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An Empirical Study on China's Foreign Aid Policy and Its Impact on Air pollution in Sub-Saharan Africa

Abstract

China's growing relationship with the developing world has sparked much debate amongst the international community. Yet, little is known of China's foreign aid policy but it seems to be concentrated on strategic and political objectives. This study aims to unravel the motives behind such aid, and investigate the potential impact it has on Sub-Saharan Africa's fragile environment. Data on Chinese aid commitments are obtained from AidData on 48 countries between the years 2000-2010, and that of CO_2 emissions, from the World Bank database. Using an OLS Panel FE estimation, commercial self-interests are found to dominate China's aid allocation. Results indicate recipient countries are; resource-rich, open towards Chinese exports, and politically unstable. No evidence is found to suggest China is seeking to oust American and European influence on the continent, instead, evidence suggests Australia, Canada, Japan, Korea and New Zealand are raising the carbon footprint in Sub-Saharan Africa, while China has no empirical effect.

JEL classification: F35, O44, N57

Key words: official development assistance, Sub-Saharan Africa, carbon dioxide emissions, environmental Kuznets curve

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List of abbreviations

AADRI	Asia-Africa Development Research Institute
BRICS	Brazil, Russia, India, China and South Africa
BTUs	British Thermal Units
CNOOC	Chinese National Offshore Oil Corporation
CNPC	Chinese National Petroleum Corporation
DAC	Development Assistance Committee
EKC	Environmental Kuznets curve
EPI	Environmental Performance Index
FDI	Foreign Direct Investment
FOCAC	Forum on China–Africa Cooperation
IEA	International Energy Agency
LDC	Least Developed Countries
MDGs	Millennium Development Goals
MEND	Movement for the Emancipation of the Niger Delta
MOFA	China's Ministry of Foreign Affairs
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of the Petroleum Exporting industries
PRC	People's Republic of China
SCO	Shanghai Cooperation Organization
SSA	Sub-Saharan Africa
SEPA	China's State Environmental Protection Administration
WDI	World Bank Development Indicators
WGI	World Governance Indicators
WTO	World Trade Organization

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'For I know the plans I have for you,' declares the Lord, 'plans to prosper you and not to harm you, plans to give you hope and a future.'

Jeremiah 29:11

1. Introduction

"We have turned east where the sun rises, and given our backs to the west, where the sun sets."

President Mugabe
Zimbabwe's 25th Independence Anniversary

For more than a decade, global warming and climate change have challenged local and international organizations worldwide. Economic growth has often come at the expense of the environment in many industrialized nations. Africa is now the fastest growing continent with GDP levels in Sub-Saharan Africa (SSA) rising from 3.5% in 1990 to 5% in 2000 (World Bank, 2013). To explain this growth, a range of propositions have been made with trade reappearing as the principle factor. On the other hand, reduced conflict, macroeconomic stability and democratization have been viable contenders (Christensen, 2012).

SSA's trade with the rest of the world has rapidly expanded over the years, particularly with emerging economies. For example, in the late 1980s, the BRICS represented only 1% of trade in SSA but now represents over 20%.[1] Among this group of countries, China contributed the most to this export growth and has now established itself as Africa's leading trading partner (World Bank, 2013).

In addition to this, foreign aid is also argued to be influential in achieving economic growth. Reports suggest more than US$ 100 billion is disbursed every year to developing countries, and may contribute up to 15% of their GNI (Doucouliagos and Paldam, 2008). On the other hand, aid is suggested only to be effective in strong policy environments, and in areas where inflows are sufficiently modest (Burnside and Dollar, 2000; Dalgaard et al., 2004; Hansent and Tarp, 2001). China's role on Africa is progressing through its aid practices at such an alarming rate, Western governments are concerned they will lose strategic influence in Africa. Chinese foreign assistance has been provided to fraudulent and authoritarian regimes in Angola, Chad and Zimbabwe, with the belief that 'people in different regions and countries have the right and ability to handle their own issues' according to Chinese Premier Wen (Idun-Arkhurst and James

[1] Brazil, Russia, India, China and South Africa.

Laing, 2007 p.24). This approach has received mixed opinions from the local and international community alike. Conflict-stricken countries are grateful to see major infrastructures such as hospitals, roads and schools, but have seen their local economies suffer from poor labor and environmental standards. Chinese exports allow more goods and services to be available in the market which can enhance the welfare of Africans, but can also destroy local manufacturing capabilities and competitiveness over time (ibid, 2007). Foreign aid experts are concerned China's no hands approach will backtrack the progress made on instrumental issues such as democracy and governance, and ultimately worsen the continent's environmental standards.

The current foreign aid literature is hugely devoted to analyzing the impact of aid on economic growth (Alesina and Dollar, 2000, Boone 1996, Easterly 2003). The empirical focus here differs by considering the determinants of China's foreign aid policy and its environmental implications on recipient countries in SSA. Data on Chinese aid commitments are obtained from AidData on 48 countries between the years 2000-2010, and that of CO_2 emissions, from the World Bank database. Using an OLS Panel FE estimation, commercial self-interests are found to dominate China's foreign aid allocation. Results indicate recipient countries are resource-rich, open towards Chinese exports, and politically unstable. No evidence is found to suggest China is seeking to oust American and European influence on the continent. Instead, evidence suggests Australia, Canada, Japan, Korea and New Zealand, are raising the carbon footprint in Sub-Saharan Africa while China has no empirical effect.

2. Background

2.1 China's history with Africa

The People's Republic of China (PRC) was established in 1949, and since then Africa has played a pivotal part of China's foreign engagements. The relationship was first governed by close political ties and massive financial flows at a time when much of the continent was resisting colonial rule. In the year 1964, China disbursed over 50 percent of loans to the continent and in 1975, financed the 1,860km Tazara railway - the largest foreign-aid development scheme undertaken by China at the time (SAIIA, 2009). This enormous project was completed two years ahead of schedule and connected the port of Dar es Salaam to Zambia's landlocked copper belt. Notably however, China's relationship with Africa is advancing. Initially and up until 1978, the partnership was centered on politics and what China considered as the five principles of peaceful cooperation (United Nations, 2010).[2] In this regard, China only began toughening economic ties with the continent from 1990, beginning with an official trip from Chinese President Zemin in 1996, where his administration outlined their plans to create a Forum on China–Africa Cooperation (FOCAC).

The launching of the FOCAC in 2000 changed the dimension of relations between China and Africa, only this time governed by commercial interests rather than the political ideology beforehand. These engagements were signified by increases in trade, investment, finance and top governmental visits by Chinese officials to Africa. Collaboration between much of Africa and China now includes political and international matters, development policies and cultural relations (United Nations, 2010). The FOCAC continues to establish itself as a platform for coordination and dialogue between the two partners, with meetings currently running every three years. These meetings have taken place in various locations such as Beijing (2000), Addis Ababa (2003) and Sharm el-Sheikh (2009); with presidents and ministers often present.

China's engagement with Africa brings with it several interesting features that are worth highlighting in this segment. First, the commitments made under the FOCAC are forward-looking and signify China's intent to remain committed to Africa in the long-run. Second,

[2] Namely: mutual respect for territories; no hostility; no intrusion in each other's domestic affairs; equality and mutual benefit; and peaceful coexistence.

FOCAC monitors the progress made by ongoing projects in Africa, ensuring promises are met, and has in turn become an example for other countries wishing to raise their engagements with Africa. Third, China outlined environmental sustainability as a significant part of its development policy, yet it has been passively dealt with thus far. Fourth, China wishes to incorporate the private sector to help stimulate investment for growth and the creation of jobs (ibid, 2010). International trade and financial support is the space China has had a considerable impact on in the region. Merchandise trade increased from under $10 billion to over $90 billion between 2000 and 2008 (ibid, 2010). Interestingly enough, since the first FOCAC summit, China has sent over 6,000 peacekeeping personnel and security staff to Africa. This comes despite China remaining adamant about its noninterference approach in African affairs.

2.1 What is Official Development Assistance?

Official Development Assistance (ODA) is the basic financial support used to establish the foundation of a nation. Assistance of this kind is primarily targeted towards healthcare and educational services, and to the construction of major infrastructure projects (OECD Factsheet, 2008). Once the core elements for development are firmly in place, nations can typically start to attract or create other sources of development finance. ODA is therefore advocated to be the first layer of aid received by developing countries.

For aid disbursements to qualify as ODA, three conditions must be fulfilled. First, disbursements must be made through state agencies. Second, the core objective must be to enhance economic development and the welfare of the people. Third, such flows must be 'concessional in character, with a grant element of at least 25% on loans' (Ali, Malwanda and Suliman, 1999 p.504). To expand on this, ODA includes 'capital projects, food aid, emergency relief, peacekeeping efforts, technical cooperation, contributions to multilateral institutions and development banks. It excludes military aid, and non-concessional flows from official creditors, which are known as other official flows.' (OECD Factsheet, 2008).

The current international aid system largely originates from the Marshall Plan (Van de Walle, 1998). The Marshall Plan was established after the second world war by the United States to assist economies, especially those in Eastern Europe to recover from the war. Since then, foreign

aid has become an intrinsic part of the development agenda required to initiate the economic 'take-off' in poorer countries. China's take on what it defines aid as is akin to the OECD-Development Assistance Committee (DAC) definition in the sense that aid is undertaken by the government and other official agencies. However, China's foreign policy takes on various angles and is not as confined as the former. One such angle assumes the Chinese government categorizes aid as "co-operation" and "ODA" (Davies, et al., 2008). As was claimed by a top Chinese government official in their report, "co-operation" counts as any foreign direct investment (FDI) and signed agreements with Chinese state-owned firms, while "ODA" consists of human resource development, concessionary loans, debt relief and grants. Furthermore, trade concessions may also fall in this category through the use of quotas, for example, in the textile industry to make African manufacturers more competitive in the global market. However, there were conflicting views from other officials interviewed by Davies et al., (2008) identifying the transfer of funds between governments only to constitute as "aid". These conflicting definitions make Chinese foreign aid strategies that much more ambiguous, as it stands there is no official definition for Chinese aid.

3. Literature on aid and economic growth

The basic notion behind the distribution of aid is to generate development and reduce poverty. Foreign aid helps accelerate savings and investment, and enables institutions to provide basic public services. However, regardless of the empirical research on aid and growth, "the debate about aid effectiveness is one where little is settled" (Rajan, 2005, p. 54).

It is widely argued aid impacts economic growth through various channels. Clemens et al. (2004) for example, evaluate how foreign aid disbursed for support of infrastructure development and the agricultural industry, whereas Miquel-Florensa (2007) distinguish the effectiveness of tied aid as oppose to untied aid.[3] In a separate light, Asiedu and Nandwa (2006) singles out the effect of aid spent in the education sector to discover that a US$1 rise in foreign aid boosts income by US$1.64 on average. In addition, the authors analyze the consequences of aid on the environment and health sectors and how these impact growth but do not statistically find an

[3] Tied aid is given under the condition that recipient countries use it on goods and services manufactured by the donor country themselves. Whereas untied aid carries no geographical conditions.

effect. In contrast, others argue aid has been unsuccessful in raising economic development (Rajan and Subramanian, 2008). In this regard, aid may hinder development by forming a dependency attitude on recipient countries and overwhelm their administrative capacities (Kanbur, 2000). In addition, aid may displace private sector development (Krauss, 1983), worsen bureaucracy (Knack and Rahman, 2007), ruin democracies (Knack, 2000), as well as destroy manufacturing levels through the Dutch Disease (Rajan and Subramanian, 2005).

The literature on the usefulness of aid is therefore rather ambiguous (Feyzioglu et al., 1998). In investigating the determinants of Chinese aid to SSA, this paper follows the literature that ODA creates a positive impact on economic growth. Empirical evidence has been found to support this too, or at least in specific macroeconomic circumstances (Burnside and Dollar, 2000; Gomanee, Girma, and Morrissey, 2002, Dalgaard, Hansen, and Tarp, 2004).

4. Empirical analysis on the determinants of Chinese aid

4.1 Hypothesis Development

China is facing energy security concerns, and to prevent this is seeking to establish reliable suppliers for its rapidly growing economy (Humphrey and Schmitz, 2006). According to predictions by the US Department of Energy, energy consumptions in China are estimated to increase by 153% between 2002 and 2025 (See Table 1). Furthermore, since it underwent economic reforms and joined the international market in 1993, China surpassed Japan within a decade and is now the world's largest oil consuming country in the world after the United States (EIU, 2006).

Table 1: Estimated energy consumption levels in China, 2002-2025 (Quadrillion BTU)

	2002	2010	2015	2020	2025	2002-2025
Oil	10.6	18.9	21.9	25.3	29.2	4.5
Natural Gas	1.3	3.1	4.0	4.9	7.6	7.8
Coal	27.9	45.1	53.0	59.6	63.6	3.6
Nuclear	0.2	0.7	1.4	1.7	2.1	9.9
Renewables	3.1	5.2	5.7	6.2	6.7	3.4
Total	43.2	73.1	86.1	97.7	109.2	4.1

Source: Humphrey, J., and Schmitz, H. (2006), " The Implications of China's Growth for other Asian Countries." Institute of Development Studies, University of Sussex, Brighton, UK.

To meet this tremendous demand for natural resources, Chinese firms are venturing to countries such as Iran, Venezuela and the continent of Africa in the pursuit of unused energy fields (Andrews-Speed, Liao and Dannreuther, 2002). China's presence in Africa was evident in 2006 when the Chinese National Offshore Oil Corporation (CNOOC) declared a $2.3 billion agreement to purchase 45% of a key oil field in Nigeria. On the other end of the continent, The Chinese National Petroleum Corporation (CNPC) operating in Sudan, owns 40% of the leading oil company. Moreover the CNPC is building a $215 million export terminal to strengthen trade links between the two countries. Sudan's government has been criticized numerous times in the past over the genocide in Darfur, yet this has not stopped China's engagements with the nation as it selected Sudan to build its largest overseas production base.[4] Angola and other African countries have substituted loans from international bodies reminiscent to the International Monetary Fund (IMF) that bring a package of conditions to the table, whereas grants from China have no strings attached. China has out-bid the West on key capital projects through the use of concessionary loans and other aid programs to increase their competitiveness in the international financial market. African governments are being criticized of "reneging their commitments to Western companies by handing over their interests to Chinese entities." (Idun-Arkhurst and Laing, 2007 p.24). A perfect example of this was when the government of Kenya took away two concessions granted to European contractors in 2006, and handed them over to the CNOOC for oil exploration.

