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INTRA-REGIONAL TRADE IN AFRICA AND THE IMPACT OF CHINESE INTERVENTION: A GRAVITY MODEL APPROACH

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China's trade with Africa has increased significantly in the past two decades. The effects of these growing trade volumes (and financial flows) are quite contested. The purpose of this paper is to study the effects of growing Chinese influence in Africa on the intra-regional trade in the continent. This paper estimates a traditional gravity model using Poisson pseudo-maximum-likelihood estimation method for a panel of 135 countries over the period 1990-2012. The results show that African countries are marginalized from world trade. They trade less, compared to a non-African country with similar characteristics. Even though intra-regional trade in Africa is quite low, this paper finds no evidence that these trade volumes are lower than what would be expected (given the characteristics of these countries). However, the results indicate that trade relations with China have distorted patterns of trade in Africa. The analysis shows that Chinese presence has led African countries to import less from (and export less to) other African countries. The massive influx of cheap Chinese goods into African markets combined with preferential tariff treatment offered by the Chinese government to African exporters may explain these patterns. This study also looks at how the effects of Chinese engagement in Africa have changed over time. The results suggest that over the past decade, the effects of China on intra-regional trade have become less negative. Since the late 1990's, Chinese investment in infrastructure, capacity building combined with high volumes of aid have helped African countries overcome some of the infrastructural bottlenecks and could explain the relatively higher intra-regional trade in the post-2000 period.

Keywords: Gravity Model, Trade, Africa, China
JEL classification: F14

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1. INTRODUCTION

China has grown at phenomenal rates in the last few decades. However, in order to sustain these high growth rates, China needs to ensure a steady supply of natural resources like oils, minerals etc. The country's energy demands have more than doubled in the past few decades, leading to increasing pressures for meeting demands for natural resources (Vines *et al*., 2009; Taylor, 2009). These factors led China to look overseas for sources of mineral resources and could explain the increasing involvement of China in Africa since the late 1990s (Berthélemy, 2011; The Economist, 2008; Mohan, 2008; Marysse and Geenen, 2009; Kaplinsky, McCormick and Morris, 2006; Meier zu Selhausen, 2010). The NYU Wagner School Study concluded that '*China's foreign aid is driven primarily by the need for natural resources*' (Lum *et al*., 2009, p. 5). Similarly, Foster *et al*. (2008) conclude that '*most Chinese government-funded projects in Sub-Saharan Africa are ultimately aimed at securing a flow of Sub-Saharan Africa's natural resources for export to China.*'

China-Africa trade has increased sharply since 2000. China's bilateral trade with Africa grew from USD 11 billion in 2000 to about USD 170 billion in 2011 (Direction of Trade Statistics, IMF, 2012). China has gradually progressed from one of the smallest among the top 10 trading partners of Africa to become its leading bilateral trade partner.[1] To promote trade with the continent, China removed tariffs on 196 types of imports from 28 least developed Africa countries in 2005. By 2007, this had expanded to 454 items (Besada, Wang, and Whalley, 2008). Most African exports now receive duty-free access to China's market. These preferential tariff treatments have helped expand African exports to China.

But most of the products for which China grants tariff exemption are principally raw materials. Thus, most of the increased trade flows represent a rising export of natural resources to China. About two-thirds of all African exports to China are oil and oil-related products.[2] Africa showed a USD 20 billion trade surplus with China in 2011. But more than three-quarters of the continent's exports were oil, gas, metals and minerals from only five countries - Sudan, Angola, Egypt, Nigeria and South Africa. Excluding oil exports, Africa had a trade deficit with China amounting to USD 28 billion in 2011.[3] Thus, the growth of African exports to China is driven by a very few countries. Apart from these few very resource-rich countries, the majority of African countries have 'mounting trade deficits' with China (Corkin, and Burke, 2006). This highlights the asymmetry of the relationship between China and African countries.

Chinese investment in Africa has also increased dramatically. From USD 20 million per year in the early 1990s, Chinese FDI in Africa jumped close to USD 100 million in

[1] Report on International and Intra-African Trade (2013), United Nations Economic and Social Council.

[2] Shinn, David H. (2007), "Africa, China, United States, and Oil".

[3] G. Ballim (August/September 2012), "Made with China: This is Africa".

2000 and reached more than USD 1 billion in 2006 (Zafar, 2007). Most of these investments are focused on long-term access to raw materials. Five resource-rich African countries - South Africa, Nigeria, Zambia, Algeria, and Sudan accounted for 87 percent of Chinese FDI inflows on average during the four year period of 2005 to 2008 (Meier zu Selhausen, 2010). Eisenman (2012) argues that almost all of Chinese investment into rail projects in Africa is aimed at connecting African raw material suppliers with Chinese buyers and Chinese goods manufacturers with African customers.

