level, in their approach to access these critical metals.

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6 Appendix

6.1 Figure

Figure 4: **Sub-national boundaries from GADM databe of global administrative areas**

Figure 5: **China's development project location without the GADM shapefile**

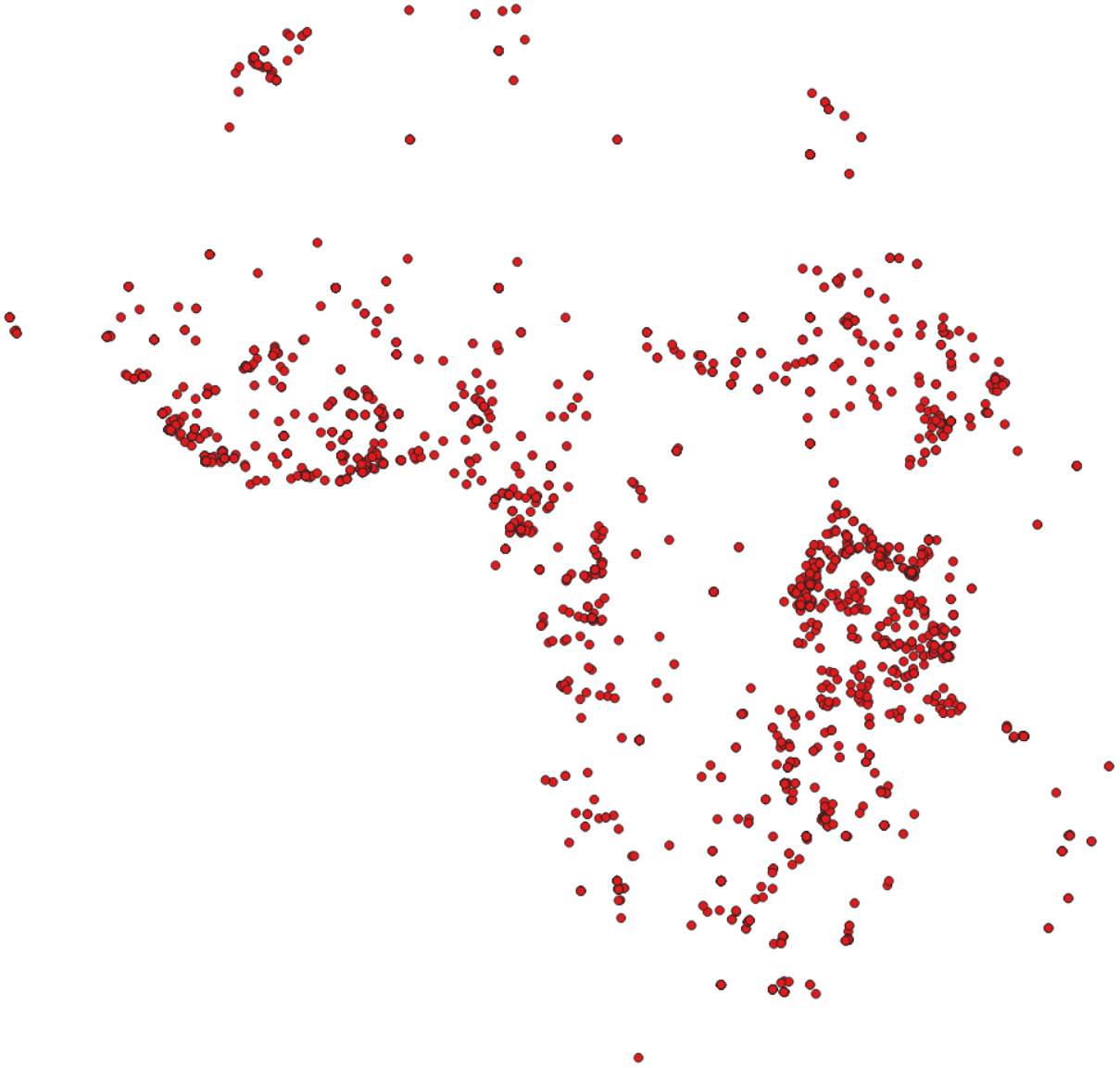
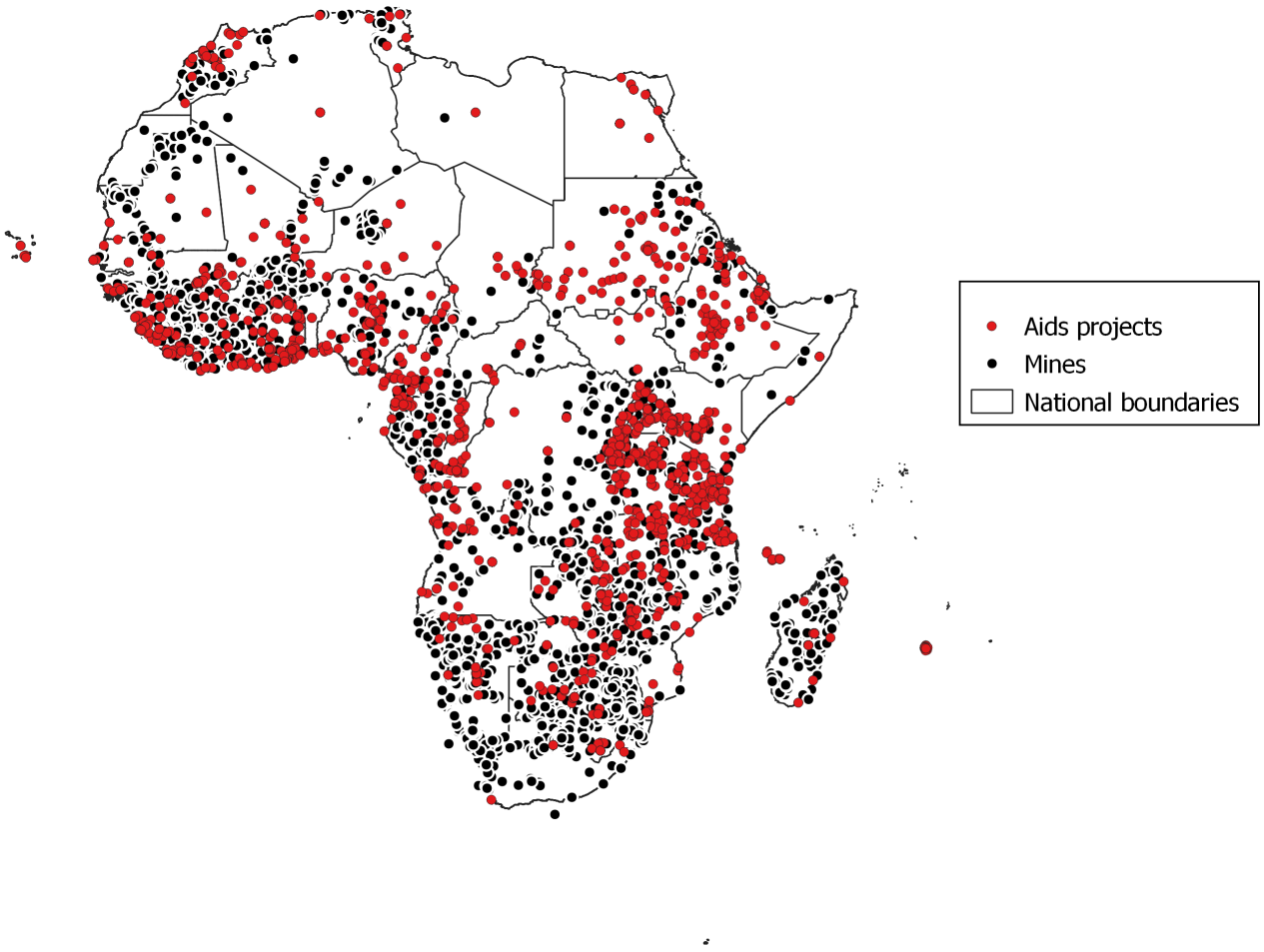