Despite China's attempts to broaden energy supplies, nearly half of its imported oil was from the Middle East in 2005. The majority of them transported via sea routes navigated by the US navy. China therefore fears disruptions of its resources particularly over political matters like Taiwan (Downs, 2000). As a consequence of this, the government in Beijing is behind a strategy to diversify gas and oil imports using pipelines from Asia and Russia. The Shanghai Cooperation Organization (SCO) is a prime example of China's emerging energy foreign policy. Through cross-border projects, energy companies are encouraged to invest and establish a trans-Asian energy infrastructure program running from Russia to Central and Southeast Asia. This comes at

[4] Bezvola. (2005), China's oil quest causes friction. See: http://mepnotes.blogspot.nl/2005/09/antoaneta-bezlova-chinas-oil-quest.html.

a time when energy commitments from Russia have not been fulfilled, falling short by 7 million tons from a promised delivery of 15 million, with Russian oil prices quadrupling in 2005.

Given the lack of Chinese presence in the Middle East, and the country's uncomfortable reliance on Russia and the US, the Chinese government is strengthening efforts to expand its imports. Africa now makes up over 30 percent of oil imports into China, with Angola displacing Saudi Arabia as the number one exporter of crude oil to China (See Table 2). This scramble for oil has enormous implications for Africa. For the producing countries like Angola and Nigeria, it promises an increase in resource rents and an equal distribution of wealth to those at the bottom of society. For China, it presents a trade partner that is deep in oil reserves, but yet creates commercial ties with an insecure and unstable region (Klare and Volman, 2006). Nevertheless, this represents a significant shift in any emerging foreign energy policies in the future as 'an increasing percentage of the world's oil supplies are expected to come from the waters off West Africa'.[5]

Table 2: Angola's Exports Around the World, 1997-2006 (in percentages)

	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Total World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
US	62.6	64.1	53.2	45.6	47.7	41.0	47.7	40.2	39.8	38.6
China	**12.7**	**4.0**	**7.4**	**20.8**	**10.5**	**13.6**	**23.4**	**29.9**	**29.6**	**34.7**
EU	14.1	17.0	17.0	17.7	26.3	26.6	13.4	10.4	14.7	8.7
South Africa	1.0	0.1	0.7	0.5	0.6	0.6	0.6	2.4	1.5	1.3
Korea	3.8	2.8	13.4	8.3	3.2	2.2	2.8	2.9	0	0

Aguilar, R., and Goldstein. A. (2009), "The Chinisation of Africa: The case of Angola" *The World Economy.*

China is now among Africa's biggest trade partners not only for oil but for minerals such as copper, aluminum, timber, cotton and other natural resources (See Appendix A.1). From 1990 to 2000, China's world consumption of iron ore, nickel, copper and aluminum increased from 7 percent to more than 15 percent (Idun-Arkhurst and Laing, 2007). However, such growing

[5] 'Angola possesses a prize as Exxon, rivals stalk oil', Wall Street Journal, December 2005.

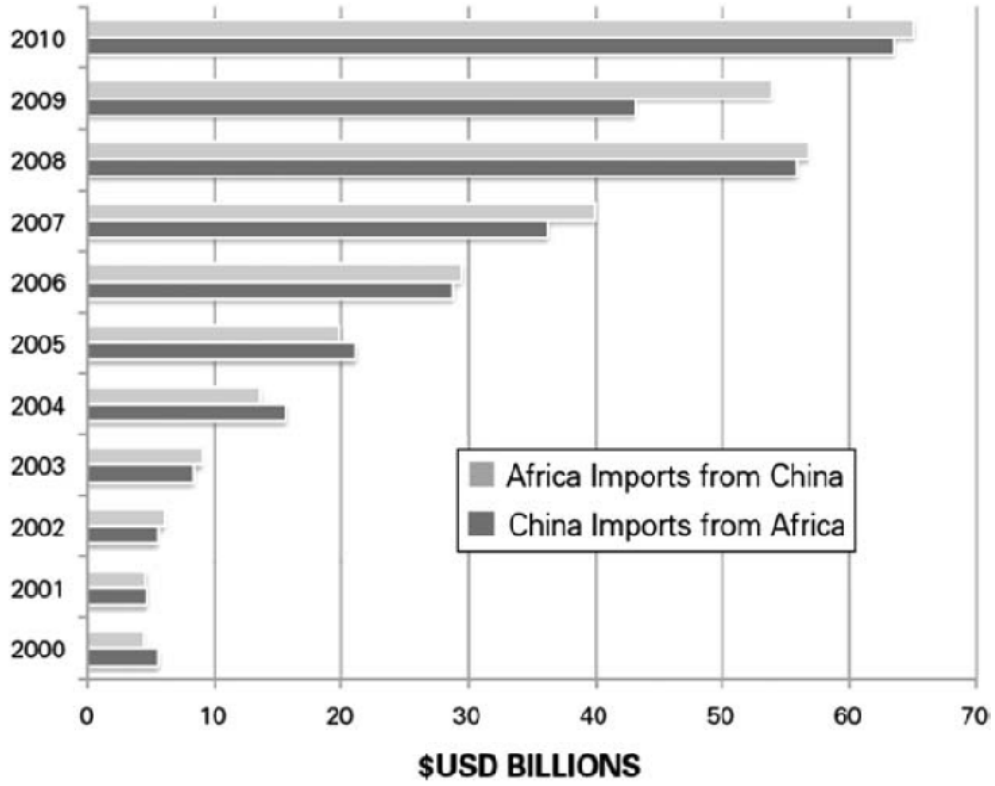
energy demands only continue to place further pressure on the environment. China was responsible for 16.5 percent of world CO_2 emissions in 2004 (Yale Center for Environmental Law & Policy, 2005) and is now the world's top emitter.[6] Furthermore, statistics from The International Energy Agency (IEA) predict China's emissions will increase to 40 percent in 2050 based on Chinese imports and domestic coal production. China therefore has an important role to play in the future of the world's climate. This proposes the first hypothesis, Hypothesis 1a: China's official development assistance is targeted towards resource-rich countries in Sub-Saharan Africa.

China is also labeled as 'the world's factory' and is searching for new markets to sell its numerous products. Reports suggest that in the near future, China's economic growth will rise to 13 percent per year. China's speedy industrialization has often led to overproduction by almost 50 percent in sectors such as electronics, textiles and footwear (Idun-Arkhurst and Laing, 2007). This growth has created the need for trade in raw materials to produce these Chinese goods and services. SSA represents a strong economic opportunity for the demand of Chinese products as it is populated by over 700 million inhabitants. This peaks to 900 million with the inclusion of North Africa, a staggering 20 percent of the population of the world. Such prospects provide Chinese producers with an enormous opportunity to tap into a growing consumer market. This was largely reflected in the 1990s when Chinese trade with Africa grew by up to 700 percent. Since then, trade has increased at a ghastly pace with China replacing the United Kingdom, France and the US as Africa's largest trading partner (Kaplinsky, McCormick, and Morris, 2010). It is reported that in 2002, trade values leaped from nearly $10 billion to over $40 billion in 2005, and further to $50 billion in 2007 and rose by 46 percent in 2008 to $109 billion. China now receives one-fifth of exports from Africa and is responsible for over 50 percent of Asian exports (Idun-Arkhurst and Laing, 2007). In 2005, China traded in goods valued at $21.1 billion from Africa and sent $18.7 billion worth of goods abroad, presenting a $2.4 billion deficit. Chinese officials argue this to be a signal of their pledge in creating a trade surplus to spur economic growth in Africa but as seen in Figure 1, this commitment was short lived. Trade

[6] Total carbon dioxide emissions in million metric tons from China (8,320) outweigh those of the United States (5610), India (1695) and Russia (1633) respectively.

deficits peaked at $10 billion in 2009, and continued in 2010 indicating an unfavorable balance of payments may persist in the future.

Figure 1: China-Africa Trade patterns 2000-2010



Source: Eisenman, J. (2012), "China–Africa Trade Patterns: Causes and consequences."

The most import-dependent SSA countries in 2007 included Sudan, South Africa and Angola, with most being manufactured goods (Kaplinsky and Farooki, 2008). This is true as ignoring fabrics, trade in intermediate goods by African countries is very minimal. Some researchers argue most imports into SSA from China have replaced imports from the rest of the world. This implies little change in national production levels and therefore little change in employment. Others such as Kaplinsky and Morris (2006) argue the opposite by stating that locally made furnishings in South Africa and Ghana have been displaced through Chinese penetration into the market. Trade unions in Zambia protest Chinese imports are destroying their clothing and electrical sectors, and Nigerians accuse China for the loss of nearly half a million jobs.[7] Furthermore, on an empirical standpoint, Egziabher (2006) conducts a quantitative analysis of

[7] See www.nzherald.co.nz accessed on July 12th 2014.

Ethiopian domestic producers and concludes that due to competition from China, 28 percent of producers turned insolvent, and 32 percent downsized in activity. In addition to this, the average size of production staff dramatically fell from 41 to 17 in small-medium enterprises.

China is evidently flooding its goods and services into the region. For SSA, such exports provide increased competition and a wider variety of products which improves the well-being of Africans. In the long-run however, such trade relations could de-industrialize the continent's manufacturing capabilities and competitiveness especially in textile and clothing - sectors that a majority of Africans are heavily reliant on. This would lead to a loss in employment and a fall in production levels, dampening the region's economic growth and add to its poverty concerns. China has tremendous responsibility as a trading superpower and can use this to shape its aid policy to prevent such losses. Even after the use of quotas on Chinese garments, imports to the EU and US still fell by 16 and 17 percent respectively (Idun-Arkhurst and Laing, 2007). This proposes the second part of the hypothesis; Hypothesis 1b: China's official development assistance is targeted towards Sub-Saharan countries more open towards their exports.

On a political standpoint, realists argue superpowers fear one another and compete for world power (Mearsheimer, 2001). A vital part of China's foreign aid program is the recipient country's position on the 'One-China policy.' This policy states Taiwan is not a separate and sovereign country as it claims, and is the only condition China sets on partnering states. This political strategy has proved successful as most African countries have rejected Taiwan's independent status, choosing instead to strengthen diplomatic ties with China.[8] Moreover, in 2006, a Global Affairs assessment asked American subjects to rate on a 0–10 scale the amount of influence they believed superpowers had in the world. China received a significant score (6.4) above the EU (6.0) and Russia (5.6), yet evenly tied with Japan (6.4), but slightly behind the United Kingdom (6.7) with the United States ranking first (8.5) (Xie and Page, 2010). Furthermore, under this survey, 70 percent of Americans feared China's rise to global power will be a major risk to the United States in years to come. In Europe, there are growing tensions of a 'continental drift' between the EU and Africa. This has been reflected by widening cracks in

[8] Only Burkina Faso, Malawi, Swaziland and Sao Tome and Principe continue to share diplomatic ties with Taiwan.

trade, governance and politics, and has subsequently been pinned to be the reason behind the EU's loss of leadership on the African continent. Other scholars maintain China is avoiding conflict and is seeking peaceful coexistence with other superpowers (Goldstein, 2005). Neo-liberals on the other hand, envision China to play an integral part in creating world peace through their economic and diplomatic engagements (Ikenberry, 2008). Government officials in China insist they are not seeking to threaten anyone, but create a more harmonious world (China State Council, 2005).

This comes after numerous occasions in which Western governments have cut diplomatic ties with corrupt or oppressive African countries. China currently makes no such discrimination and has instead moved in to make itself known in nations where the West have refused to continue relations. These include countries such as Zimbabwe and Sudan. As a realist would, China may view the decline of Western influence and popularity as an opportunity to strengthen alliances in Africa for both economic and political benefits (Idun-Arkhurst and Laing, 2007). There are also growing fears among the international community China is aiming to divide the World Trade Organization (WTO) by mobilizing the 42 African members to turn the rules and regulations of trade to its own benefit. Of the 160 members, Africa is the largest regional bloc in the WTO and with its support, China will have the means and the power to change the state of affairs of trade between countries (ibid, 2007). This leads to Hypothesis 2a: China's official development assistance factors in US and EU aid to Sub-Saharan Africa to position itself as a dominant superpower.

On an altruistic standpoint, China also claims its aid is more attentive to the needs of recipient countries than aid from other donors. This implies China provides aid to countries with similar or lower levels of economic development. Moreover, China distances itself from the political affairs of recipient countries and therefore Chinese aid should be independent of the institutional quality of its partners. This presents the second part of the hypothesis, Hypothesis 2b: China's official development assistance is allocated irrespective of the quality of governance of Sub-Saharan countries.

4.2 Data

Overview

This section explains the data and estimation procedure. This study uses panel data from 48 SSA countries for the period 2000–2010. The list of countries can be found in Appendix B.1. Panel data as oppose to cross-sectional data applied in other empirical studies such as Yasin (2005), and Billet (1991) is beneficial for a number of reasons. To begin with, panel data is more fitting for this analysis as it provides more information and degrees of freedom. In addition, the data is withdrawn from countries similar in their phases of development, economic design, history and geography. These give consistency to the observations obtained in reducing variations and in removing outliers common with cross-sectional data. These characteristics give more weight to the empirical results and the conclusions that arise.

The data is obtained from the following databases; World Bank Development Indicators (WDI), AidData, Organization of Economic Development (OECD), UN Comtrade, and World Governance Indicators (WGI). The descriptive statistics and their respective sources are reported in Appendix C.1 and D.1. As this paper examines China and Sub-Saharan Africa, two areas known to have unreliable data, it is difficult to conduct robustness checks that can make the results more sound. In addition to this, a sample selection bias may exist. In C.1, the total number of observations varies considerably from as low as 270 to 528, and the empirical framework is restricted to a sample of 109. If these missing observations cause the sample to be unrepresentative, this may cause a sample selection bias that leads to the Ordinary Least Squares (OLS) coefficients to be biased. Moreover, if the missing observations are arbitrary, or dependant on an exogenous factor in the model then there is no issue.