Since the late 1990s China's aid to Africa has also increased significantly. There's no consensus in the literature so far regarding the determinants of Chinese aid to Africa. While Naím (2007) argues that political and commercial interests are the principle determinants of Chinese aid to Africa, Dreher and Fuchs (2011) argue that China is no different from other donors and Chinese aid allocations are not dominated by natural resource considerations. However, a large number of studies do suggest that Chinese aid is increasingly directed towards resource-rich Sub-Saharan African economies (Kaplinsky, and Morris, 2009; Brookes, and Shin, 2006). The asymmetric patterns of aid and investment allocations could lead to asymmetries in the patterns of infrastructural, institutional development in the continent and this could affect patterns of intra-regional trade.

It is believed that the rising trade has a significant positive impact on the African economies. On the export side, they gain from China's demand for commodities. As Broadman (2007) argues, the rising demand for raw materials by China has led to increased global commodity prices thereby improving the terms of trade for African raw materials exporters. On the import side, African countries benefit from the cheap consumption and capital goods (OECD, 2006; Alden, 2007). However, cheap products from China are also leading to the displacement of existing and potential local producers thereby destroying local manufacturing capabilities and competitiveness. Domestically produced clothing and furniture manufactures in both Ghana and South Africa are being displaced by imports from China (Kaplinsky, and Morris, 2008). In Ethiopia, a study of 96 micro, small and medium domestic producers reported that as a consequence of Chinese competition, 28 percent were forced into bankruptcy, and 32 percent downsized activity (Kaplinsky, McCormick, and Morris, 2010).

On the other hand, Jenkins and Edwards (2006) argue that 'most of these imports into Sub-Saharan Africa have substituted for imports from outside of Sub-Saharan Africa, with the possible exception of Ethiopia and Nigeria, suggesting little displacement of domestic production and few negative impacts on employment and local production'. Rapid trade expansion with China has benefitted African countries by opening up opportunities for export. However, not all African countries have benefitted equally since African countries differ greatly in terms of their natural resource endowments (World Bank, 2004b).

Most of Chinese development and financial assistance is tied to the purchase of Chinese goods. These, combined with the preferential tariff treatment, may have a trade

creation effect (increased exports to and imports from China). However, at the same time, they may also lead to trade diversion (affecting not just Africa's trade with other partners but also hampering potential trade between African countries). China's investment in Africa has been concentrated in the development of natural-resource sector and infrastructure, both of which help advance China-Africa trade volumes (but have played a limited role in helping the integration of African countries with the rest of the world). Barma, Ratner and Weber (2007) also believe that trade volumes between China and Africa are 'in excess of what standard economic models of trade would predict' (Eisenman, J., 2012). Thus, China might be responsible for distorting patterns of intra-African trade. These distortions could have serious implications for the welfare of the African population. If intra-Africa trade levels are below their potential, it means that there may be gains to be realized from increasing the amount of trade. African governments could enter into trade agreements that increase the intra-regional trade thereby allowing African countries to reach higher levels of welfare.

In this paper, I use a modified version of the strategy proposed by Foroutan and Pritchett (1993) in their influential study 'Intra-Sub-Saharan African Trade: is it too little?',[4] to study the effect of growing Chinese presence in the continent since the late 1990's on intra-African trade volumes. I use the traditional gravity model to predict bilateral trade between the African countries and see if intra-regional trade in Africa is above or below its predicted levels. I introduce additional variables in the gravity model equation to account for Africa-specific factors. The coefficients for these variables help to identify if trade patterns of the African countries differ from those of similar[5] non-African countries included in the sample - these differences indicating some sort of distortions in African trade patterns. Finally, I also introduce China-specific factors to see if these distortions in the patterns of bilateral trade can be explained by the rising Chinese presence since 2000.

The remainder of this paper is organized as follows. Section 2 reviews the divergent views in the existing literature regarding intra-regional trade in Africa and the effect of China. Section 3 lays out the traditional gravity model of bilateral trade. Section 4 describes the data and the methodology used in the paper. Section 5 looks at the results from the estimated model. Robustness checks are included in Section 6. Section 7 discusses some limitations of the paper and Section 8 concludes.

[4] The authors estimate a traditional gravity model (using a Tobit estimation) to study if intra-Sub-Saharan African trade is higher or lower than what would one would expect based on the gravity model.

[5] Defined as 'similarity in economic, geographic, political, cultural factors' that are included as determinants of trade in the gravity model.

2. INTRA-REGIONAL TRADE AND IMPACT OF CHINA: EXISTING LITERATURE

According to UNCTAD 2008 report on 'Economic Development in Africa', intra-regional trade has never been an important source of trade for Africa, accounting for only 8 percent of total exports in 2006. Some of the reasons for this, according to UNCTAD are - similarity of the exports structures (most of them being commodity exporters), high transaction costs (poor geography and infrastructure) and the presence of many barriers to trade.

The fact that these trade volumes are low does not necessarily imply that there are distortions in trade patterns. As Foroutan and Pritchett (1993) note, the intra-regional trade in Sub-Saharan Africa may be quite low, but taking into account the fact that most of these countries are very poor with low populations, there seems to be no evidence that these trade volumes are lower than what one would expect given the characteristics of these economies.