Figure 6: **Average natural resource rents in percentage of GDP from 2000 to 2017**



6.2 Tables

Table 6 : Robustness test keeping only China's ODA as defined by the OECD

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	PPML	OLS	PPML	OLS	PPML	OLS	PPML
Mines	0.0372	0.162***	-0.0107	0.118*	-0.00470	0.113*	0.000215	0.122*
	(0.85)	(2.77)	(-0.30)	(1.87)	(-0.12)	(1.81)	(0.01)	(1.96)
Night light	0.127	0.164***	0.240**	0.233***	0.252**	0.245***	0.244**	0.231***
	(1.57)	(4.56)	(2.10)	(4.24)	(2.13)	(4.34)	(2.02)	(3.98)
Population	0.0858	0.250***	0.0222	0.191***	0.0192	0.199***	0.0146	0.202***
	(0.96)	(5.11)	(0.25)	(3.35)	(0.22)	(3.43)	(0.16)	(3.48)
Capital region	2.694***	1.374***	2.647***	1.355***	2.632***	1.369***	2.579***	1.352***
	(6.43)	(8.23)	(6.31)	(8.16)	(6.27)	(8.19)	(6.20)	(8.06)
Oil & gas	0.161	0.116	0.0674	0.0707	0.104	0.157	0.0776	0.139
	(1.29)	(0.59)	(0.52)	(0.36)	(0.79)	(0.77)	(0.57)	(0.69)
Area (in km)			0.177**	0.124*	0.175**	0.127*	0.183**	0.117
			(2.27)	(1.68)	(2.30)	(1.70)	(2.39)	(1.54)
Port					-0.177	-0.253	-0.163	-0.252
					(-1.22)	(-1.64)	(-1.11)	(-1.62)
Road density							1.123	0.530
							(1.03)	(1.28)
N	8508	2857	8508	2857	8508	2857	8508	2857
R^2	0.333		0.334		0.335		0.336	
pseudo R^2		0.387		0.388		0.389		0.390