Dependent Variable

The main variable of interest in this study is the Official Development Assistance from China to SSA. Data on this variable is obtained from AidData.[9] The highest amount of Chinese ODA is directed towards Ghana. This may be explained by the fact Ghana hosted the African Football

[9] A database compiled to fill the void of China's foreign aid policy. The research team behind the online platform string various resources together from official government data, published journals, the web, and newspaper articles by primarily using the media search engine Factiva.

Cup of Nations in 2008, with the assistance of sports facilities and stadiums constructed by the Chinese government. Ghana is also expected to become a significant oil producer in the near future, and could be China's strategy of gaining a foothold on the nation in exchange for resources (Baumuller et al., 2011). Other top recipients include, Nigeria, Ethiopia, Mozambique and Uganda. The individual year with the highest flows is 2010, the most recent year in this analysis, culminating to almost $2.5 billion. Moreover, a change in Chinese relations began when it declared it would raise the amount of aid disbursed to Africa by two times what it was in 2006 by 2009, with the aim of reaching "the target of mutual benefit and a win-win situation between China and African countries" (Ministry of Commerce, 2007). This may explain why Mozambique received a grand sum of $700 million in 2009, up from a mere $94 million in 2006, and was by far the largest climb found. Ethiopia ranked second, receiving $109 million in 2009, up from $4 million in 2006. In contrast, there are countries in the sample that did not receive ODA from China over the period measured. These include Sao Tome and Principe, Burkina Faso, The Gambia, and Swaziland – all of which violate China's One China Policy in recognizing Taiwan as a sovereign nation, signifying China's intent to become a dominant superpower.[10] It is important to note that Chinese ODA was found to be only a fraction of EU and US ODA over the period of analysis, worth only 10% and 27% respectively (see Appendix E.1). However, caution needs to be undertaken when addressing this finding as China does not categorize aid to recipient countries under the same definition OECD member states do. This leaves out many potential avenues of aid under China's development agenda that are not classified as ODA, and are therefore not statistically captured here.

[10] With the exception of The Gambia which defected more recently in 2013 to preserve 'national interests'. See http://www.asianews.it/news-en/After-18-years,-Gambia-breaks-diplomatic-relations-with-Taiwan-29553.html accessed on July 11th 2014

Figure 2: Chinese ODA in five-year periods from 2000-2010 (US Billions)

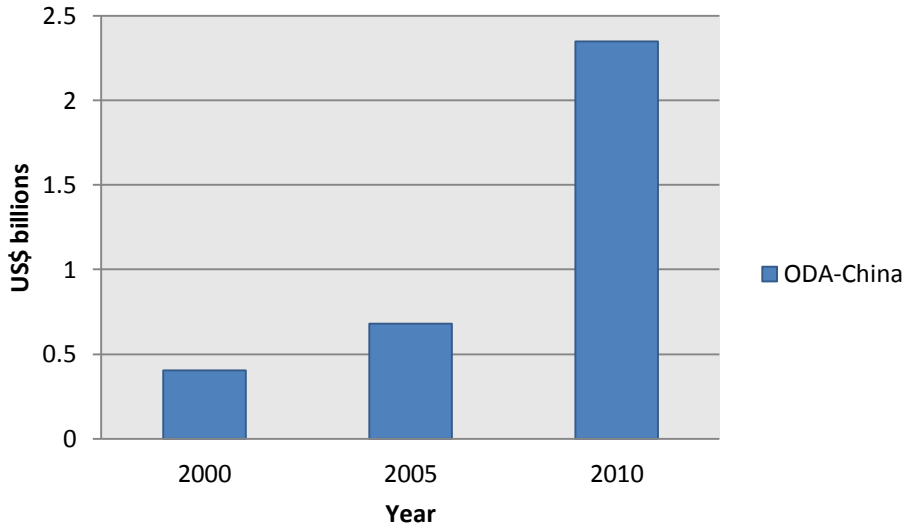


Table 3: Top recipients of Chinese ODA 2000-2010 (US Billions)

Ghana	1.80
Nigeria	1.70
Zimbabwe	1.30
Mozambique	1.10
Ethiopia	1.00
Mauritania	0.60
Mauritius	0.53
Zambia	0.45
Namibia	0.42
Uganda	0.39
Rwanda	0.33

Explanatory Variables

The explanatory variables in this study are used in relation to the aid literature to control for factors also known to influence disbursements. To begin with, GDP per capita (PPP) is used to keep the standard of living fixed across the period of analysis (reported in constant 2011 US dollars). Buckley et al. (2006), argue GDP levels can be used to proxy for market attractiveness and size, but are also used here to normalize Chinese Foreign Direct Investment which suffers from severe volatility. Data on this variable is obtained from the Ministry of Commerce which publicized the most detail account of Chinese FDI activity from around the world, however; this data is only available from 2004. Total population is used to proxy for how big the recipient country may be, as bigger countries require more tools and resources to grow. Corruption on the other hand is added to control for institutional quality. Aid is usually allocated to more effective governments, but corruption is also known to inhibit governments from achieving their cause (Svensson, 2005). This variable is put in place to determine whether Chinese aid is similar to that of traditional donors on the continent which are known to support good governance and human rights issues.

4.3 Methodology

To test the hypothesis outlined, China's position as a donor is first challenged against that of DAC countries.[11] To do this, an empirical analysis is conducted on the standard set of possible determinants for aid outlined above: GDP per capita, corruption and population (Lee, 2012). The data is transformed into natural logarithms and the GDP per capita and population variables are squared. This quadratic specification helps to test the consistency of aid between donor countries regarding the size of the country and the socio-economic needs of their recipients. Additionally, it assesses the extent of the population bias. The advantage of logarithms is the estimated coefficients can be seen as elasticities. In other words, the estimated coefficients represent a relative change not an absolute change. Natural logarithms may also reduce the statistical

[11] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, European Union, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, United Kingdom, United States.

problem of heteroskedasticity (Gujarati, 1995), where the variables are assumed to have different variances.

In this study, OLS Fixed Effects methodology (FE) is employed. The advantage of this method is the error term ($\in_t$) excludes the time invariant factors explicit to individual countries that may influence ODA, otherwise known as unobserved heterogeneity. In other words, the residuals of some observations may be correlated. OLS estimation critically assumes the residuals are uncorrelated with the regressors. If this assumption is broken, the coefficients of the explanatory variables will be biased under this analysis (Verbeek, 2008). The FE technique combats the problem of unobserved heterogeneity by eliminating it entirely using a common method referred to as within transformation. A potential downfall to this approach is the absence in the variation in the variables that remain, and in addition, FE may lead to a loss of degrees of freedom.[12] Furthermore, unique factors expected to influence ODA may be unobservable such as institutional arrangements and public opinion, but may be correlated with the independent variables at hand. However, as they are difficult to empirically measure the use of instrumental variables is not used in this analysis. To strengthen the FE estimation technique, White's heteroskedasticity-consistent errors are applied to prevent biased OLS standard errors and misleading inferences (Dewatripont, Hansen, and Turnovsky, 2003).

4.4 Empirical Results

Turning to the analysis, the effects of GDP per-capita are expected to be significantly negative for both China and DAC countries. Higher performing countries are viewed to be less dependent on aid as they have the skills and funding necessary to steer themselves to economic growth. Institutional quality is represented using the corruption index, and as hypothesized, is expected to not be a determining factor for Chinese aid allocations. This is due to its non-interference approach emphasized in its foreign aid policy agenda, but on the other hand, is expected to be

[12] An alternative method is the use of Random Effects (RE) estimation. The advantages of RE are that time invariant variables remain, and a much higher variation is found. After using the Hausman Test to reveal which method is valid, results reject the null hypothesis in favor of the FE estimation at the 1% significance level.

significant for DAC member states. For this reason, critics have stated China is undermining the efforts of traditional donors by rewarding poor governance with aid. Yet, it is well known that Western donors may not be as credible as they otherwise claim to be (Alesina and Weder, 2002). Logged population is used to proxy for any small-country bias, and is essential as the dependent variable is not measured in per capita terms.

The empirical results in Table 4 indicate recipient need is not an important factor in China's allocation of aid. This finding disagrees with Brautigam (2008), who stresses Chinese aid does indeed attend to the needs of less developed countries. Although positive in sign, this effect is statistically insignificant and goes against the conventional grain that aid increases with lower levels of GDP. As hypothesized however, China is found to ignore the institutional quality of recipient countries. What is more surprising is that DAC aid is seen to have a similar effect. To countercheck these results further analysis is conducted in Table 4 by running a separate regression that includes a greater depth of quality governance measures. Notably, these variables were also used by Dreher and Fuchs (2011). Again, China is found to allocate aid irrespective of the rule of law, political stability and regulatory quality of its partner countries in SSA, but yet this is a significant concern to DAC countries. A 1% rise in political stability leads to a 82% reduction in ODA flows, and more stringent regulations see institutions rewarded with a 51% increase in aid disbursements.

Turning to another analysis, Table 4 also indicates the need-orientation of donor countries. DAC member states are found with significant effect to assist nations with higher child mortality and poorer access to clean water. This points towards the commitment of developed nations in achieving the Millennium Development Goals (MDGs) of elevating the socio-economic needs of developing countries. China does not take account any of this, with all stated variables remaining insignificant throughout the three regressions performed. Accusations that it may indeed be undermining the efforts of Western donors robustly stand. There is sufficient evidence to suggest China is funding less effective, and more corrupt governments and ignoring the needs of chronic poverty and child malnutrition. These findings are also supported by Dreher and Fuchs (2011), and contradict the claims China's aid policy is more need-oriented than developed countries. It is

worth noting however, DAC members are observed to raise the debt burden of African states, an area China has increasingly vowed to relieve.

Table 4: Differences between Chinese and DAC aid

OLS Fixed Effects

Dependent Variable		**Chinese aid**	**DAC aid**
Baseline	Population	-1.20 (0.79)	**1.02***** (0.31)
	Population squared	0.20 (0.17)	**-0.24***** (0.06)
	GDP p.c	2.83 (2.06)	-0.38 (0.88)
	GDP p.c squared	-0.17 (0.48)	-0.04 (0.05)
	Corruption	-0.17 (0.57)	-0.29 (0.27)
	Observations Adjusted R-squared	233 0.0002	417 0.05
Institutional Quality	Rule of Law	0.09 (0.66)	0.56 (0.36)
	Political Stability	-0.01 (0.25)	**-0.82***** (0.14)
	Regulatory Quality	-0.11 (0.49)	**0.51**** (0.21)
	Observations Adjusted R-squared	247 0.01	453 0.04
Need-Orientation	External Debt	-0.027 (0.15)	**0.12*** (0.07)
	Child Mortality	0.05 (0.24)	**-0.29***** (0.09)
	Access to Water	0.47 (0.66)	**-2.06***** (0.26)
	Observations Adjusted R-squared	251 0.02	478 0.05

-Numbers in parenthesis are heteroskedastic-corrected standard errors

***** significant at the 1% level **significant at the 5% level *significant at the 10% level**

In order to examine the strategic determinants behind the Sino-African relationship, the following theoretical model is framed and estimated:

$$Ln(Chineseaid) = \beta_0 + \beta_1 Ln(NaturalResources)^{-1} + \beta_2 Ln(Exports)^{-1} + \beta_3 Ln(ExternalDebt)^{-1} + \beta_4 Ln(TelephoneLines)^{-1} + \beta_5 Ln(FDI)^{-1} + \beta_6 Ln(ODA\text{-}US)^{-1} + \beta_7 Ln(ODA\text{-}EU)^{-1} + \in_t$$

All independent variables, with the exception of the dependent variable (Chinese aid) are lagged by one year since, as emphasized in other empirical research, the allocation of aid depends on the most recent information available (Nnadozie, 2000).[13] As anticipated, these variables are often used on countries that exhibit a particular economic and politic interest. In China's case, economic interests are shaped by its ability to meet its energy security needs. *NaturalResources* is the variable used to capture this motive, and are the financial contributions from forests, coal, oil, minerals and natural gas towards total GDP. As China is embarking on projects culminating from copper mining in Zambia to timber logging in Liberia, this variable is intended to pick up any activity in the extraction sector. Chinese demand for natural resources is so substantial, an inverse in the terms of trade in developing countries is being witnessed as illustrated between 2000-5 in Figure 1 (Kaplinsky, 2005). Therefore, Chinese aid is expected to rise in relation to natural resource rents of recipient countries (H2a). To capture the motive that China may be using its foreign aid program as a means to promote its own exports, the variable *Exports* is added to account for this. SSA's imports from China in relation to trade with the industrialized nations increased from 1.8 percent (1990) to 3.8 percent (1997) to 12.3 percent (2004). Although this outlines that SSA's trade with China in the period tested is relatively small in relation to developed countries, there is no doubt Sino-African trade is growing fast. Given that this growth continues, the impact on SSA's future manufacturing capabilities may be substantial (Kaplinsky, McCormick and Morris, 2007). However, whether such high growth rates are due to China's growing economy or aid policy begs to be tested. To measure China's altruistic move into SSA, *ExternalDebt* is added. Between 2000 and 2003, China wrote off nearly $2 billion US dollars worth of African debt in more than 30 countries. By relieving countries of their debt, Beijing

[13] The model was estimated using a technique that corrects the heteroskedasticity problem namely White's heteroskedasticity-corrected estimation technique.

insists African governments can focus more on raising their own economic status. China is also argued to compete with Western countries, namely the United States, in gathering the support of some African regimes. For this reason, the variables *ODA-US* and *ODA-EU* are used to assess the strategic intent of China to increase its aid to recipient countries affiliated to the United States (US) and Europe (EU) through their aid programs.[14] In addition, physical capital was controlled for using the number of telephone lines per 100 people to represent infrastructure development and communications in the region. China has been keen in constructing roads, airports and stadiums however, as argued by Asiedu (2002), this does not measure how dependable such infrastructure is for which consistent data is unavailable.