On the other hand, there are others who believe that intra-regional trade in Africa is below its potential[6] and in order to facilitate faster economic development in Africa, greater regional integration is required. A large number of regional trade agreements have been signed in the past decade[7] to expand intra-regional trade and take advantages of economies of scale. However, despite the existence of these agreements in the continent, intra-Africa trade remains extremely low.

However, there are divergent views in this second group when it comes to assessing the impact of China on intra-Africa trade. The growing engagement of China in the continent has led some to believe that China could help Africa overcome its regional integration weaknesses. China's financing and construction of transport corridors, among other infrastructure development projects, could help in promoting and furthering the process of regional integration.[8] However, according to others, this may not be the case. Giovannetti and Sanfilippo (2009), using a generalized methods of moments estimation,[9] show that rising exports from China to Africa have come at the expense of intra-regional trade - with specific regard to intra-Sub-Saharan African trade. According to the Africa Research Institute,[10] '*efforts to promote intra-African trade and integration are frustrated by the continued preference of China - and other trade*

[6] Potential trade refers to expected trade, given the economic, geographical, cultural characteristics of the countries concerned.

[7] There were over 30 RTAs in Africa at end of 2005 (http://www.indoAfrican.org/Regional%20 Trade%20Agreement.pdf).

[8] 'China as a driver of regional integration in Africa: Prospects for the future' (http://www.ccs.org.za/ wp-content/uploads/2009/06/ china-as-a-driver-of-regional-integration-in-Africa_dbsa-conference-report.pdf).

[9] The authors estimate an augmented gravity model with product level disaggregated data.

[10] 'Between extremes China and Africa' (Briefing Note 1202 October 2012).

partners - for bilateral relations.' Similarly, Chinese clothing imports have not only reduced domestic production in Kenya, but have also displaced imports from neighbouring countries, many of which were previously produced by small-scale tailors, dressmakers, and knitters.[11]

Improving growth and development prospects of Africa is one of the prime concerns of the world economy today. Given the uncertainty regarding the impact of Chinese presence on Africa, it seems important to test these diverging views. If the effect of China on the intra-regional trade is positive (maybe due to better infrastructure facilities), then the problem may be less severe than the case where China has the effect of lowering this trade. The latter could imply that China is distorting patterns of trade by diverting exports and imports away from neighbouring African countries thereby preventing these countries from realizing gains from economies of scale etc. If this is the case, then the African countries need to rethink their 'China policies' and probably take steps to promote greater regional integration with the other African countries.

3. THE GRAVITY MODEL

The theoretical justifications of the gravity model have been disputed quite often, but empirically, the model has been quite successful in explaining the patterns of bilateral trade observed today (Bergstrand, 1989; Anderson and van Wincoop, 2003; Helpman *et al*., 2008). According to the traditional gravity model, the bilateral trade between two countries is an increasing function of the incomes of both countries and a decreasing function of the distance between the two countries. The gross domestic product (GDP) of the exporting country indicates the supply capacity whereas the importing country's GDP indicates the total demand. Transport costs are a major determinant of the bilateral trade between two countries and distance can be considered as a proxy for these transport costs.[12] It is common to include a dummy for whether countries share a common border. The effect of this variable on trade is expected to be positive as sharing a border implies lower transportation costs. Cultural and historical factors are often included in the gravity model. If the two countries share a common language, it is likely to increase trade by facilitating communications and making transactions easier. Similarly, if two countries share colonial links, one would expect these colonial links to have a positive impact on bilateral trade volumes. However, certain forms of colonialism promoted bilateral trade with the European metropole at the expense of trade with other countries. The effect of colonial link is therefore ambiguous. Being landlocked can have

[11] McCormick *et al*. (2007) for the case of Kenya.

[12] Geographical distance may be a poor approximation of all the economic barriers for international trade. The gravity model is therefore augmented with other variables to account for policy and political barriers that hamper trade.

a detrimental effect on the trade volumes by increasing transport costs. Certain policy choices, such as the existence of preferential trade arrangements between two countries, are likely to improve bilateral trade between the countries. Larger distances to all other countries might also increase bilateral trade between two countries (because they do not have alternative trading partners). Thus, a remoteness index is often included in the gravity model equation. This remoteness variable can be considered as a proxy for 'multilateral resistance'. The importance of multilateral resistance as a determinant of bilateral trade was emphasized by Anderson and van Wincoop (2003). An alternative strategy for doing this is to introduce country fixed effects. However, this gets rid of time-invariant factors like distance, border etc. from the estimation and hence renders this technique unsuitable for analyzing the effects of Chinese intervention.