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 6 : Robustness test keeping only China's ODA as defined by the OECD

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML
Mine	0.0440	0.182***	0.101*	0.161***	0.162***	0.118*	0.113*	0.122*	0.138**	0.141**
	(0.90)	(3.21)	(1.77)	(2.74)	(2.77)	(1.87)	(1.81)	(1.96)	(2.20)	(2.25)
Night Light		0.373***	0.373***	0.167***	0.164***	0.233***	0.245***	0.231***	0.166***	0.163**
		(16.78)	(16.68)	(4.75)	(4.56)	(4.24)	(4.34)	(3.98)	(2.64)	(2.56)
Population			0.299***	0.252***	0.250***	0.191***	0.199***	0.202***	0.165***	0.183***
			(5.98)	(5.16)	(5.11)	(3.35)	(3.43)	(3.48)	(2.70)	(2.98)
Capital region				1.360***	1.374***	1.355***	1.369***	1.352***	1.422***	1.408***
				(8.32)	(8.23)	(8.16)	(8.19)	(8.06)	(7.99)	(7.94)
oil & gas					0.116	0.0707	0.157	0.139	-0.0328	-0.0457
					(0.59)	(0.36)	(0.77)	(0.69)	(-0.17)	(-0.24)
Area (in km)						0.124*	0.127*	0.117	0.0633	0.0386
						(1.68)	(1.70)	(1.54)	(0.75)	(0.46)
Port							-0.253	-0.252	-0.145	-0.190
							(-1.64)	(-1.62)	(-0.91)	(-1.18)
Road density								0.530	0.588	0.567
								(1.28)	(1.43)	(1.33)
Precipitation									0.0113	0.00383
									(0.23)	(0.08)
Temperature										0.385***
										(2.65)
N	2857	2857	2857	2857	2857	2857	2857	2857	2101	2089

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

New : Robustness test keeping only China's ODA as defined by the OECD

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML	PPML
Mines	-0.0556	0.120**	0.0546	0.106*	0.107*	0.0505	0.0314	0.0430	0.0624	0.0665
	(-1.27)	(2.13)	(0.94)	(1.69)	(1.71)	(0.75)	(0.49)	(0.67)	(0.97)	(1.04)
Distance	0.000678***	0.000770***	0.000732***	0.000667***	0.000668***	0.000675***	0.000708***	0.000707***	0.000486***	0.000479***
	(7.18)	(7.64)	(7.18)	(6.51)	(6.51)	(6.65)	(6.91)	(6.88)	(4.28)	(4.19)
Night Light		0.381***	0.378***	0.189***	0.187***	0.287***	0.307***	0.293***	0.211***	0.213***
		(18.62)	(18.53)	(5.96)	(5.76)	(5.51)	(5.67)	(5.30)	(3.42)	(3.38)
Population			0.274***	0.232***	0.231***	0.148***	0.166***	0.172***	0.160***	0.179***
			(5.46)	(4.75)	(4.73)	(2.68)	(2.93)	(3.04)	(2.64)	(2.93)
Capital region				1.220***	1.230***	1.191***	1.217***	1.191***	1.268***	1.252***
				(7.71)	(7.59)	(7.39)	(7.58)	(7.33)	(7.12)	(7.10)
Oil & gas					0.0797	0.0140	0.153	0.127	-0.0143	-0.0300
					(0.43)	(0.07)	(0.79)	(0.65)	(-0.08)	(-0.16)
(Area) (in km)						0.173**	0.178**	0.166**	0.145	0.105
						(2.39)	(2.39)	(2.21)	(1.55)	(1.14)
Port							-0.410**	-0.407**	-0.292*	-0.355**
							(-2.54)	(-2.51)	(-1.79)	(-2.14)
Road density								0.617	0.674	0.636
								(1.45)	(1.58)	(1.45)
Precipitation									0.461	0.317
									(1.09)	(0.75)
Temperature										0.440***
										(2.93)
N	3328	3328	3328	3328	3328	3328	3328	3328	2496	2484
pseudo R^2	0.308	0.449	0.459	0.481	0.481	0.483	0.486	0.487	0.465	0.469

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 7 : Robustness test with the net ODA received (constant US$ 2020)