[14] Caution is needed during the interpretation of this variable. as evidence may also suggest China is collaborating, rather than competing with Western governments for the diplomatic support of African regimes via its aid program.

Table 5: Determinants of Chinese Aid

OLS Fixed Effects					
		(1)	(2)	(3)	(4)
Dependent Variable:	**Chinese aid**				
	Constant	**3.44*** (2.00)	**3.83***** (1.28)	**4.01***** (1.22)	**4.39***** (1.13)
	Total natural resources	0.33 (0.27)	0.31 (0.19)	**0.32*** (0.19)	**0.37**** (0.17)
	Exports	0.47 (0.31)	0.33 (0.23)	0.35 (0.22)	**0.38*** (0.22)
	External debt	0.22 (0.33)	0.13 (0.10)		
	US aid	0.21 (0.24)	0.40 (0.22)	0.10 (0.10)	
	EU aid	0.10 (0.23)			
	Infrastructure development	0.52 (0.35)	**0.40*** (0.22)	**0.42**** (0.21)	**0.42**** (0.21)
	FDI	0.00 (0.15)			
	Political stability	**0.79*** (0.45)	0.32 (0.35)		
	Observations	109	179	190	193
	Adjusted R-squared	0.19	0.18	0.19	0.16

-Numbers in parenthesis are standard errors

***** significant at the 1% level** ****significant at the 5% level** ***significant at the 10% level**

H1a	Chinese aid is targeted towards resource-rich countries in SSA	Satisfied (+)
H1b	Chinese aid is targeted towards countries more open to their exports in SSA	Satisfied (+)
H2a	Chinese aid factors in US and EU aid when allocating its aid to SSA	Not Satisfied
H2b	Chinese aid is allocated irrespective of the quality of governance of SSA	Satisfied (No effect)

The empirical results indicate natural resource endowments play a part in China's foreign aid policy to SSA. In regressions (3) and (4) of Table 5, disbursements are positive and statistically significant to a rise in resource rents. This satisfies H1a, empirically suggesting 'China is out to the eat the world' (Boshard, 2008, p.8). In exchange for aid, China could be seeking to acquire natural resources in the region to meet its energy demands, as is the case in Nigeria, Ghana and Angola (see Appendix G.1). Although relatively marginal, this finding is also confirmed by (Dreher and Fuchs, 2011) who find a 10% rise in a recipient country's oil production, increased their share of Chinese medical personnel by 0.007 and 0.010 respectively. Regarding China's exports into SSA markets, evidence is also found to explain a significant rise in aid allocations when countries are more open towards them for trade (also satisfying H1b.) These results therefore fully explain China's commercial interests under this analysis. However, foreign direct investments are omitted early on in regression (2) due to such a high insignificance with the dependent variable. The same goes for political stability, European aid, and later US aid. Once again, China is found to erode democracy and basic human right issues in the region as was evident in Table 4, satisfying H2b, but no evidence suggests China bases its foreign aid policy on that of Western donors, failing to meet H2a.[15] This approach is consistent with some literature such as Simon and McGillivray (2002) who test whether bilateral donors respond to the aid allocations of other donors.

Notably, the presence of good infrastructure and communications has a positive influence on Chinese aid and is consistent across the board. This may be a result of the over 800 state-owned companies operating in the private sector on the continent. As one suspects, Chinese entrepreneurs are attracted to well-connected transport links, and communication networks to help lower start-up costs. Furthermore, the analysis proves Chinese aid is not significantly directed to heavily indebted countries as reports suggest. This could once again be a result of China's development agenda not to consider debt relief as 'aid' per say. Biggeri and Sanfilippo (2009), empirically find that Chinese capital outflows are channeled towards Angola and Sudan, countries that do not receive as much financial assistance from developed countries. This adds up

[15] The model is also checked for stationarity by employing the panel unit root test created by Pedroni (1999). The null hypothesis is rejected at the 5 percent significance level indicating no evidence of stationarity. The correlation matrix also shows no evidence of any alarming levels of multicollinearity among the explanatory variables.

because among the bodies commandeering Chinese FDI is the Ministry of Foreign Affairs (MOFA), yet another Chinese state-department that seeks to assist developing nations in achieving their goals (Davies et al., 2008). However, despite this motive such funds do not qualify for ODA due to their nature, but highlight the multi-dimensional framework of China's engagement with African countries.

5. China's environmental footprint

Notwithstanding the determinants of Chinese aid with SSA, this paper also seeks to empirically assess the direct impacts foreign aid is having on carbon dioxide emissions, particularly from China to Sub-Saharan Africa with close comparisons to DAC countries. It is often argued that Northern countries have taken strides to prevent global warming through their engagements with Africa but very few Southern countries have taken this step. The only mentioning of this in the literature is that of The Republic of Korea. Korea has been documented as a pioneer in establishing a Green Growth Initiative with Africa. This initiative run from 2009-2012 and provided training to public officials, green technologies, and the transfer of policies to governments to help them adapt to climate change. However, Korea is a member of the OECD and does not fully qualify as a developing partner to Africa, such as China, Brazil or India. This was reflected in 2008 when nearly 40% of ODA from Korea was allocated to education and health; following the fashion of other traditional donor countries. (United Nations, 2010).

As a principle contributor to Africa's growth, China must place greater emphasis on addressing the environmental impacts of its projects. Evidently, an important part of China's foreign aid policy is to dig up natural resources, however this may destroy the fragile ecosystems of their recipient countries. Traditionally, China's state-owned firms took on the social responsibilities of providing jobs and housing for its people. After 1978 when China underwent reforms, firms were ordered to focus exclusively on profits to spur economic growth. This model was soon applied by Western investors, as it provided them with a pathway to avoid stringent environmental policies at home (Boshard, 2008). Like most governments, China passes on its development policies using its foreign aid program. For example, Chinese ministers have invited their African counterparts to visit the Three Gorges Dam to understand Asia's energy sector. However, the hefty cost of the dam in monetary and environmental terms has revealed itself to not be the ideal

model for developing nations to embrace, and should not give reason for countries to prioritize economic growth over the environment anymore.

Some key examples illustrate the risks of Chinese investment on the African environment. Take Gabon for example, Sinopec[16] searched for oil in Loango National Park until the country ordered exploration to stop in 2006 (Centre for Chinese Studies, 2007). Conservation groups revealed Chinese exploration threatened plants and animals to extinction, and the Environment Ministry did not approve of the oil exploration to begin with. Moreover, the Kongou Dam, planned to generate power in Gabon is endangering the woodland of the Ivindo National Park. In a separate case, Chinese Exim bank is financing a project under Sinohydro[17] to construct a dam in Ghana, but it is predicted to flood 25 percent of Bui National Park. In Zambia, The Lower Kafue Gorge Dam, yet another Sinhoydro project, is endangering the Kafue Flats. When confronted, China's response about the impacts its overseas projects are having on the environment is that it does not govern other countries. 'Business is business. We try to separate politics from business. Secondly, I think the internal situation in the Sudan is an internal affair, and we are not in a position to impose upon them.'[18] was the Chinese deputy foreign minister's remarks on the human rights crisis in Darfur. Yet, business turned into politics when activists began to label the Beijing Olympics as the 'Genocide Olympics'. Concern for its international reputation may have been the reason China changed its diplomatic stance with Sudan and eight other countries as a result of their political affairs. It did this by prohibiting them from receiving concessional export credits (McGregor, 2007).

With this in mind, China has intensified efforts to address the environmental issues it faces. The government banned timber logging in 1998, reinstated the water law in 2002 and implemented laws on environmental impact assessments in 2003 (Boshard, 2008). Other measures such as the green credit policy modeled by enforcement agencies such as SEPA provide a watchdog for stricter compliance. Tough environmental regulations at home may however force Chinese companies to move abroad and take their polluting habits with them. This puts regions with weak environmental policies such as Africa at risk. An example of this was in 1998 when China

[16] A Chinese oil and gas company.
[17] A Chinese state-owned hydropower engineering and construction company.
[18] New York Times, 8 August 2004.

prohibited the logging of timber from old-growth forests. Chinese timber companies soon closed down or left the country and this gave rise to China becoming the world's biggest importer of timber. The alarming fact is that nearly 90% of these imports violate host country laws in Equatorial Guinea, Cameroon and many other countries worldwide.[19]

In comparison, multilateral development banks, and OECD countries have adopted policies to safeguard the environment ever since the 1980s. This ultimately led to the formation of the 'Common Approaches to the environment' bill in 2001. This ensured export credit agencies would 'benchmark projects against host country standards, against one or more relevant environmental standards and guidelines published by the World Bank Group, or other multilateral development banks.' (OECD Council, para. 12.1, 2003). China quite notably is not an OECD member state, and the Western community fears China Exim Bank and other similar financial institutions not signed to the Common Approaches bill will continue to pursue projects rejected by Western countries. This potentially threatens the livelihoods of local communities and endangers rare plants and animals.

6. Literature on aid and the environment

The impact foreign aid transfers have on the environment in developing countries has previously been researched (Arvin, Dabir-Alai, and Lew, 2006). The literature, however, is concentrated on the relationship trade has with the environment (Lofdahl, 2002). In a study by Copeland and Taylor (2000) the authors empirically find the income generated from trade and the income generated from economic growth affect the levels of pollution differently. Of particular interest is that economic growth in richer and poorer countries have distinguishable effects on the environment. This implies poorer economies may accept aid for growth and in return destroy the environment. Surprisingly, not many studies delve on the relationship between foreign aid and the environment. Arvin, Dabir-Alai and Lew (2006) show that, depending on the level of external debt within a developing country, aid can have a negative impact on pollution. This result holds particularly for newly industrialized countries as they are in a transitory phase of development. However, the picture is different for lower-income countries like SSA, where more

[19] Global Timber, Accessed from: http://www.globaltimber.org.uk/ChinaIllegalImpExp.htm on 13th July, 2014

aid fosters less pollution. But these results are biased by the fact the authors do not take other variables into account which could potentially affect the relationship between aid and the environment. Kretschmer, Hubler and Nunnenkamp (2011) try to counter these shortcomings by adding other explanatory variables to their regression like the level of development, investment ratio, industry share, import ratio and foreign direct investment in a GMM panel regression. The authors are especially interested in studying the relationship between foreign aid and carbon, as well as energy intensities. The results show foreign aid reduces energy intensity, especially when the variable aid for energy is included in the regression. However, aid does not have a significant impact on carbon emissions even when the variable aid for industry is included in the regression (Kablan, 2013).

Chao and Yu, 1999 examine what impact linking aid to environmental conditions may have on welfare. Moreover, Branden and Bromley (1981) argue global emissions affect the utility of individual countries with this finding later supported by (Dockner and Long, 1993). In a separate study, Niho (1996) suggests environmental quality is a function of the environmental qualities between trading partners and how efficient green technologies are in reducing pollution in recipient countries relative to donor countries.

Addison, Mavrotas and McGillivray (2004) suggest that reduced aid to developing countries would lower economic growth and as a consequence pollution levels. Taking the assumption environmental quality can be perceived as a normal good then, the more poor a country is, the lower the level of income it has, and hence the likelihood it will adopt lower environmental standards as well. As a country becomes richer, foreign aid can raise these standards. At the same time aid may prove disastrous to the environment in poorer countries if polluting companies shift their production to low-income countries. Although these point of views may be correct, there is no empirical study on China's foreign aid policy and the environment in SSA.

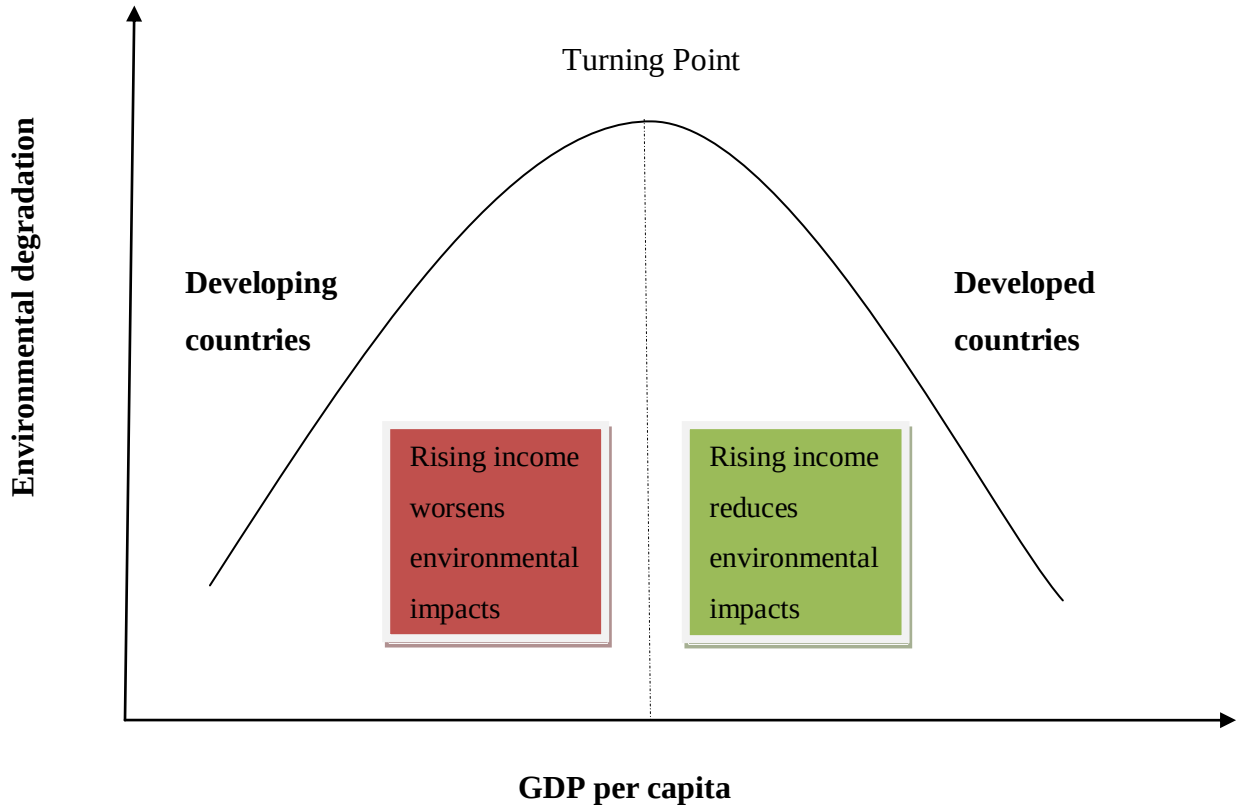
Despite the growing concerns of pollution, establishing acceptable global standards and finding an agreement between signatories has proven challenging **(**Arvin, Dabir-Alai and Lew (2006). The Kyoto Protocol has not been adhered to particularly by the world's richest and most prolific polluters. Now the debate on pollution is focusing on how greenhouse gases from poorer

countries can be controlled better. Environmental degradation may be influenced by foreign aid flows from developed countries in a number of possible ways. One such way is that foreign aid may create development at an unwarranted pace and destroy the environment in the process. A prime example of this is the rapid misuse of an economy's natural resources base, or an increase in the levels of carbon dioxide emissions. The latter being the empirical investigation under this analysis.