The traditional gravity model (in logarithmic terms) can be represented by the following equation:

$$\begin{aligned}\ln T_{ijt} &= \alpha_0 + \alpha_1 \ln Y_{it} + \alpha_2 \ln Y_{jt} + \alpha_3 \ln D_{ij} + \alpha_4 pop_{it} + \alpha_5 pop_{jt} + \alpha_6 border_{ij} \\ &\quad + \alpha_7 landlocked_i + \alpha_8 landlocked_j + \alpha_9 \ln remoteness_{it} + \alpha_{10} \ln remonteness_{jt} \\ &\quad + \alpha_{11} comlang_{ij} + \alpha_{12} colony_{ij} + \alpha_{13} PTA_{ijt} + \varepsilon_{ijt},\end{aligned} \quad (1)$$

where,

$\ln T_{ijt}$ = logarithmic value of bilateral trade (import or export) between countries i and j at time t,

$\ln Y_{it}$, $\ln Y_{jt}$ = logarithmic values of GDP's of countries i and j respectively at time t,

$\ln D_{ij}$ = logarithmic value of bilateral distance between countries i and j (calculated using the great circle distance algorithm),

pop_{it}, pop_{jt} = populations of the country i and j, respectively, at time t,

$border_{ij} = 1$ if countries share a common border,

$landlocked_i$, $landlocked_j = 1$ if country is landlocked,

$\ln remonteness_{it}$, $\ln remonteness_{jt}$ = logarithmic of the GDP-weighted average distance to all other countries for i and j at time t,

$comlang_{ij} = 1$ if countries i and j share the same official/second languages,

$colony_{ij} = 1$ if countries i and j share colonial links (direct or indirect),

$PTA_{ijt} = 1$ if countries i and j are a part of the same Preferential Trade Agreement at time t,

ε_{ijt} = is the error term.

One can estimate the traditional gravity model and use the estimated coefficients

from the model to predict bilateral trade[13] between various country pairs. One could compare these predicted values with the actual values to see if trade volumes are lower/higher than the potential volumes - that is, to identify if the patterns of trade that we observe are distorted in some way. The main aim of the paper is to investigate if there are distortions in the patterns of African trade (particularly intra-regional trade) and if these distortions could be attributed to the influence of China engagement in the continent. As already mentioned, I use a modified version of the strategy introduced by Foroutan and Pritchett (1993) to directly test for these effects by introducing Africa and China specific variables in the estimation of Equation (1). The estimated model allows me to identify distortions in the pattern of trade of African countries vis-à-vis similar non-African countries. It also allows me to determine if intra-regional trade in Africa is below/above its potential level and if the presence of China can help in explaining these distortions. The details of the approach adopted in the paper are explained in the next section.

4. DATA AND METHODOLOGY

4.1. Data

The analysis covers a panel of 135 countries for the period 1990-2012.[14] The list of included countries is reported in Appendix 1. Data from several different sources were compiled together to create the dataset used in the paper. The data for bilateral trade flows comes from WITS UN Comtrade.[15] The data for GDP and GDP per capita (at constant 2005 prices) comes from the World Bank's World Development Indicators report. The data for other gravity model variables i.e., distance, contiguity, common language (official and second language), colonial ties (direct and indirect links), landlocked comes from Santos Silva and Tenreyro (2006). The data for preferential trade agreements (PTA) comes from Kohl, T. (2014), forthcoming.

4.2. Estimation Method

This paper estimates the traditional gravity model for a panel of 135 countries over the period 1990-2012 using GDP, population, distance, common borders/languages/

[13] I will be using the term 'potential trade' interchangeably with 'predicted trade' henceforth.

[14] Certain countries like Yugoslavia split into different independent nations during the period under study. Due to difficulties in merging the data, these countries have been dropped from the dataset. In case of Ethiopia, data for 1990 includes data for both Eritrea and Ethiopia. After 1991, however, data is reported for only Ethiopia.

[15] HS 1988/92 nomenclature/product classification.

culture, whether landlocked or not, whether part of a preferential trade agreement or not, as explanatory variables.

The gravity model has traditionally been estimated using ordinary least squares (OLS) regression. However, Silva and Tenreyro (2006), using Monte Carlo simulations, show that in the presence of heteroscedasticity,[16] estimating a log-linearized model using OLS leads to severely biased estimates. Consequently, there has been a shift in the literature towards other estimation techniques for the estimation of gravity models. Zero trade flows between countries is another problem that is commonly faced in gravity model estimations. The estimation technique should be able to adequately deal with this problem as well.[17] One approach in the literature has been to use a Tobit specification with left-censoring at zero. This technique is able to deal with the problem of zero trade flows. However, Tobit estimation assumes that factors that determine whether two countries trade or not, are the same as the factors that determine the volume of bilateral trade between those two countries. This may or may not be true. There is no clear theoretical foundation why a Tobit technique should be preferred.[18] Another alternative is to use a sample selection model, such as the Heckman model (Tran, Wilson, and Hite, 2013). However, the Heckman gravity model is based on the log-linear specification and hence, it suffers from problems of heteroskedasticity (Liu, 2009). The third approach is to use negative binomial models. However, as Tran *et al*. (2013) argue, negative binomial is not scale-invariant. This makes it unsuitable to use in the context of gravity model because a model with the trade values measured in dollars will yield estimates different from those estimated using trade values measured in thousands of dollars.