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.000**	-0.0538***	-0.853**	-0.0464**	-0.847**	-0.0461**
	(-2.33)	(-2.62)	(-2.13)	(-2.42)	(-2.08)	(-2.38)
GDP	-0.00609	-0.00237	0.0213	-0.000801	0.0208	-0.000837
	(-0.02)	(-0.18)	(0.08)	(-0.06)	(0.07)	(-0.06)
Debt	0.0146	0.000813	0.0157	0.000869	0.0157	0.000872
	(1.13)	(1.25)	(1.21)	(1.33)	(1.21)	(1.33)
Trade	0.142***	0.00741***	0.111***	0.00589***	0.112***	0.00596***
	(3.52)	(3.80)	(2.76)	(3.02)	(2.79)	(3.05)
Education	0.0276	0.00182	0.0193	0.00135	0.0182	0.00129
	(0.29)	(0.41)	(0.21)	(0.30)	(0.19)	(0.29)
Life expectancy	2.163***	0.110***	2.416***	0.123***	2.401***	0.122***
	(3.47)	(3.68)	(3.71)	(3.91)	(3.65)	(3.84)
Resource rents			0.159*	0.00776**	0.158*	0.00771**
			(1.95)	(2.02)	(1.93)	(1.99)
Resource discoveries					-0.0672	-0.00348
					(-0.33)	(-0.38)
N	510	509	510	509	510	509
R^2	0.875		0.877		0.877	
pseudo R^2		0.011		0.011		0.011

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 8 : Robustness test with the net ODA received (constant 2020 US$)

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.000**	-0.0538***	-1.018**	-0.0545***	-1.010**	-0.0540***
	(-2.33)	(-2.62)	(-2.51)	(-2.81)	(-2.46)	(-2.76)
GDP	-0.00609	-0.00237	-0.0406	-0.00392	-0.0408	-0.00393
	(-0.02)	(-0.18)	(-0.14)	(-0.29)	(-0.14)	(-0.29)
Debt	0.0146	0.000813	0.0165	0.000911	0.0165	0.000915
	(1.13)	(1.25)	(1.23)	(1.35)	(1.23)	(1.35)
Trade	0.142***	0.00741***	0.126***	0.00665***	0.127***	0.00673***
	(3.52)	(3.80)	(2.91)	(3.18)	(2.92)	(3.20)
Education	0.0276	0.00182	0.0397	0.00240	0.0385	0.00234
	(0.29)	(0.41)	(0.42)	(0.53)	(0.40)	(0.52)
Life expectancy	2.163***	0.110***	2.365***	0.119***	2.344***	0.118***
	(3.47)	(3.68)	(3.48)	(3.64)	(3.40)	(3.55)
Mineral rents			0.139**	0.00675**	0.140**	0.00676**
			(2.20)	(2.24)	(2.20)	(2.24)
Oil rents			-0.00445	-0.000260	-0.00534	-0.000308
			(-0.07)	(-0.08)	(-0.08)	(-0.10)
Natural gas rents			0.0176	0.000305	0.0136	0.0000887
			(0.09)	(0.04)	(0.07)	(0.01)
Resource discoveries					-0.0850	-0.00444
					(-0.44)	(-0.52)
N	510	509	509	508	509	508
R^2	0.875		0.876		0.876	
pseudo R^2		0.011		0.011		0.011

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 9 : Robustness test with the net ODA and official aid received (current US)

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.372***	-0.0751***	-1.127**	-0.0628***	-1.110**	-0.0619***
	(-2.61)	(-2.98)	(-2.43)	(-2.81)	(-2.35)	(-2.73)
GDP	-0.193	-0.0131	-0.147	-0.0104	-0.149	-0.0105
	(-0.62)	(-0.88)	(-0.49)	(-0.74)	(-0.50)	(-0.75)
Debt	0.0149	0.000856	0.0168	0.000950	0.0169	0.000957
	(1.17)	(1.32)	(1.30)	(1.44)	(1.30)	(1.45)
Trade	0.259***	0.0136***	0.207***	0.0110***	0.210***	0.0112***
	(6.00)	(6.46)	(4.92)	(5.34)	(4.93)	(5.35)
Education	0.115	0.00650	0.101	0.00570	0.0984	0.00555
	(1.12)	(1.31)	(1.00)	(1.16)	(0.96)	(1.13)
Life expectancy	2.371***	0.122***	2.796***	0.142***	2.757***	0.140***
	(3.28)	(3.48)	(3.55)	(3.74)	(3.44)	(3.62)
Resource rents			0.266**	0.0130***	0.264**	0.0129***
			(2.58)	(2.66)	(2.52)	(2.60)
Resource discoveries					-0.173	-0.00892
					(-0.75)	(-0.86)
N	510	509	510	509	510	509
R^2	0.863		0.867		0.867	
pseudo R^2		0.012		0.012		0.012

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 10 : Net official development assistance and official aid received (current US$))