7. Theoretical Framework

Carbon Dioxide (CO_2) is naturally found on earth and is vitally exchanged between organisms, oceans and soil for their survival. Since the industrial revolution, increased human activity, and the destruction of carbon sinks like forests and wetlands has diminished the ability for natural systems to remove carbon from the atmosphere. The accumulation of these and other gases has increased global temperatures and is dangerously affecting human health and ecosystems. CO_2 is the largest contributor among greenhouse gases and has two principal sources; the burning of fossil fuels and deforestation. It is suggested climate change is largely a consequence of development but it is also scientifically suggested that when economic growth exceeds a certain threshold, the level of environmental destruction typically falls. As a result, an inverted U-shape curve exists between GDP per capita and pollution levels, commonly known as the environmental Kuznets curve (EKC) (Kuznets, 1955).

Figure 3: Environmental-Kuznets Curve



(Own compilation)

Previous studies have employed the EKC theory, and suggested that economic growth driven by international trade is critical for the maintenance or improvement in environmental quality. The turning points necessary for these to occur are also found to vary from country-to-country and by pollutant type (Asafu-Adjaye, 1999). Using the EKC concept under this analysis, CO_2 emissions are expected to have a positive relationship with per capita GDP levels initially, then a negative relationship beyond the EKC threshold. Notably however, there are different views relating to the EKC theorem. Galeotti et al. (2006) argue findings on the EKC hypothesis are "at best mixed", and Munasinghe (2008) insists underdeveloped countries can achieve their target growth rates while still maintaining lower pollution levels. This means the takeoff needed to become a higher-income economy can occur without undergoing the inverted U-shape curve through what Munasinghe (2008) terms as "sustainomics".

It is widely agreed that industrialized countries have contributed to climate change, and should be held accountable for containing carbon emissions. The agreements under current climate change initiatives such as the Kyoto Protocol require developed countries to reduce their emissions to a baseline of 1990 levels, and will use their financial muscle to help combat greenhouse emissions around the world by 2030. This has resulted in the formation of various environmentally sustainable programs such as the Bali Road Map, whereby, developed countries are required to provide financial and technical support to poorer countries. This, and similar programs are viewed to be of particular importance in effectively reducing carbon emissions as they give incentives to less developed countries to embrace sustainable practices. Since the 2000s however, there has been an influx of aid disbursements also from China to SSA, as China attends to its resource-security concerns. This has impacted the development of SSA in various ways and implies that for climate change to be fought effectively around the world, reforms must extend beyond the standard North-South engagements but must also incorporate the growing South-South relations. It is yet to be seen, however, if more generous ODA would assist in changing future climate outcomes. Surprisingly, no quantitative analysis on the impact Chinese aid could be having on carbon emissions has been conducted. To my knowledge, this is the first study that examines this issue and aims to fill this gap through the following hypothesis; Hypothesis 3: China's official development assistance is destroying the environment of recipient countries in Sub-Saharan Africa.

8. Empirical analysis on the impact of foreign aid on carbon dioxide emissions

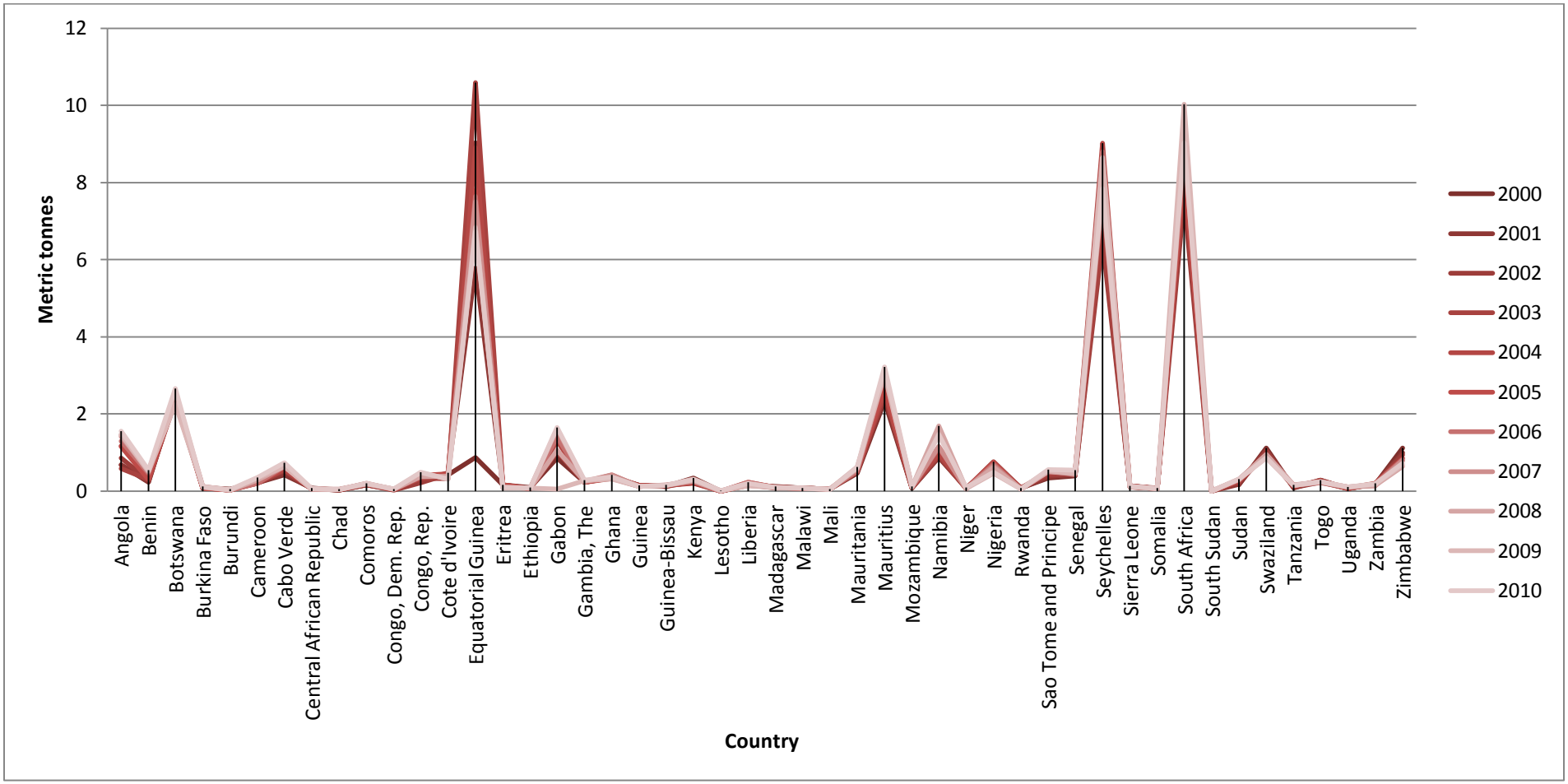
8.1 Data, Methodology and Results

In this empirical analysis, interest is placed on the impact of foreign aid (ODA) on carbon dioxide emissions in SSA. The idea here is to link CO_2 emissions in developing countries to infrastructure development, population and other control variables likely to explain it – an empirical step further than Arvin, Dabir-Alai and Lew (2006). A panel dataset is used over the period 2000-2010 over 48 countries (see Appendix B.1). In line with section 2, The OLS FE model is employed to control for unobserved heterogeneity, and the standard errors are corrected for using heteroskedasticy. In addition, stationarity is checked for using the panel unit root test and is found not to exist at the 5% level. Descriptive statistics of the data obtained and their

respective sources are reported in Appendix C.2 and D.1 Notably in this section, CO_2 is the main variable of interest and is obtained from the World Bank Database with Chinese aid now taking on the independent variable role. Equatorial Guinea, Seychelles, and South Africa are consistently found to be the top contributors of carbon dioxide emissions in the region over the sample period. Equatorial Guinea peaks in 2003, with over 10 metric tons that year alone (see Figure 3). Globally, these countries rank 53rd, 48th and 42nd respectively which puts them on par with many industrialized countries. Overall however, Africa is the least polluting continent in the world, contributing over one billion metric tons in 2010 which was a measly 3.6% of global emissions, and 13.7% of China's CO_2 emissions alone.[20] China, the United States and the European Union in total account for over 50% of total CO_2 emissions around the world with India, Japan and Russia quickly emerging as well (PBL Netherlands Environmental Assessment Agency, 2013).

[20] See The Guardian website. Accessed from <http://www.theguardian.com/environment/datablog/2012/jun/21/world-carbon-emissions-league-table-country.> on July 13th 2014

Figure 4: Carbon dioxide emissions among Sub-Saharan countries, 2000-2010



To examine the impact on the environment from this Sino-African partnership, the following theoretical model is framed and estimated:

$$Ln(CO_2) = \beta_0 + \beta_1 Ln(China\text{-}ODA)^{-1} + \beta_2 Ln(US\text{-}ODA)^{-1} + \beta_3 Ln(EU\text{-}ODA)^{-1} + \beta_4 Ln(GDP\ p.c)^{-1} + \beta_5 Ln(GDP\ p.c\ squared)^{-1} + \beta_6 Ln(UrbanPopulation)^{-1} + \beta_7 Ln(Trade)^{-1} + \beta_8 Ln(EnergyUse)^{-1} + \beta_9 Ln(TelephoneLines)^{-1} + \beta_{10} Ln(PrimarySchool)^{-1} + \beta_{11} Ln(RuleofLaw)^{-1} + \in_t$$

All independent variables are lagged by one year since the effects of pollution on the environment occur over time. The dependent variable, CO_2 is used as a proxy for the environmental footprint of donor countries in SSA, and represents carbon dioxide emissions produced from the combustion of fossil fuels and the manufacturing of cement. Although it only captures fuel consumption, carbon emissions are known to also exist from residual buildings as well as commercial and public services. Fuel consumption however, is reported to be the largest contributor to global warming and has thus been selected for this analysis. The explanatory variables *China-ODA, US-ODA* and *EU-ODA* are added to examine how the three largest donors fair against one another in reducing environmental pollution in the region. For this, China is hypothesized to have a significant and positive effect in raising CO_2 emissions in the region, with the US and EU having a negative effect. To emphasize, when analyzing aid effectiveness, disbursements rather than commitments are used in the empirical model as commitments do not imply actual aid flows to the recipient country, and in this respect actual flows can also be delayed (Dreher, Nunnenkamp and Thiele, 2008).

GDP p.c is used to control for the country's level of development. A higher GDP per capita reflects a higher level of productivity and according to the EKC hypothesis, a stronger incentive to pollute less. To confirm this, the variable *GDP p.c squared* is used to assess the possibility that an inverted U-shape curve exists. As the countries in the sample are in a transitory phase of development, the expected sign is ambiguous and therefore not defined here. Trade openness is another variable widely used in the literature and is used to proxy trade revenues as a percentage of GDP. Similar to *GDP p.c, trade* is expected to positively influence CO_2 emissions by raising aggregate production. Other control variables are also added: *UrbanPopulation* and

TelephoneLines are assumed to positively impact CO_2 emissions as the population increases, and infrastructure improves, consumption activities rise and thus *EnergyUse.* On the contrary, education is expected to negatively impact CO_2 emissions as the more informed the general public is on pollution matters, the less likely they will engage in activities that destroy the environment represented using *Primaryschool*. Lastly, the literature on aid outlines the importance of institutions and policies. For instance, Burnside and Dollar (2000) and Boone (1996) introduce a range of variables to measure the quality of governance in recipient countries of aid as discussed in section 2. *RuleofLaw* is appropriately used in this section to proxy for institutional quality which takes into account corruption, bureaucracy quality, law and order.

To begin with, all international transfers to SSA are regressed against CO_2 emissions to determine whether a significant relation does exist and can be found in Appendix H.1. A correlation is evident as was supported by Arvin, Dabir-Alai and Lew (2006). In their study, the authors make use of the Granger methodology arguing it provides greater weight than other tests observed in Geweke, Meese, and Dent, (1983). Under this study, the first round of empirical results indicates that a 1% rise in world aid to SSA leads to a 14% decrease in carbon dioxide emissions and is significant at the 1% level. Given the controls used, institutional quality meets the expected negative sign as increased monitoring helps prevent illegal environmental activity from taking place. Trade openness however, is found to have the opposite effect to what was expected as it reduces CO_2 emissions by 35%. Urban population, infrastructure development and energy consumption are all found to significantly raise CO_2 emissions in SSA as predicted, however, *GDP p.c, GDP p.c squared* and *Primaryschool* are on the other hand insignificant.