The approach that is used quite often in the literature now is the Poisson pseudo-maximum-likelihood (PPML) estimation technique as suggested by Silva and Tenreyro (2006). This technique is able to deal with both the problems of heteroskedasticity and zero values of the dependent variable. The authors use Monte Carlo simulations to show that the PPML estimator provides consistent estimates for gravity model coefficients (even if the data itself is not distributed as a Poisson). The *ppml* command[19] in stata can be used to estimate the gravity model with 'level' of trade as the dependent variable to yield consistent estimates. In this paper, I use the PPML estimation technique to estimate the gravity model. However, since there is no consensus in the literature regarding the best method for estimating the gravity model, I also estimate the model using Tobit (the second most commonly used specification) to see if the results are robust to the choice of estimation technique. The Tobit estimates are discussed in Section 6.

[16] Usually a severe problem in the gravity equation estimations.

[17] If zero trade values reported in the data actually represent zero trade, then truncating the sample by dropping these observations will lead to a loss of information and results will be inconsistent. This approach is not recommended.

[18] Herrera (2010), 'Comparing alternative methods to estimate gravity models of bilateral trade'.

[19] This command automatically incorporates the *robust* option.

4.3. Methodology

As already mentioned in Section 3, in order to estimate the effects of Chinese presence in the continent, I estimate a modified version of Equation (1). Just as Foroutan and Pritchett (1993), I include the following additional dummies in the estimation of Equation (1):

African_rep = 1 if the reporter country is in Africa,
Oilexporter_rep = 1 if the reporter country is an African oil exporter,[20]
African_both = 1 if both the reporter and the partner countries are in Africa.

The coefficient for the first dummy indicates how much trade patterns of non-oil exporting African countries are different from those of similar non-African countries. The coefficient for the second dummy gives the differential effect if the reporter country is an oil-exporting African country. Looking at the coefficients of these dummies can give us an idea about the distortions in the trade patterns of African countries. The third dummy, for both countries being African, tells us whether intra-regional trade in Africa is higher or lower than what the gravity model would predict given the GDPs, populations, distances and other characteristics of the two countries.

In this paper, I introduce additional China-specific variables to account for the effect of Chinese presence. For each country pair and year combination, these additional dummies are as follows:

(a) African_both*China_presence=1 if both the reporter and partner countries are African and if either of the countries had trade relations with china in that particular year.[21]

(b) (African_both*China_presence)*(after 2000)=1 if African_both*China_presence = 1 and if the year of observation is 2000 or beyond.

(c) (African_both*China_presence)*(oilexporter_rep)=1 if African_both*China_ presence = 1 and if the reporter country is an oil exporter.

(d) (African_both*China_presence)*(oilexporter_rep)*(after 2000)=1 if (African_ both*China_presence)*(oilexporter_rep)=1 and the year of observation is 2000 or beyond.

[20] Oil exporters are defined as countries where fuels accounted for more than 50 percent of merchandise exports in 2011 and include Algeria, Angola, Chad, Congo, Equatorial Guinea, Gabon, Libya, Nigeria and the Sudan, (Intra-African trade: unlocking private sector dynamism, UNCTAD).

[21] In order to create the interaction dummy, first, a China_direct dummy was created which takes the value 1 if either of the countries in the country pair was China. This was then used to create a China_presence dummy, which takes the value 1 if either of the countries in the sample had trade relations with China in that particular year. These were then interacted with African_both dummy.

Using the coefficients of these interaction dummies, I estimate the effect of trade relations with China on intra-regional trade in Africa. I divide the data into two periods: Pre-2000 (1990-1999) and Post-2000 (2000-2012). The latter is the period when Chinese engagement in the African continent started growing at very rapid rates. I estimate the effects of China on intra-African trade for the two periods separately to see if the effects of Chinese engagement have changed over time. Given the heterogeneity in the relation of China with African countries, it is interesting to see how the impact of Chinese presence on intra-regional trade varies for that of an oil abundant reporter countries vis-à-vis a non-oil abundant reporter countries.[22] Hence, I estimate the effects on intra-African trade for both groups of countries and see how these have changed over time. The derivation of the formulae used in estimating these effects is explained in Appendix 2.

5. RESULTS

Table 1 presents the estimation results for the traditional gravity model using PPML. Bilateral import patterns may be determined differently from bilateral export patterns and hence the model is estimated for imports and exports separately (Foroutan and Pritchett, 1993).

Columns 1 and 3 report the gravity model estimates for exports, without and with time fixed effects respectively. Similarly, columns 2 and 4 report the estimates for imports, without and with time fixed effects respectively. In each case, the dependent variable is the level of bilateral trade measured in 1,000 USD. Although the dependent variable for the PPML regression is specified as exports and imports in levels rather than in logarithmic terms, the coefficients of independent variables entered in logarithmic terms can be interpreted as simple elasticities and the coefficients of independent variables entered in levels can be interpreted as semi-elasticities (as under OLS).[23] The test for joint significance of year fixed effects has a p-value of zero. In other words, the time fixed effects are jointly significant. Hence, I use the coefficients from columns 3 and 4 for interpretations of the results.