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.372***	-0.0751***	-1.364***	-0.0741***	-1.347***	-0.0731***
	(-2.61)	(-2.98)	(-2.91)	(-3.29)	(-2.83)	(-3.20)
GDP	-0.193	-0.0131	-0.257	-0.0160	-0.258	-0.0160
	(-0.62)	(-0.88)	(-0.81)	(-1.06)	(-0.81)	(-1.07)
Debt	0.0149	0.000856	0.0176	0.000995	0.0178	0.00100
	(1.17)	(1.32)	(1.33)	(1.48)	(1.33)	(1.48)
Trade	0.259***	0.0136***	0.224***	0.0119***	0.227***	0.0121***
	(6.00)	(6.46)	(5.01)	(5.45)	(5.00)	(5.43)
Education	0.115	0.00650	0.124	0.00688	0.122	0.00675
	(1.12)	(1.31)	(1.23)	(1.41)	(1.19)	(1.38)
Life expectancy	2.371***	0.122***	2.793***	0.142***	2.749***	0.139***
	(3.28)	(3.48)	(3.38)	(3.52)	(3.24)	(3.37)
Mineral rents			0.214***	0.0103***	0.214***	0.0103***
			(3.09)	(3.14)	(3.09)	(3.14)
Oil rents			0.0175	0.000849	0.0156	0.000748
			(0.22)	(0.22)	(0.19)	(0.19)
Natural gas rents			0.179	0.00764	0.170	0.00717
			(0.73)	(0.67)	(0.68)	(0.61)
Resource discoveries					-0.182	-0.00950
					(-0.82)	(-0.95)
N	510	509	509	508	509	508
R^2	0.863		0.866		0.866	
pseudo R^2		0.012		0.012		0.012

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

New : Robustness test with ODA related to technical and financial assistance

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	2.431	0.133	3.065	0.179	3.046	0.178
	(1.01)	(1.01)	(1.30)	(1.38)	(1.29)	(1.37)
GDP	4.586***	0.266***	4.605***	0.267***	4.606***	0.267***
	(3.79)	(4.04)	(3.89)	(4.18)	(3.89)	(4.18)
Debt	0.0442	0.00270	0.0505	0.00305*	0.0505	0.00305*
	(1.41)	(1.56)	(1.63)	(1.80)	(1.62)	(1.79)
Trade	0.0514	0.00506	-0.167	-0.00813	-0.171	-0.00828
	(0.29)	(0.50)	(-0.89)	(-0.78)	(-0.91)	(-0.79)
Education	-0.699**	-0.0402**	-0.553*	-0.0317*	-0.550*	-0.0316*
	(-2.24)	(-2.35)	(-1.75)	(-1.84)	(-1.73)	(-1.82)
Life expectancy	-3.969	-0.255	-2.739	-0.190	-2.691	-0.187
	(-1.07)	(-1.25)	(-0.72)	(-0.91)	(-0.70)	(-0.90)
Mineral rents			0.829**	0.0465**	0.829**	0.0466**
			(2.46)	(2.51)	(2.46)	(2.52)
Oil rents			0.395*	0.0257**	0.396*	0.0258**
			(1.72)	(2.01)	(1.71)	(2.01)
Natural gas rents			-0.324	-0.0213	-0.314	-0.0208
			(-0.56)	(-0.69)	(-0.54)	(-0.68)
Resource discoveries					0.177	0.00719
					(0.21)	(0.16)
N	398	397	397	396	397	396
R^2	0.300		0.316		0.316	
pseudo R^2		0.016		0.017		0.017

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

New : Robustness test with ODA related to technical and financial assistance

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	2.431	0.133	3.006	0.168	2.985	0.167
	(1.01)	(1.01)	(1.28)	(1.30)	(1.26)	(1.29)
GDP	4.586***	0.266***	4.791***	0.279***	4.793***	0.279***
	(3.79)	(4.04)	(3.93)	(4.22)	(3.93)	(4.22)
Debt	0.0442	0.00270	0.0455	0.00276	0.0454	0.00276
	(1.41)	(1.56)	(1.44)	(1.59)	(1.43)	(1.59)
Trade	0.0514	0.00506	-0.0437	-0.000666	-0.0474	-0.000844
	(0.29)	(0.50)	(-0.23)	(-0.06)	(-0.25)	(-0.08)
Education	-0.699**	-0.0402**	-0.729**	-0.0422**	-0.726**	-0.0421**
	(-2.24)	(-2.35)	(-2.33)	(-2.47)	(-2.31)	(-2.45)
Life expectancy	-3.969	-0.255	-3.440	-0.223	-3.389	-0.221
	(-1.07)	(-1.25)	(-0.91)	(-1.07)	(-0.88)	(-1.05)
Resource rents			0.450	0.0274	0.453	0.0275
			(1.34)	(1.47)	(1.34)	(1.47)
Resource discoveries					0.188	0.00851
					(0.24)	(0.21)
N	398	397	398	397	398	397
R^2	0.300		0.303		0.303	
pseudo R^2		0.016		0.016		0.016