In comparing the impacts on the environment between donor countries; Australia, Canada, Japan, Korea and New Zealand are added to the analysis to weigh up how other OECD countries including the United States and the European Union compare to China. The first group of countries are listed as 'The Rest of the World' and are empirically found to have no significant effect on CO_2 emissions in SSA, alongside the US and EU (see Appendix H.2). Contrary to popular belief, China is found to be the only aid donor significantly reducing pollution levels in the region. This is a striking result because China has come under significant scrutiny regarding

its domestic pollution levels, let alone those it may impose on others through foreign engagements. Furthermore, the EKC theoretical framework is proved correct, with per capita GDP raising CO_2 levels by 5% suggesting an inverted U-shape curve exists between aid and pollution levels in the region. Energy consumption is also significantly found to raise CO_2 emissions at the 1% level. All other controls are insignificant including institutional quality and education which were also found in the study by Kablan (2013).

Lastly, we turn once more to Equatorial Guinea, Seychelles and South Africa. These three countries are found to have data points outside the norm of the population, and therefore can be argued to misrepresent the average country in SSA in pollution terms. Evidently, their CO_2 emissions are almost 8 times those of the sample mean. It is likely these countries will have a disproportionately stronger impact on the parameter estimates than others, and therefore reduce the power of the empirical tests performed. For this reason, Equatorial Guinea, Seychelles and South Africa are omitted from the analysis. Under this effect, China is now found to not significantly reduce CO_2 emissions as was initially found. The EU on the other hand lowers CO_2 emissions by 29% for every 1% increase in foreign aid disbursements. The Rest of the World however is shockingly found to have an opposite effect in SSA by raising the levels of pollution at the 10% significance level (see Table 6).

Table 6: The effect of aid allocations on carbon dioxide emission in Sub-Saharan Africa (excluding Equatorial Guinea, Seychelles and South Africa)

OLS Fixed effects

Dependent Variable - CO_2 emissions (metric tons)									
Constant	-0.34 (0.38)	**-8.23***** **(0.61)**	-2.60 (3.16)	**-5.00*** **(2.76)**	-4.83 (3.00)	**-19.04***** **(2.71)**	**-14.61***** **(3.59)**	**-21.67***** **(5.30)**	**-18.38**** **(7.16)**
China	**0.16***** **(0.05)**	**0.07*** **(0.04)**	**0.07*** **(0.04)**	0.05 (0.04)	0.05 (0.04)	0.01 (0.03)	-0.004 (0.03)	-0.03 (0.03)	-0.02 (0.04)
US	**-0.12*** **(0.07)**	-0.02 (0.04)	-0.03 (0.04)	0.02 (0.04)	0.02 (0.04)	-0.02 (0.04)	0.00 (0.04)	-0.10 (0.06)	-0.11 (0.07)
EU	**-0.45***** **(0.12)**	-0.10 (0.07)	-0.04 (0.08)	**-0.15*** **(0.08)**	**-0.16**** **(0.07)**	**-0.29***** **(0.07)**	**-0.20***** **(0.07)**	**-0.27**** **(0.10)**	**-0.29***** **(0.08)**
Rest of the world[21]	**0.23**** **(0.09)**	0.05 (0.06)	0.04 (0.05)	**0.11**** **(0.06)**	**0.11**** **(0.06)**	-0.01 (0.05)	-0.03 (0.04)	0.08 (0.06)	**0.13*** **(0.06)**
GDP p.c		**1.05***** **(0.07)**	-1.02 (1.16)	-0.54 (1.10)	-0.52 (1.10)	**4.33***** **(0.84)**	**2.88**** **(1.11)**	**6.05***** **(1.74)**	**4.72*** **(2.25)**
GDP p.c squared			**0.13*** **(0.07)**	0.08 (0.07)	0.08 (0.07)	**-0.26***** **(0.06)**	**-0.18**** **(0.07)**	**-0.35***** **(0.11)**	**-0.26*** **(0.14)**
Urban population				**1.00***** **(0.15)**	**1.03***** **(0.23)**	**0.66***** **(0.21)**	**0.82***** **(0.21)**	0.39 (0.32)	0.56 (0.41)
Trade					-0.10 (0.28)	-0.11 (0.21)	-0.09 (0.22)	-0.41 (0.35)	-0.62 (0.43)
Energy use						**0.91***** **(0.20)**	**0.79***** **(0.24)**	**1.07***** **(0.21)**	**0.94***** **(0.24)**
Infrastructure development							**0.20***** **(0.07)**	0.17 (0.11)	0.20 (0.12)
School enrolment								-0.84 (0.49)	-0.61 (0.51)
Rule of Law									**-0.53*** **(0.30)**
Observations	207	204	204	204	203	135	135	82	76
Adj R-squared	0.07	0.55	0.56	0.65	0.65	0.82	0.84	0.92	0.92
-Numbers in parenthesis are heteroskedastic-standard errors *** significant at the 1% level ** significant at the 5% level * significant at the 10% level									

[21] Australia, Canada, Japan, Korea, New Zealand.

These findings are also confirmed using robustness checks. The EU and US are still found to create a safer environment for recipient countries, while evidence strongly suggest Australia, Canada, Japan, Korea and New Zealand, are degrading Africa's environment. China once again remains insignificant under this analysis (see Table 7). To expand, the two robustness checks conducted use dependent variables on Air Quality and The Environmental Performance of recipient countries. Air Quality is represented using atmospheric particulate matter (PM), and it measures the average population exposed to $PM_{2.5}$. PM includes the fusion of liquid and solid air droplets that vary in size between 2.5 and 10 microns in diameter. Unlike other air pollutants, $PM_{2.5}$ or 'fine particles' as they are sometimes called, can enter through the nose and mouth and cause lung and heart problems.

These dependent variables are added to ensure the air pollution findings thus far are concrete. Sources of fine particles include gas emissions from power plants and motor vehicles, forest fires, wood and agricultural burning and industrial processes. Larger particles such as PM_{10} are more visible to the human eye, but can be eliminated from the body through coughing, sneezing and swallowing. It is $PM_{2.5}$ that are harmful especially to young children and pregnant women and is therefore the variable chosen for this part of the analysis. This is of grave concern as SSA is among the regions facing the fastest population growth rates in the world. Air pollution is an area that is often overlooked by policy makers in developing countries as governments instead choose to steer their economies to rapid growth with little concern for the environment. For the safety of its people, especially the most vulnerable members of society, a lot more emphasis needs to be placed to ensure public health is not jeopardized. Moving on to Table 7, evidence still suggests the Rest of the World is polluting the atmosphere in the region, while the EU and US maintain their positions in lowering air pollution levels. China remains insignificant yet again, implying it stands in between on this issue. This points to China not being the villain most studies paint them to be, but more must be done in this regard if China hopes to be seen as a sustainable partner in Africa.

Table 7: The effect of aid allocations on air quality in Sub-Saharan Africa (excluding Equatorial Guinea, Seychelles and South Africa)

OLS Fixed effects

Dependent Variable		**Air quality[22] ($PM_{2.5}$)**	**Air quality[23] ($PM_{2.5}$EX)**	**Air quality[24] ($PM_{2.5}$ 10µg/m^3)**	**Air quality[20] ($PM_{2.5}$15 µg/m^3)**
	Constant	9.71 (13.82)	0.06 (0.24)	0.35 (0.93)	0.03 (0.14)
	China	-0.03 (0.12)	0.002 (0.002)	0.002 (0.008)	-0.0003 (0.001)
	US	-0.11 (0.19)	**-0.01***** **(0.003)**	**-0.05***** **(0.01)**	**-0.01***** **(0.001)**
	EU	**-0.77***** **(0.24)**	**-0.007*** **(0.004)**	**-0.03*** **(0.01)**	0.002 (0.002)
	Rest of the world	**0.83***** **(0.19)**	**0.008***** **(0.003)**	**0.05**** **(0.02)**	0.003 (0.002)
	GDP p.c	7.15 (4.1)	0.05 (0.08)	0.18 (0.29)	-0.02 (0.05)
	GDP p.c squared	**-0.65*** **(0.31)**	-0.004 (0.005)	-0.02 (0.08)	0.002 (0.003)
	Urban population	**4.95***** **(0.77)**	**0.05***** **(0.02)**	**0.17**** **(0.08)**	0.004 (0.01)
	Trade	**1.85*** **(1.05)**	0.01 (0.02)	0.08 (0.08)	0.01 (0.01)
	Energy use	0.29 (0.34)	**0.01**** **(0.006)**	**0.05*** **(0.03)**	0.002 (0.003)
	Infrastructure development	0.38 (0.32)	**-0.02**** **(0.01)**	-0.03 (0.03)	**-0.01***** **(0.004)**
	School enrolment	**-9.25***** **(1.28)**	**-0.11***** **(0.02)**	**-0.45***** **(0.10)**	**-0.03*** **(0.02)**
	Rule of Law	1.45 (1.04)	-0.01 (0.01)	-0.05 (0.06)	**-0.02*** **(0.01)**
	Observations	78	78	78	78
	Adj R-squared	0.83	0.74	0.59	0.71
	-Numbers in parenthesis are heteroskedastic-standard errors *** significant at the 1% level **significant at the 5% level *significant at the 10% level				

[22] Average exposure is calculated by multiplying the $PM_{2.5}$ concentration by the population exposed. It reflects the 'typical' air pollution a person would experience in a country in a given day.

[23] Average proportion of the population whose exposure to $PM_{2.5}$ is above the World Health Organization threshold.

[24] Average proportion of the population whose exposure to $PM_{2.5}$ is above the interim targets of 10 and 15 micrograms per cubic meter µg/m^3.

Table 8: The effect of aid allocations on environmental quality in Sub-Saharan Africa (excluding Equatorial Guinea, Seychelles and South Africa)

OLS Fixed effects

Dependent Variable: EPI Index									
Constant	**3.52*** (0.08)**	**2.47*** (0.16)**	**4.24*** (0.78)**	**4.43*** (0.78)**	**4.90*** (0.76)**	**2.18*** (0.75)**	**3.56*** (0.88)**	**5.30** (1.86)**	**5.50** (1.99)**
China	**0.04*** (0.01)**	**0.03*** (0.01)**	**0.03** (0.01)**	**0.03*** (0.00)**	**0.03** (0.01)**	**0.03*** (0.01)**	**0.02*** (0.01)**	0.02 (0.02)	0.02 (0.02)
US	-0.03 (0.01)	-0.00 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.00 (0.01)	-0.00 (0.01)	0.00 (0.01)	-0.02 (0.02)	-0.02 (0.03)
EU	-0.04 (0.03)	**0.03* (0.02)**	0.03 (0.02)	0.03 (0.02)	0.01 (0.02)	0.03 (0.02)	**0.06*** (0.02)**	**0.12*** (0.03)**	**0.12*** (0.03)**
Rest of the world[25]	**0.05* (0.03)**	-0.01 (0.01)	-0.01 (0.02)	-0.02 (0.02)	0.00 (0.02)	**-0.04** (0.02)**	**-0.05*** (0.02)**	**-0.04* (0.02)**	-0.03 (0.03)
GDP p.c		**0.14*** (0.02)**	**-0.51* (0.27)**	**-0.55* (0.27)**	**-0.51* (0.27)**	0.34 (0.23)	-0.12 (0.28)	**-1.45** (0.55)**	**-1.55** (0.62)**
GDP p.c squared			**0.04** (0.02)**	**0.05** (0.02)**	**0.04** (0.02)**	-0.01 (0.02)	0.01 (0.02)	**0.11*** (0.03)**	**0.12*** (0.04)**
Urban population				-0.05 (0.02)	0.04 (0.05)	-0.12 (0.07)	-0.06 (0.08)	**-0.23* (0.12)**	**-0.22* (0.12)**
Trade					**-0.25*** (0.04)**	**-0.16** (0.06)**	**-0.17*** (0.06)**	-0.22 (0.13)	**-0.28* (0.13)**
Energy use						**0.16*** (0.04)**	**0.14*** (0.04)**	**0.08* (0.04)**	0.06 (0.05)
Infrastructure development							**0.06*** (0.02)**	-0.02 (0.02)	-0.02 (0.05)
School enrolment								**0.63** (0.23)**	**0.67*** (0.22)**
Rule of Law									-0.11 (0.17)
Observations	192	189	189	189	188	123	123	72	72
Adjusted R-squared	0.08	0.28	0.30	0.30	0.42	0.49	0.54	0.77	0.77
-Numbers in parenthesis are heteroskedastic-standard errors *** significant at the 1% level **significant at the 5% level *significant at the 10% level									

[25] Australia, Canada, Japan, Korea, New Zealand.

The second robustness check refers to the Environmental Performance Index (EPI). The EPI rates how well countries perform under environmental matters in two areas: protection of human health, and the protection of ecosystems. Using nine measures,[26] the report ranks 178 countries around the world that putting Switzerland at the very top, China 118th, and Somalia last. The average rank for SSA countries found under this analysis is 34, with Equatorial Guinea, South Africa and Seychelles performing worse than the average at 40th, 55th and 51st respectively. This also supports the reasoning to omit these three countries from the empirical framework once again as they will fail to uniformly distribute the data. European aid is the only kind found to improve the environmental ranking of its aid recipients in SSA by 12% and is significant at the 1% level (see Table 8). All regressions are gradually controlled for using the same variables as Table 7, reaffirming that Chinese aid poses no significant threat to the environment of its developing partners in SSA.

9. Policy recommendations

The growing partnership between China and SSA presents the possibilities of relieving the region from poverty and poor infrastructure. These potential benefits however, are not automatic and require African countries to adopt well-defined strategies to ensure the official assistance obtained stimulates economic activity, and helps in the achievement of regional and national targets. One such target is the 7 percent average growth rate outlined in the MDGs. For this, African countries must improve their engagements with the market and produce goods and services sensitive to any rises in income, and those that are better suited for the international market. As it stands, trade patterns with China are similar to those shared between Africa and Western partners which is precariously reinforcing the commodity dependence of the past. Policy makers in Africa should step up their efforts to transform their economies and add value to the goods and services they produce. This has the potential to reverse the current pattern of trade and generate a favorable balance of payments for African economies. One such way is through the support of the private sector from local governments through the provision of incentives to Chinese firms to encourage them to transfer their skills and technology. In addition,

[26] Health impacts, Air quality, Water and Sanitation, Water resources, Agriculture, Forests, Fisheries, Biodiversity and Habitat, Climate and Energy.