The model was also estimated using ordinary least squares (OLS) with 'trade' and 'one plus trade' as dependent variables. The Breusch-Pagan test rejected the null of homoskedasticity in both cases with a p-value of zero. The R^2 value in both cases was lower than those obtained for PPML (in the ranges of 0.71-0.72). Both these results suggest that PPML estimation would be more suitable than OLS. The paper only reports

[22] This captures the idea that China's engagement with natural resource rich countries may be different from the rest of Africa and hence there may be an asymmetry in the effect of Chinese presence on intra-African trade depending on whether the country is resource rich or not.

[23] Shepherd, B. (2012), Chapter 4 (Alternative Gravity Model Estimators).

the PPML estimates.[24]

Table 1. Traditional Gravity Model Estimates using PPML (in 1,000 USD)

Sample Period	1990-2012			
Dependent variable	Export	Import	Export	Import
	(1)	(2)	(3)	(4)
Log partner GDP (in millions)	0.8167***	0.7826***	0.8085***	0.7731***
	(0.006)	(0.0038)	(0.0059)	(0.004)
Log reporter GDP (in millions)	0.7942***	0.8338***	0.7836***	0.8238***
	(0.0047)	(0.0070)	(0.0048)	(0.0068)
Partner population (in thousands)	0.092**	0.636***	0.036	0.580***
	(0.00)	(0.00)	(0.00)	(0.00)
Reporter population (in thousands)	0.522***	0.216***	0.426***	0.161***
	(0.00)	(0.00)	(0.00)	(0.00)
Log distance	-0.8564***	-0.8172***	-0.8709***	-0.8330***
	(0.0143)	(0.014)	(0.0146)	(0.0145)
Border	0.0506*	0.0401	0.0989***	0.0906***
	(0.0279)	(0.0283)	(0.0272)	(0.0279)
Landlocked reporter	-0.3860***	-0.2788***	-0.3995***	-0.2915***
	(0.0381)	(0.0372)	(0.0364)	(0.035)
Landlocked partner	-0.3018***	-0.3113***	-0.3188***	-0.3316***
	(0.04)	(0.035)	(0.0378)	(0.0335)
Log remoteness reporter	0.7130***	0.8610***	0.7087***	0.8619***
	(0.0326)	(0.0274)	(0.0317)	(0.0281)
Log remoteness partner	0.9199***	0.7679***	0.9030***	0.7511***
	(0.031)	(0.0301)	(0.0313)	(0.0296)
Common language	0.7084***	0.6653***	0.6859***	0.6430***
	(0.0454)	(0.0406)	(0.0435)	(0.0394)
Colonial link	-0.3481***	-0.3421***	-0.3248***	-0.3192***
	(0.049)	(0.0444)	(0.0474)	(0.0433)
Preferential trade agreement	0.4921***	0.3829***	0.4031***	0.2907***
	(0.0229)	(0.0235)	(0.0232)	(0.024)
Reporter African	-0.4459***	-0.04	-0.5019***	-0.0938***
	(0.0293)	(0.0248)	(0.0286)	(0.024)
Reporter oil exporter	1.0378***	-0.1497***	1.0279***	-0.1601***
	(0.0562)	(0.0412)	(0.0530)	(0.0394)
Both African	0.8339***	1.8379***	0.9521***	2.0461***
	(0.1915)	(0.4057)	(0.2057)	(0.4203)

[24] The results for OLS have not been included due to the word limit but are available on request.

Both African and China presence	-0.1681	-1.8504***	-0.1397	-1.9207***
	(0.2026)	(0.4089)	(0.2167)	(0.4237)
Both African and China presence after 2000	0.3178***	0.5243***	0.0806	0.2889***
	(0.0885)	(0.0779)	(0.0891)	(0.0787)
Both African and China presence and reporter oil exporter	-1.7977***	-1.1524***	-1.7759***	-1.1309***
	(0.1967)	(0.1332)	(0.1952)	(0.1326)
Both African and China presence and reporter oil exporter after 2000	0.7204***	0.3195**	0.6754***	0.2863*
	(0.2217)	(0.1567)	(0.2201)	(0.1559)
Constant	-14.4113***	-14.6745***	-13.5535***	-13.8519***
	(0.3859)	(0.3468)	(0.3903)	(0.3535)
No. of Observations	219174	232798	219174	232798
R^2	0.777	0.7744	0.7838	0.7777
Pseudo log-likelihood	-4.876e+10	-5.119e+10	-4.640e+10	-4.860e+10
Year fixed effects	No	No	Yes	Yes
Test for year fixed effects: χ^2			$\chi^2(22) =$ 589.39	$\chi^2(22) =$ 658.25
Probability $> \chi^2$			0.0000	0.0000

Notes: Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

As can be seen from the table, the signs of most of the variables are as expected. A higher GDP of both the reporter and partner has a positive impact on the bilateral trade. A one percent rise in the GDP of either the reporter or the partner causes bilateral trade (exports and imports) to increase by approximately 0.8 percent. Increasing the population of the partner country by 1,000 will cause exports to rise by approximately 53 percent and imports to rise by approximately 17 percent.[25] Positive effects of population growth on bilateral trade are a result of both demand side (larger markets) and supply side (greater workforce) factors. The model predicts that a one percent increase in the distance between two countries would decrease the volume of bilateral trade by 0.87 percent for exports and 0.83 percent for imports. Countries that share borders have about 9.5 percent higher trade volumes than countries that do not share a border. If the reporter country and/or the partner country are landlocked, it becomes difficult to trade. The model predicts that a landlocked reporter exports approximately 33 percent less (and imports 25 percent less) than a similar country that is not landlocked. As theory suggests, remoteness has a positive impact on the bilateral trade between two countries. A one percent increase in the remoteness index for the reporter country leads to 0.71 percent higher export volumes and 0.86 percent higher import volumes.