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

New : Robustness test with Debt-related ODA

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.785	-0.101	-1.839	-0.121	-1.839	-0.121
	(-0.35)	(-0.46)	(-0.46)	(-0.73)	(-0.46)	(-0.73)
GDP	0.164	0.0148	2.119	0.126	2.119	0.126
	(0.09)	(0.19)	(1.06)	(1.54)	(1.06)	(1.54)
Debt	0.0396	0.00236	0.164	0.00938**	0.164	0.00938**
	(0.34)	(0.46)	(1.47)	(1.99)	(1.47)	(1.99)
Trade	0.456	0.0261*	1.022**	0.0600***	1.022**	0.0600***
	(1.46)	(1.92)	(2.25)	(3.11)	(2.25)	(3.11)
Education	-0.119	-0.00784	-0.334	-0.0177	-0.334	-0.0177
	(-0.16)	(-0.24)	(-0.52)	(-0.66)	(-0.52)	(-0.66)
Life expectancy	-5.988	-0.351*	-13.62**	-0.792***	-13.62**	-0.792***
	(-1.38)	(-1.85)	(-2.38)	(-3.25)	(-2.38)	(-3.25)
Mineral rents			-0.422	-0.0256*	-0.422	-0.0256*
			(-1.29)	(-1.82)	(-1.29)	(-1.82)
Oil rents			-2.253	-0.132**	-2.253	-0.132**
			(-1.60)	(-2.15)	(-1.60)	(-2.15)
Natural gas rents			-2.009	-0.118*	-2.009	-0.118*
			(-1.32)	(-1.82)	(-1.32)	(-1.82)
Resource discoveries					0	0
					(.)	(.)
N	71	58	71	58	71	58
R^2	0.649		0.712		0.712	
pseudo R^2		0.007		0.008		0.008

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

New : Robustness test with Debt-related ODA

	(1)	(2)	(3)	(4)	(5)	(6)
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.785	-0.101	-2.069	-0.124	-2.069	-0.124
	(-0.35)	(-0.46)	(-0.42)	(-0.59)	(-0.42)	(-0.59)
GDP	0.164	0.0148	2.108	0.126	2.108	0.126
	(0.09)	(0.19)	(0.95)	(1.37)	(0.95)	(1.37)
Debt	0.0396	0.00236	-0.0257	-0.00162	-0.0257	-0.00162
	(0.34)	(0.46)	(-0.21)	(-0.30)	(-0.21)	(-0.30)
Trade	0.456	0.0261*	0.544*	0.0320**	0.544*	0.0320**
	(1.46)	(1.92)	(1.77)	(2.43)	(1.77)	(2.43)
Education	-0.119	-0.00784	-0.382	-0.0219	-0.382	-0.0219
	(-0.16)	(-0.24)	(-0.55)	(-0.75)	(-0.55)	(-0.75)
Life expectancy	-5.988	-0.351*	-8.421*	-0.498***	-8.421*	-0.498***
	(-1.38)	(-1.85)	(-1.95)	(-2.65)	(-1.95)	(-2.65)
Resource rents			-0.677	-0.0403**	-0.677	-0.0403**
			(-1.50)	(-2.04)	(-1.50)	(-2.04)
Resource discoveries					0	0
					(.)	(.)
N	71	58	71	58	71	58
R^2	0.649		0.672		0.672	
pseudo R^2		0.007		0.007		0.007

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 14 : Summary statistics of macro analysis

	Count	Mean	Sd	Min	Max
ODA	758	16.99378	2.052801	7.352071	23.79368
Population	862	15.90973	1.500357	11.30382	19.04104
GDP	827	7.19451	1.000162	5.555394	9.70739
Debt	764	2.862992	4.620305	.0006069	59.67141
Trade	843	5.703213	2.195536	-1.224186	10.7945
Mineral rents	836	.4036466	.6791519	0	3.264333
Oil rents	830	.7769611	1.279483	0	4.215275
Natural gas rents	827	.1458587	.3611353	0	1.905914
Life expectancy	867	4.057938	.1356369	3.674806	4.334647
Resources discoveries	867	.0069204	.0829485	0	1
Education	531	1.816303	1.061418	-1.311484	4.1026
Resources rents	830	2.171923	.973735	.0011706	4.232912
N	867				

Table 11 : Robustness test with the total net bilateral Aid flows from 3 of the largest DAC donors

	USA		GERMANY		JAPAN	
	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-0.918	-0.0598	2.602***	0.159***	-0.00914	-0.00883
	(-1.24)	(-1.46)	(3.76)	(3.90)	(-0.01)	(-0.13)
GDP	-0.115	-0.0155	0.965**	0.0576**	-0.815	-0.0569
	(-0.17)	(-0.43)	(2.14)	(2.20)	(-1.24)	(-1.45)
Debt	-0.0191	-0.00120	-0.0846***	-0.00607***	-0.0298*	-0.00196*
	(-1.13)	(-1.07)	(-4.68)	(-4.88)	(-1.70)	(-1.70)
Trade	0.223**	0.0143***	-0.0103	-0.00108	0.380**	0.0250***
	(2.38)	(2.64)	(-0.13)	(-0.24)	(2.48)	(2.64)
Education	0.304*	0.0197**	-0.479***	-0.0293***	-0.241	-0.0150
	(1.87)	(2.19)	(-3.72)	(-3.86)	(-1.08)	(-1.13)
Life expectancy	4.275***	0.224***	-2.651*	-0.165*	2.914	0.179
	(3.50)	(3.31)	(-1.80)	(-1.88)	(1.41)	(1.44)
Resources rents	0.310**	0.0172**	0.431***	0.0255***	-0.0794	-0.00623
	(2.03)	(2.03)	(2.95)	(3.10)	(-0.43)	(-0.58)
Resources discoveries	0.0487	0.00124	-0.424**	-0.0240**	-0.374	-0.0230
	(0.22)	(0.11)	(-2.18)	(-2.24)	(-1.36)	(-1.53)
N	486	486	489	489	478	478
R^2	0.885		0.822		0.710	