Chinese firms should train local employees and use part of their profits to spur innovation and create even further opportunities employees and use part of their profits to spur innovation.

Despite being known as an economic powerhouse, China is still a developing country and can also use this to offer advice tailored to the needs of Africans. For example, China is a pioneer in green technologies around the world which can be essential for rural electrification in Africa (Boshard, 2008). A Sino-African relationship of this sort can stimulate growth and attract foreign investment that can help initiate an economic take-off. However, as China's development agenda demonstrates, such growth may damage the environment in the process. On this note, African governments should learn to use international transfers such as aid more effectively to achieve national and regional goals such as the MDGs. This can be achieved by getting parliaments and business owners to actively participate in the creation of policies in the region. In negotiating contracts with Chinese companies, governments must ensure the civil society and other relevant stakeholders are well represented. As a result, respective agencies can be held accountable for any commitments agreed, and this will improve the likelihood resources will be used to their maximum capacity. The transparency obtained will also lessen any public skepticism generated from these partnerships and give them more credibility.

African countries must recognize that if they aim to attract market-seeking, rather than resource-seeking investments, governments must create a dynamic and efficient market appealing to domestic and foreign investors. Aid should be redirected to sectors that create investment, employment, regional cohesion and that help boost the productive capacity of the region. African and Chinese partnerships can be the ideal model for this, and governments can play a bigger role in ensuring these fundamentals are met. The unavailability of data has also made it harder to understand the trends and scale of Chinese aid to the region. African governments, in collaboration with international organizations such as the IMF, should develop a platform to share data and help improve the decision making among foreign policy experts.

Despite no ample evidence, Chinese partners should give more thought to the impact their commercial actions are having on the environment in Africa. It is on record that up to 70,000 people have been displaced in Sudan due to Chinese operations. Communities have been given

no choice but to resettle in arid desert locations with poor soil and no realistic source of incomes. In Zambia, 46 miners lost their lives working in a Chinese-owned mine, and was soon the cause of riots in 2005. The MEND and guerilla organizations in Nigeria are fighting against environmental degradation and have subsequently kidnapped expatriate workers including Chinese to make a statement. There are also reports of growing resentment against cheap clothing from China that have led to protests in Zimbabwe and South Africa (Mohan and Power, 2009). China's foreign ministry must act towards creating a more sustainable development agenda that does not harm the lives of Africans and its own workers abroad.

Chinese aid may not statistically raise CO_2 emissions, but this variable does not capture other environmental factors concerning Africa such as soil erosion, poaching and insect infestation. To prevent any further environmental degradation, impact assessments must be conducted and approved by national governments and international organizations alike. Awareness of this should also encourage domestic firms to take further steps to be environmentally responsible of their activities in the region. The EU and US have been, and are likely to continue to be important partners for Africa. In this regard, Western countries should be more open to Chinese aid but yet ensure it complements rather than destroys any progress made on democracy and poverty alleviation. Reports are already emerging that Chinese companies are beginning to cooperate with oil moguls in Asia and the West, such as Shell and Exxon Mobil Corp in African states despite their scramble for African oil (Idun-Arkhurst and Laing, 2007).

Industrialized countries should toughen the standards on their investments abroad as evidence repeatedly suggests; Australia, Canada, Korea, Japan and New Zealand are by a long way worsening the region's air quality. In general however, world aid is improving the environment in the region as evidenced in Appendix I.1 and I.2 even after the inclusion of Equatorial Guinea, Seychelles and South Africa. Despite these findings, aid conditions should be revised to identify and redesign policies that work for Africans as there is still much to be done in coordinating the many foreign engagements of donor countries on the region.

10. Conclusion and further research

China's relationship with southern countries has generated much interest and raised questions on the role it has played towards achieving economic development in Africa. All in all, the collaboration has strengthened the political and cultural ties between the two countries but very few studies examine the impact this relationship is having on the environment. This study uses panel data for the years 2000-2010, and the OLS FE technique to examine the effect Chinese aid is having on air quality, and also determine the motives behind China's aid in SSA. The analysis reveals commercial interests dominate the development partnership with aid targeted towards resource-rich countries and those open towards Chinese exports. No empirical evidence is found to suggest an altruistic motive or political scramble between China and Western donors exists on the region. Instead, evidence suggests Australia, Canada, Japan, Korea and New Zealand are raising the carbon footprint in Sub-Saharan Africa while China has no empirical effect.

Although the results are marginally small, further attention is needed to assess the long-run impacts that international transfers are having in developing countries. Empirical evidence suggests the accusations China is acting as a predator in Africa seem unfair. However, China must increase its efforts to ensure ecosystems and local communities are protected as evidence points to them taking a statistically indifferent stance on environmental matters. In this regard, governments and international bodies should do more research particularly in the subject of air pollution as it is a serious health concern affecting all members of society. It is critical governments, and international institutions create strategies to stabilize atmospheric gases especially through aid granted to the construction of power plants, factories, and combustion related activities.

It is also important to stress that it would be misleading to generalize the countless and significant differences between all Sub-Saharan Africa's states, each with their own histories, cultures and traditions. In particular, when it comes to identifying and implementing solutions, African countries need to be understood from within their own particular contexts. As a responsible global actor, China must strengthen its social and environmental rules of engagement with African nations if it aims to silence critics and become a long-term partner on the continent.

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11. Appendix

A.1: The Impact of the Chinese presence in Africa

Key African Exports to China	**Key Countries**
Crude Oil	Angola, Congo Brazzaville, Equatorial Guinea, Sudan
Logs	Liberia, Gabon, Cameroon, Congo Brazzaville, Equatorial Guinea,
Iron ore and concentrates	Mauritania , Mozambique, South Africa, Liberia
Diamonds	South Africa
Cotton	Cote d'Ivoire, Cameroon , Mali, Burkina Faso, Benin
Ores and concentrates of non-ferrous base metals	Rwanda, South Africa, Nigeria Congo Brazzaville, D.R. Congo
Tobacco	Zimbabwe
Iron/Steel coils	South Africa
Platinum	South Africa
Manganese ores and concentrates	Cote d'Ivoire , South Africa, Gabon, Ghana
Copper and copper alloys	Namibia, Zambia, Congo Brazzaville, South Africa
Aluminum and alumna	South Africa
Wood of non-coniferous species	South Africa, Cameroon, Congo Brazzaville, Gabon, Ghana, Congo Brazzaville

Source: Broadman , H. (2007). "Africa's Silk Road – China and India's New Economic Frontier", The World Bank, Washington DC

Key African Imports from China	**Key Importing Countries**
Clothing and textiles	Cote d'Ivoire , Nigeria, Ethiopia, Madagascar, Gambia, Ghana, Benin, Sudan, Togo, Kenya, South Africa, Sudan,
Footwear	Benin, Nigeria, Togo, South Africa, Ghana
Motorcycles	Cameroon, Nigeria, Guinea, Togo, Mali
Batteries and accumulators	Togo, Benin, Kenya, Nigeria
Rice	Tanzania, Cote d'Ivoire, Nigeria, Ghana, Liberia
Travel goods, handbags, suitcases, purses	Kenya, South Africa, Nigeria, Ghana, Kenya, Tanzania
Electrical, electronics and telecom equipment	Zambia, South Africa, Nigeria, Ethiopia, Uganda, Angola
Construction equipment/materials	Benin, South Africa, Sudan, Kenya, Nigeria, Ghana South Africa

Source: UN COMTRADE

B.1: *List of Sub- Saharan Africa Countries in alphabetical order*

Angola	Congo Rep	Kenya	Niger	Swaziland
Benin	Cote d'Ivoire	Lesotho	Nigeria	Tanzania
Botswana	Equatorial Guinea	Liberia	Rwanda	Togo
Burkina Faso	Eritrea	Madagascar	Sao Tome and Principe	Uganda
Burundi	Ethiopia	Malawi	Senegal	Zambia
Cameroon	Gabon	Mali	Seychelles	Zimbabwe
Cabo Verde	The Gambia	Mauritania	Sierra Leone	
Central African Republic	Ghana	Mauritius	Somalia	
Chad	Guinea	Mozambique	South Africa	
Congo Dem. Rep	Guinea-Bissau	Namibia	South Sudan	

C.1: *Descriptive Statistics- ODA-China*

Variable	Unit	No. of obs	Mean	Std. Dev
Dependent Variable				
Chinese aid	Constant 2005 US$	270	48.75	123.83
Independent Variable				
Population	Millions (midyear estimates)	528	7.53	12.31
GDP p.c PPP	Constant 2011 US$	508	4010.23	5967.85
Corruption Index	0 (weak) to 5 (strong) in governance performance	471	1.88	0.60
Rule of Law Index	0 (weak) to 5 (strong) in governance performance	470	1.77	0.67
Regulatory Quality Index	0 (weak) to 5 (strong) in governance performance	470	1.78	0.65
Political Stability Index	Estimates range 0 (weak) to 5 (strong) governance performance	470	1.95	0.97
Resources	% of GDP	509	15.14	17.93
Chinese Exports	US$	370	0.02	0.02
External Debt	% of GNI	484	90.79	134.45
Telephone lines	Per 100 people	510	3.01	5.80
Chinese FDI	% of GDP	247	0.00	0.01
DAC aid	US$	528	434.94	775.11
US aid	US$	514	93.67	171.79
EU aid	US$	517	266.55	575.18

C.2: *Descriptive Statistics-* CO_2 *emissions*

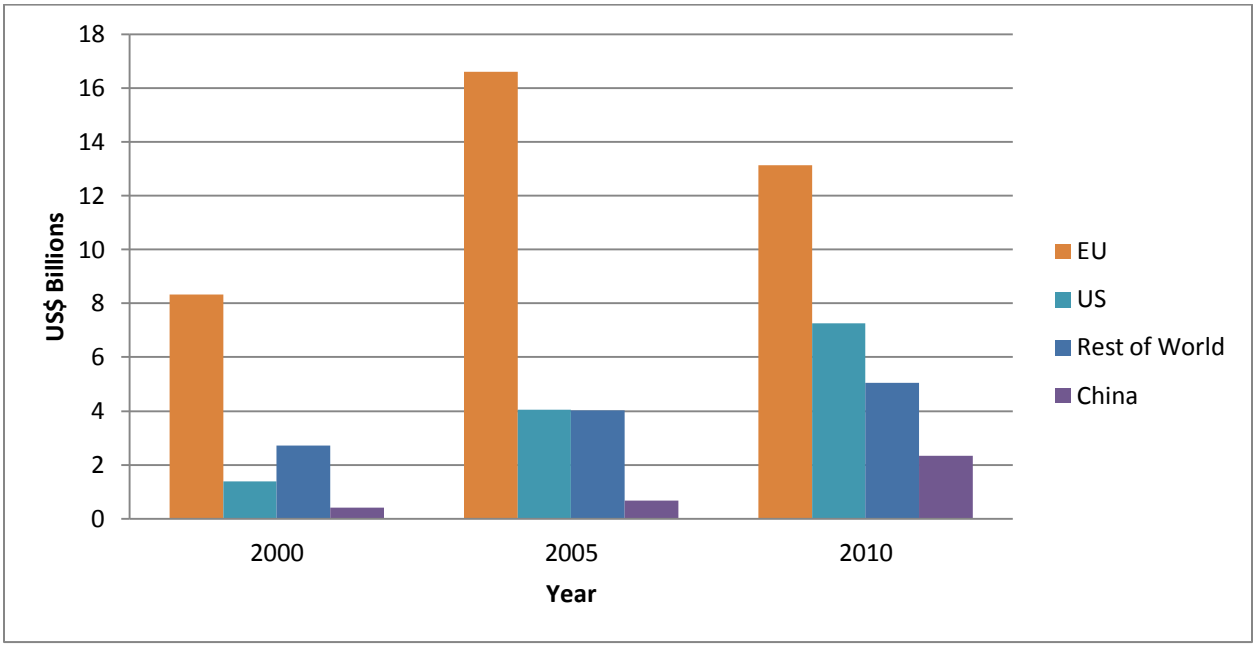
Variable	Unit	No. of obs	Mean	Std. Dev
Dependent Variable				
CO_2 Emissions	Metric tons per capita	510	0.90	1.98
Independent Variables				
World aid	US $	528	459.87	776.78
Rest of the world aid	US $	528	82.76	816.86
Urban population	Millions	528	36.25	15.33
Trade	% of GDP	507	77.12	36.71
Energy use	kg of oil equivalent per capita	282	621.55	597.92
Primary school enrolment	% net	318	73.17	-0.50

D.1 Sources and definitions

Variable	Definition	Unit	Source
Dependent Variables			
Chinese aid	Official aid flows to recipient countries from China.	Constant 2005 US$	Strange, Parks, Tierney, et al. (2013)
CO_2 emissions	Carbon dioxide emissions from the consumption of solid, liquid, and gas fuels and gas flaring.	Metric tons per capita	World Bank. (2013) (http://data.worldbank.org/indicator)
Independent Variables			
Population	All residents regardless of legal status or citizenship--except for refugees.	Millions (midyear estimates)	World Bank. (2013) (http://data.worldbank.org/indicator)
GDP p.c PPP	GDP per capita based on purchasing power parity (PPP).	Constant 2011 US$	World Bank. (2013) (http://data.worldbank.org/indicator)
Corruption Index	Perceptions of the extent to which public power is exercised for private gain.	0 (weak) to 5 (strong) in governance performance	World Bank. (2013) (http://info.worldbank.org/governance/wgi/index.aspx#home)
Rule of Law Index	Perceptions of the extent to which agents have confidence in and abide by the rules of society.	0 (weak) to 5 (strong) in governance performance	World Bank. (2013) (http://info.worldbank.org/governance/wgi/index.aspx#home)
Regulatory Quality Index	Perceptions of the ability of the government to formulate and implement sound policies and regulations..	0 (weak) to 5 (strong) in governance performance	World Bank. (2013) (http://info.worldbank.org/governance/wgi/index.aspx#home)
Political Stability Index	Perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means.	Estimates range 0 (weak) to 5 (strong) governance performance	World Bank. (2013) (http://info.worldbank.org/governance/wgi/index.aspx#home)
Total Natural Resources	The sum of oil rents, natural gas rents, coal rents, mineral rents, and forest rents.	% of GDP	World Bank. (2013) (http://data.worldbank.org/indicator)
Chinese Exports	Exports of goods and services from China to Sub-Saharan countries.	Current US$	UN Comtrade database (http://comtrade.un.org/data/)
External Debt Stocks	Debt owed to nonresidents repayable in currency, goods, or services.	% of GNI	World Bank. (2013) (http://data.worldbank.org/indicator)
Telephones lines	Fixed telephone lines from a subscriber's terminal equipment to the public switched telephone network.	Per 100 people	World Bank. (2013) (http://data.worldbank.org/indicator)
Chinese FDI	Direct investment from Chinese business partners to the production or businesses located in Sub-Saharan Africa.	% of GDP	MOFCOM (2010)