[25] These effects have been estimated using the formula: $\%\Delta y = 100[\exp(\beta) - 1]$.

Countries with colonial links have bilateral trade volumes 27 percent lower than countries without colonial links. Sharing a common language has a positive impact on bilateral trade. Being a part of the same preferential trade agreement (PTA) leads to significantly higher trade between countries that are members of the PTA than those that are not. This is true for both export (50 percent increase) and import volumes (33 percent increase).

Now, let us look at the estimates of the Africa and China specific variables that I included in the estimation of the traditional gravity model. If the reporting country is African and not oil abundant, then its exports are lower by 40 percent (and imports by about 10 percent) than a similar non-African country. This result seems to be in line with existing literature that suggests that most African countries remain more or less marginalized from global trade (Sachs and Warner, 1997; Subramanian and Tamirisa, 2001). If a country is African but oil abundant, its exports are almost 70 percent larger than that of a non-oil exporting country with similar characteristics. On import side, however, the patterns are just as before - the country imports 22 percent less than a similar non-African country. These results also show heterogeneity in trade patterns for resource-rich and resource-poor African countries. On import side, both seem to be marginalized from global trade. But on export side, resource-rich countries are actually exporting much higher volumes than what would be expected. This could possibly be a reflection of the growing demands for fuel by China and other Western countries and the consequent commodity price boom. If both countries are African, the trade between the pair is larger than what one would expect for a pair with similar characteristics. For example, on export side African countries are exporting more than double of what one could expect based on the gravity model estimates. This is in line with the finding Foroutan and Pritchett (1993) that intra-regional trade in Africa is actually more than what one would predict given the determinants of bilateral trade.

Now, let us look at the coefficients of the China-specific dummies to estimate the impact of Chinese presence on intra-regional trade in Africa (for oil exporting countries vis-à-vis non-oil exporting countries for the period pre-2000 and post-2000).

For non-oil exporting countries, China's presence in the continent during the period 1990-1999 has had the effect of deterring intra-regional trade in Africa. This means that an African country imported less from (and exported less to) another African country in a given year if either of them had trade relations with China in that particular year. This effect is quite significant in magnitude for the case of imports. Trade relations with China cause imports from (exports to) other African countries to be lower by approximately 85 percent (13 percent). These results support the studies mentioned in Section 3 that suggest that cheap imports from China have hurt imports from neighbouring African countries thereby lowering intra-Africa trade.

For oil-exporting countries as well, China's presence in the pre-2000 period adversely affected intra-Africa trade. However, it is interesting to note the much larger magnitudes of these impacts. In the case of exports, China's presence causes exports to other African countries to decline by 85 percent - this impact is much stronger than the

impact on a non-oil exporting country. The trends for imports are similar (a decline of 95 percent). Thus, we see that the patterns of distortion in trade due to China's presence are significantly larger for an oil-exporting country vis-à-vis a non-oil exporter. This could be a reflection of the asymmetry of Chinese trade relation with resource-rich countries and with the rest of Africa.[26]

Looking at these results, one can conjecture that in the period before 2000, trade relations with China led African countries to import much less from other African countries - possibly due to influx of cheap goods from China. Similarly, there was a diversion of exports away from other African countries. The latter effect was much stronger for an oil-exporting country - possibly reflecting the growing exports of oil and other natural resources to China (and a few other countries).

After 2000, however, the extent of Chinese presence in the continent started increasing at a much faster pace. And as described in the introduction to this paper, these trends in growing trade were accompanied by growing foreign direct investment (FDI) and aid flows to the continent.[27] Thus, it is important to look at how the effects of Chinese presence on intra-regional trade have changed over time.

The impact of trade relations with China on intra-regional trade in Africa continues to be negative even in the period from 2000-2012. This holds true for both oil-exporting and non-oil exporting countries. For a non-oil exporter, exports to other African countries were lower by 6 percent and imports from other African countries were lower by about 80 percent (still significant) as a result of Chinese presence. For an oil exporter, the corresponding figures were 68 and 90 percent, respectively. The patterns of distortion in trade follow the same trends as in the pre-2000 period: (1) distortions are much more for imports; (2) distortions are greater for an oil-exporting country; (3) distortions in exports are relatively much larger for an oil-exporter than for a non-oil exporter.