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 12 : Heterogeneity test with resources rents in percentage of GDP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Resources rents superior to 20% of GDP						**Resources rents inferior to 20% of GDP**					
	LSDV	PPML	LSDV	PPML	LSDV	PPML	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.660	-0.0992	4.390	0.274	4.390	0.274	4.442**	0.249**	4.678**	0.266**	4.670**	0.265**
	(-0.22)	(-0.24)	(0.52)	(0.61)	(0.52)	(0.61)	(2.19)	(2.22)	(2.32)	(2.40)	(2.30)	(2.38)
GDP	-3.469	-0.207	-3.857	-0.227	-3.857	-0.227	5.525***	0.317***	5.450***	0.312***	5.450***	0.312***
	(-0.78)	(-0.86)	(-0.92)	(-1.04)	(-0.92)	(-1.04)	(4.92)	(5.11)	(4.70)	(4.92)	(4.70)	(4.92)
Debt	-0.0581	-0.00338	-0.153	-0.00904	-0.153	-0.00904	0.0612*	0.00366**	0.0689**	0.00412**	0.0689**	0.00412**
	(-0.54)	(-0.56)	(-1.47)	(-1.62)	(-1.47)	(-1.62)	(1.84)	(2.02)	(2.04)	(2.25)	(2.04)	(2.25)
Trade	0.452	0.0285	-0.332	-0.0202	-0.332	-0.0202	-0.127	-0.00647	-0.249	-0.0139	-0.251	-0.0140
	(1.22)	(1.38)	(-0.67)	(-0.76)	(-0.67)	(-0.76)	(-0.69)	(-0.63)	(-1.31)	(-1.32)	(-1.30)	(-1.31)
Education	1.196	0.0728	1.637*	0.0980*	1.637*	0.0980*	-0.886***	-0.0499***	-0.769**	-0.0431**	-0.768**	-0.0431**
	(1.21)	(1.34)	(1.72)	(1.95)	(1.72)	(1.95)	(-2.73)	(-2.79)	(-2.32)	(-2.37)	(-2.29)	(-2.34)
Life expectancy	-5.260	-0.343	-9.517	-0.582	-9.517	-0.582	-6.736**	-0.401**	-5.828*	-0.348*	-5.806*	-0.347*
	(-0.34)	(-0.40)	(-0.54)	(-0.63)	(-0.54)	(-0.63)	(-2.32)	(-2.45)	(-1.81)	(-1.94)	(-1.77)	(-1.90)
Mineral rents			0.987*	0.0568**	0.987*	0.0568**			0.454	0.0268	0.454	0.0268
			(1.75)	(1.99)	(1.75)	(1.99)			(1.51)	(1.63)	(1.50)	(1.63)
Oil rents			1.252*	0.0792**	1.252*	0.0792**			0.447*	0.0259*	0.447*	0.0259*
			(1.88)	(2.26)	(1.88)	(2.26)			(1.69)	(1.79)	(1.69)	(1.79)
Natural gas rents			1.205	0.0662	1.205	0.0662			-0.517	-0.0293	-0.512	-0.0291
			(0.92)	(1.02)	(0.92)	(1.02)			(-0.83)	(-0.85)	(-0.81)	(-0.85)
Resources discoveries					0	0					0.0623	0.00263
					(.)	(.)					(0.08)	(0.06)
N	64	64	63	63	63	63	406	406	406	406	406	406
R^2	0.412		0.478		0.478		0.272		0.282		0.283	
pseudo R^2		0.016		0.019		0.019		0.013		0.014		0.014