DAC aid	Official aid flows to recipient countries from DAC members.	US $	OECD. Stat Extracts http://stats.oecd.org
US aid	Official aid flows to recipient countries from the United States.	US $	OECD. Stat Extracts http://stats.oecd.org
EU aid	Official aid flows to recipient countries from the European Union.	US $	OECD. Stat Extracts http://stats.oecd.org
World aid	Official aid flows to recipient countries from DAC member states and China.	US $	OECD. Stat Extracts http://stats.oecd.org
Rest of world aid	Official aid flows to recipient countries from Australia, Canada, Japan, Korea and New Zealand.	US $	OECD. Stat Extracts http://stats.oecd.org
Urban Population	People living in urban areas as defined by national statistical offices.	Millions	World Bank. (2013) (http://data.worldbank.org/indicator)
Trade	The sum of exports and imports of goods and services.	% of GDP	World Bank. (2013) (http://data.worldbank.org/indicator)
Energy use	Use of primary energy before transformation to other end-use fuels.	kg of oil equivalent per capita	World Bank. (2013) (http://data.worldbank.org/indicator)
Primary School Enrolment	The ratio of children of official primary school age enrolled in primary school to the total population of the official primary school age.	% net	World Bank. (2013) (http://data.worldbank.org/indicator)
Robustness Checks			
Air Quality (PM)	Population weighted exposure to PM2.5.	% of average population exposed to PM2.5 in micro-grams per cubic meter	Hsu, A., J. Emerson, M. Levy, et al. (2014) (http://epi.yale.edu/downloads)
Environmental Performance Index (EPI)	Ranks how well countries perform on high-priority environmental issues.	Overall rank of 178 countries	Hsu, A., J. Emerson, M. Levy, et al. (2014) (http://epi.yale.edu/downloads)

E.1: *ODA allocations among China, US, EU and the Rest of the World from 2000-2010*



Source: AidData (2013) and OECD aid statistics (2014)

G.1: *Major resources for infrastructure loans 2011-2012*

Country	Guarantee	Main funded projects	Concessional Loan	Year and Bank
Nigeria	Oil	General infrastructure	$3 billion	2012 CDB/Exim Bank
Ghana	Oil	General infrastructure	$3 billion	2012 CDB
Angola	Oil	General infrastructure	$3 billion	2011 Exim Bank

Source: Lum, T et al (2009), "China's Assistance and Government Sponsored Activities in Africa, Latin America and SE Asia." Congressional Research Service

H.1: The effect of world aid on carbon dioxide emission in Sub-Saharan Africa

OLS Fixed effects

Dependent Variable: CO_2 emissions (metric tons)									
Constant	-0.39 (0.26)	**-9.55*** (0.24)**	**-5.05*** (1.21)**	**-3.42*** (1.03)**	**-3.47*** (1.17)**	**-14.05*** (1.67)**	**-9.18*** (1.87)**	**-14.54*** (2.63)**	**-11.55*** (3.31)**
World aid[27]	**-0.22*** (0.05)**	-0.01 (0.02)	-0.01 (0.02)	0.02 (0.02)	0.02 (0.02)	**-0.17*** (0.03)**	**-0.11*** (0.03)**	**-0.16*** (0.03)**	**-0.14*** (0.04)**
GDP p.c		**1.24*** (0.03)**	-0.28 (0.40)	**-1.29*** (0.38)**	**-1.30*** (0.39)**	**2.49*** (0.51)**	**0.97* (0.56)**	**2.94*** (0.88)**	1.78 (1.15)
GDP p.c squared			**0.09*** (0.02)**	**0.14*** (0.02)**	**0.14*** (0.02)**	**-0.11*** (0.03)**	-0.03 (0.04)	**-0.16** (0.06)**	-0.08 (0.08)
Urban population				**0.78*** (0.08)**	**0.77*** (0.10)**	0.12 (0.13)	**0.32*** (0.12)**	**0.46*** (0.13)**	**0.52*** (0.14)**
Trade					0.04 (0.12)	-0.04 (0.12)	0.04 (0.11)	**-0.28** (0.12)**	**-0.35*** (0.13)**
Energy use						**0.73*** (0.12)**	**0.69*** (0.12)**	**0.84*** (0.14)**	**0.75*** (0.17)**
Infrastructure development							**0.28*** (0.03)**	**0.37*** (0.06)**	**0.38*** (0.06)**
School enrolment								-0.11 (0.24)	0.06 (0.27)
Rule of Law									**-0.34* (0.18)**
Observations	506	494	494	494	492	274	274	168	155
Adjusted R-squared[28]	-0.01	0.75	0.75	0.80	0.80	0.81	0.85	0.91	0.91
R-squared	0.10	0.77	0.78	0.82	0.82	0.86	0.89	0.95	0.95
-Numbers in parenthesis are heteroskedastic-standard errors *** significant at the 1% level **significant at the 5% level *significant at the 10% level									

[27] DAC member states and China.

[28] The negative adjusted R-squared suggests a poor fit of the model, but in bivariate regressions such as this, the R-squared specification provides a more precise explanation. Notably under this analysis, 10% of the total variability in CO_2 emissions is explained by world aid.

H.2: The effect of aid allocations on carbon dioxide emissions in Sub-Saharan Africa

OLS Fixed effects									
Dependent Variable: CO_2 emissions (metric tons)									
Constant	-0.26 (0.38)	**-8.21*** (0.58)**	-3.66 (2.35)	-2.24 (2.04)	-2.11 (2.52)	**-16.44*** (2.62)**	**-11.96*** (3.11)**	**-24.75*** (5.63)**	**-23.29*** (5.86)**
China	**0.12** (0.06)**	0.07 (0.04)	0.07 (0.04)	**0.06* (0.03)**	**0.06* (0.03)**	0.02 (0.03)	-0.01 (0.03)	**-0.11** (0.05)**	**-0.10** (0.05)**
US	**-0.23*** (0.08)**	-0.05 (0.04)	-0.04 (0.04)	-0.02 (0.04)	-0.02 (0.03)	**-0.07** (0.03)**	-0.05 (0.03)	-0.00 (0.05)	-0.04 (0.06)
EU	**-0.35*** (0.11)**	-0.11 (0.06)	-0.08 (0.06)	**-0.10* (0.06)**	**-0.10** (0.05)**	**-0.15** (0.06)**	-0.08 (0.05)	-0.02 (0.06)	0.01 (0.06)
Rest of the[29] world	**0.19** (0.08)**	0.08 (0.04)	**0.07* (0.04)**	**0.10* (0.04)**	**0.10** (0.04)**	-0.07 (0.06)	-0.06 (0.04)	-0.00 (0.07)	0.02 (0.07)
GDP p.c		1.066 (0.07)	-0.56 (0.06)	**-1.52** (0.77)**	**-1.54* (0.84)**	**3.19*** (0.80)**	**1.76* (0.95)**	**5.50*** (1.81)**	**4.96** (2.00)**
GDP p.c squared			**0.10** (0.04)**	**0.15*** (0.05)**	**0.15*** (0.05)**	**-0.18*** (0.05)**	-0.10 (0.06)	**-0.32*** (0.11)**	**-0.27* (0.13)**
Urban population				**0.93** (0.14)**	**0.94*** (0.23)**	0.23 (0.21)	**0.42** (0.21)**	0.10 (0.34)	0.33 (0.49)
Trade					-0.04 (0.28)	0.05 (0.21)	0.03 (0.22)	0.48 (0.44)	-0.15 (0.66)
Energy use						**1.00*** (0.20)**	**0.89*** (0.22)**	**1.39*** (0.25)**	**1.11*** (0.39)**
Infrastructure development							**0.21** (0.06)**	**0.43*** (0.12)**	0.51 (0.15)
School enrolment								-0.66 (0.50)	-0.25 (0.65)
Rule of Law									-0.57 (0.56)
Observations	215	212	212	212	211	139	139	83	77
Adjusted R-squared	0.22	0.65	0.66	0.73	0.73	0.83	0.85	0.92	0.92
-Numbers in parenthesis are heteroskedastic-standard errors *** significant at the 1% level **significant at the 5% level *significant at the 10% level									

[29] Australia, Canada, Japan, Korea, New Zealand.

I.1: The effect of world aid on air quality in Sub-Saharan Africa (excluding Equatorial Guinea, Seychelles and South Africa)

OLS Fixed effects

Dependent Variable	Air quality[30] ($PM_{2.5}$)	Air quality[31] ($PM_{2.5}$EX)	Air quality[32] ($PM_{2.5}$ 10µg/m^3)	Air quality[28] ($PM_{2.5}$15µg/m^3)
Constant	**-31.65***** (11.13)	-0.21 (0.20)	**-4.38***** **(1.46)**	**-2.67**** **(1.06)**
World aid	**0.50***** **(0.17)**	0.004 (0.003)	**-0.06**** **(0.03)**	**-0.05***** **(0.02)**
GDP p.c	**18.18***** **(3.63)**	0.10 (0.07)	**2.14***** **(0.54)**	**1.22***** **(0.40)**
GDP p.c squared	**-1.14***** **(0.23)**	-0.006 (0.004)	**-0.15***** **(0.03)**	**-0.08***** **(0.03)**
Urban population	**1.49***** **(0.50)**	**0.04***** **(0.01)**	**0.20***** **(0.07)**	0.04 (0.04)
Trade	0.79 (0.74)	-0.01 (0.01)	0.01 (0.09)	0.02 (0.04)
Energy use	-0.25 (0.32)	-0.002 (0.006)	**0.07**** **(0.03)**	**0.05**** **(0.02)**
Infrastructure development	0.20 (0.35)	-0.005 (0.006)	**0.07*** **(0.03)**	0.01 (0.02)
School enrolment	**-6.98***** **(1.23)**	**-0.06***** **(0.02)**	**-0.47***** **(0.15)**	**-0.21**** **(0.09)**
Rule of Law	-0.05 (0.79)	**-0.03***** **(0.01)**	**0.20**** **(0.08)**	**0.17***** **(0.06)**
Observations	147	147	147	147
R-squared	0.59	0.51	0.58	0.55

-Numbers in parenthesis are heteroskedastic-standard errors

*** significant at the 1% level **significant at the 5% level *significant at the 10% level

[30] Average exposure is calculated by multiplying the $PM_{2.5}$ concentration by the population exposed. It reflects the 'typical' air pollution a person would experience in a country in a given day.

[31] Average proportion of the population whose exposure to $PM_{2.5}$ is above the World Health Organization threshold.

[32] Average proportion of the population whose exposure to $PM_{2.5}$ is above the interim targets of 10 and 15 micrograms per cubic meter µg/m^3.

I.2: The effect of world aid on air quality in Sub-Saharan Africa

OLS Fixed effects

Dependent Variable		**Air quality[33] ($PM_{2.5}$)**	**Air quality[34] ($PM_{2.5}$EX)**	**Air quality[35] ($PM_{2.5}$ 10µg/m^3)**	**Air quality[28] ($PM_{2.5}$15µg/m^3)**
	Constant	**13.11*** (3.62)**	0.05 (0.06)	**1.03** (0.39)**	0.40 (0.25)
	World aid	**0.43*** (0.16)**	0.003 (0.003)	**-0.07** (0.03)**	**-0.06*** (0.02)**
	GDP p.c	**-0.0009*** (0.0001)**	-4.19E-06 (3.01E-06)	**-8.43E-05*** (2.40E-05)**	**-5.02E-05*** 1.79E-05**
	GDP p.c squared	**0.21*** (0.05)**	0.002 (0.0009)	0.008 (0.006)	**0.007* (0.004)**
	Urban population	**1.40*** (0.47)**	**0.04*** (0.01)**	**0.21*** (0.07)**	0.04 (0.04)
	Trade	0.62 (0.73)	-0.01 (0.01)	-0.02 (0.09)	0.006 (0.04)
	Energy use	-0.15 (0.31)	-0.002 (0.006)	**0.06* (0.03)**	**0.05** (0.02)**
	Infrastructure development	0.24 (0.33)	-0.005 (0.006)	**0.07* (0.03)**	0.01 (0.02)
	School enrolment	**-6.97*** (1.24)**	**-0.06*** (0.02)**	**-0.44*** (0.15)**	**-0.20** (0.09)**
	Rule of Law	0.33 (0.76)	**-0.03** (0.01)**	**0.21** (0.09)**	**0.18*** (0.07)**
	Observations	147	147	147	147
	R-squared	0.36	0.18	0.27	0.22
	-Numbers in parenthesis are heteroskedastic-standard errors *** significant at the 1% level **significant at the 5% level *significant at the 10% level				

[33] Average exposure is calculated by multiplying the $PM_{2.5}$ concentration by the population exposed. It reflects the 'typical' air pollution a person would experience in a country in a given day.

[34] Average proportion of the population whose exposure to $PM_{2.5}$ is above the World Health Organization threshold.

[35] Average proportion of the population whose exposure to $PM_{2.5}$ is above the interim targets of 10 and 15 micrograms per cubic meter µg/m^3.

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