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 13 : Heterogeneity test with resources rents in percentage of GDP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Resources rents superior to 20% of GDP						**Resources rents inferior to 20% of GDP**					
	LSDV	PPML	LSDV	PPML	LSDV	PPML	LSDV	PPML	LSDV	PPML	LSDV	PPML
Population	-1.660	-0.0992	-1.382	-0.0824	-1.382	-0.0824	4.442**	0.249**	4.541**	0.255**	4.530**	0.255**
	(-0.22)	(-0.24)	(-0.15)	(-0.16)	(-0.15)	(-0.16)	(2.19)	(2.22)	(2.26)	(2.31)	(2.23)	(2.28)
GDP	-3.469	-0.207	-3.517	-0.209	-3.517	-0.209	5.525***	0.317***	5.568***	0.320***	5.571***	0.320***
	(-0.78)	(-0.86)	(-0.76)	(-0.84)	(-0.76)	(-0.84)	(4.92)	(5.11)	(4.94)	(5.16)	(4.94)	(5.17)
Debt	-0.0581	-0.00338	-0.0595	-0.00346	-0.0595	-0.00346	0.0612*	0.00366**	0.0641*	0.00384**	0.0641*	0.00384**
	(-0.54)	(-0.56)	(-0.56)	(-0.59)	(-0.56)	(-0.59)	(1.84)	(2.02)	(1.90)	(2.09)	(1.90)	(2.09)
Trade	0.452	0.0285	0.433	0.0273	0.433	0.0273	-0.127	-0.00647	-0.162	-0.00874	-0.165	-0.00889
	(1.22)	(1.38)	(1.00)	(1.16)	(1.00)	(1.16)	(-0.69)	(-0.63)	(-0.86)	(-0.84)	(-0.86)	(-0.84)
Education	1.196	0.0728	1.215	0.0740	1.215	0.0740	-0.886***	-0.0499***	-0.909***	-0.0514***	-0.906***	-0.0512***
	(1.21)	(1.34)	(1.14)	(1.27)	(1.14)	(1.27)	(-2.73)	(-2.79)	(-2.81)	(-2.88)	(-2.77)	(-2.85)
Life expectancy	-5.260	-0.343	-5.510	-0.358	-5.510	-0.358	-6.736**	-0.401**	-6.291**	-0.374**	-6.261**	-0.372**
	(-0.34)	(-0.40)	(-0.33)	(-0.40)	(-0.33)	(-0.40)	(-2.32)	(-2.45)	(-2.08)	(-2.20)	(-2.04)	(-2.16)
Resource rents			0.0718	0.00429	0.0718	0.00429			0.229	0.0143	0.231	0.0144
			(0.08)	(0.09)	(0.08)	(0.09)			(0.79)	(0.89)	(0.79)	(0.89)
Resource discoveries					0	0					0.0957	0.00496
					(.)	(.)					(0.13)	(0.12)
N	64	64	64	64	64	64	406	406	406	406	406	406
R^2	0.412		0.412		0.412		0.272		0.273		0.273	
pseudo R^2		0.016		0.016		0.016		0.013		0.013		0.013

t statistics in parentheses

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table 15 : Summary statistics of micro analysis

	Count	Mean	Sd	Min	Max
China's aid total flows	10436	5866522	7.97e+07	0	5.21e+09
China's aid ODA flows	10494	1418255	2.66e+07	0	1.51e+09
Night Light	10635	1.963646	5.989502	0	48.19841
Population	10635	1091995	1736613	6046.85	2.19e+07
Capital region	10635	.0662906	.248801	0	1
Mines	10635	3.576869	12.58313	0	139
Oil & gas	10635	.1734838	.3786828	0	1
Area	10635	41106.88	81046.73	41.56429	626800
Port	10635	.1861777	.3892683	0	1
Road density	10635	.0919435	.146404	0	1.874231
Temperature	8915	23.58425	4.060947	9.12	31.3
Precipitation	8,960	3929.769	2334.153	1	7891
Distance	11,678	331.6557	401.3149	1	1216
N	10635				

Table 16 : Countries included in the sample for the macro level analysis

Algeria	Madagascar
Angola	Mali
Burundi	Mozambique
Benin	Mauritania
Central African Republic	Mauritius
Cote d'Ivoire	Malawi
Cameroon	Namibia
Congo, Dem Rep	Niger
Congo, Rep	Nigeria
Comoros	Rwanda
Cabo Verde	Sudan
Djibouti	Senegal
Egypt, Arab Rep	Sierra Leone
Eritrea	Somalia
Ethiopia	South Sudan
Gabon	Seychelles
Ghana	Chad
Guinea	Togo
Gambia, The	Tunisia
Guinea-Bissau	Tanzania
Equatorial Guinea	Uganda
Kenya	South Africa
Libya	Zambia
Lesotho	Zimbabwe
Morocco	

Table 1: Cross-correlation table

Variables	ODA	Population	GDP	Debt	Trade	LE	Education	MR	OR	NGR	RD	RR
ODA	1.000											
Population	0.003	1.000										
GDP	0.026	-0.326	1.000									
Debt	-0.004	-0.133	0.295	1.000								
Trade	0.109	0.518	0.334	0.067	1.000							
LE	0.127	-0.118	0.499	0.133	0.303	1.000						
Education	0.097	0.061	0.720	0.242	0.537	0.680	1.000					
MR	0.047	0.156	-0.085	-0.098	0.255	0.017	0.129	1.000				
OR	-0.067	0.162	0.450	0.092	0.439	0.138	0.288	-0.193	1.000			
NGR	-0.022	0.192	0.345	0.042	0.360	0.224	0.313	-0.174	0.528	1.000		
RD	-0.012	0.085	0.042	-0.011	0.130	0.052	0.078	0.010	0.032	0.010	1.000	
RR	-0.077	0.393	-0.196	-0.108	0.321	-0.258	-0.131	0.153	0.617	0.330	-0.011	1.000

LE = Life Expectancy MR = Mineral Rents OR = Oil Rents NGR = Natural Gas Rents RD = Resources discoveries RR = Resources Rents