However, it is interesting to note that the negative effects of Chinese presence on intra-regional trade have become smaller over time. The distortions for imports remain quite high even post-2000 but there has been a significant improvement on export side - 7 percentage points for non-oil exporting countries and 17 percentage points for oil-exporting countries. These positive trends in the 2000-2012 period suggest that the growing volumes of aid and FDI from China (used primarily for financing infrastructure projects - road building, railway rehabilitation, developing industrial capacity etc.) over the past decade may have helped African countries overcome some of the infrastructural

[26] As mentioned in the 'Introduction' section, China's growing demand for natural resources and energy supplies has led to a much greater involvement of the country in resource-rich countries of Africa as opposed to the rest of the continent. Thus, it seems plausible that the distortions in trade patterns are larger for oil-exporting countries.

[27] Most of the aid was 'aid for trade'. The idea of 'aid for trade' gained prominence with the Doha Round where the proposal for an 'aid for trade' package was made.

bottlenecks and allowed them to trade more with each other. The fact that these positive trends are more pronounced for oil-exporting countries may render credibility to this causation story because even though investments were made in both resource-rich and resource-poor countries (to enable cheap goods from China to penetrate the African markets), the major chunk of investments were concentrated in countries with abundant natural resources. Significant investments were made to develop export-specific infrastructure in these countries to enable easier export of oil and other resources. Thus, it is not surprising that improvements in export volumes are larger when the reporting country is an oil exporting country.

Thus, the regression results show that Chinese presence in the continent has distorted patterns of intra-regional trade. Even though intra-African trade is higher than what one might expect based on the gravity model, the results suggest that trade relations with China lead to a diversion of trade away from African countries (to China possibly). In the post-2000 period, however, the situation has improved slightly. Growing Chinese investment and aid, leading to improved infrastructure and production capacities could explain these improvements in intra-regional trade in the continent in 2000-2012 period relative to 1990-1999.

6. ROBUSTNESS CHECKS

No consensus has been established in the literature regarding the estimation technique that is most suitable for estimation of the gravity model. Since the seminal work of Silvas and Tenreyro (2006), a lot of papers have made use of the PPML technique for gravity model estimations. However, some papers still make use of the Tobit specification. As already described in Section 4, the Tobit model has its disadvantages but it is worthwhile to check the robustness of our results to the choice of this estimation technique. The results for the Tobit specification are reported in Table 2.[28] The dependent variable in this case is *logarithmic* as compared to PPML estimation where it is in *levels*.

[28] The results are also robust to estimation using PPML on the truncated sample. But as argued before, dropping observations is not a recommended approach. These results have not been included due to constraints on word limit and due to some obvious limitations of this technique.

Table 2. Robustness Checks with Tobit Estimation (in 1,000 USD)

Sample Period	1990-2012			
Dependent variable	Log Export	Log Import	Log Export	Log Import
	(1)	(2)	(2)	(4)
Log partner GDP (in millions)	0.9744***	1.3015***	0.9737***	1.3016***
	(0.0026)	(0.0025)	(0.0026)	(0.0025)
Log reporter GDP (in millions)	1.4288***	1.0539***	1.4256***	1.0506***
	(0.003)	(0.0027)	(0.003)	(0.0027)
Partner population (in thousands)	0.065 **	0.166***	0.066**	0.166***
	(0.00)	(0.00)	(0.00)	(0.00)
Reporter population (in thousands)	0.142***	0.156***	0.145***	0.166***
	(0.00)	(0.00)	(0.00)	(0.00)
Log distance	-1.4356***	-1.2628***	-1.4394***	-1.2608***
	(0.0099)	(0.0095)	(0.01)	(0.0095)
Border	0.6658***	0.3887***	0.6688***	0.3860***
	(0.0357)	(0.0345)	(0.0356)	(0.0344)
Landlocked reporter	-0.1157***	-0.3295***	-0.1233***	-0.3365***
	(0.0164)	(0.0150)	(0.0163)	(0.0150)
Landlocked partner	-0.8228***	-0.3386***	-0.8262***	-0.3382***
	(0.015)	(0.0141)	(0.0150)	(0.0141)
Log remoteness reporter	0.9860***	0.2014***	0.9818***	0.1941***
	(0.0199)	(0.0193)	(0.0199)	(0.0192)
Log remoteness partner	0.5662***	1.1957***	0.5648***	1.1958***
	(0.0216)	(0.0202)	(0.0216)	(0.0201)
Common language	0.6346***	0.6878***	0.6347***	0.6868***
	(0.0164)	(0.0155)	(0.0164)	(0.0155)
Colonial link	0.3070***	0.4543***	0.3071***	0.4573***
	(0.0172)	(0.0162)	(0.0172)	(0.0162)
Preferential trade agreement	0.5294***	0.5959***	0.5168***	0.6030***
	(0.0168)	(0.0162)	(0.017)	(0.0163)
Reporter African	-0.0049	0.2272***	-0.005	0.2333***
	(0.0168)	(0.015)	(0.0168)	(0.015)
Reporter oil exporter	-0.4880***	-0.6314***	-0.4942***	-0.6410***
	(0.0444)	(0.0368)	(0.0444)	(0.0368)
Both African	3.0136***	-0.6723	2.7979***	-0.8922
	(0.4727)	(0.5477)	(0.474)	(0.5485)
Both African and China presence	-2.4678***	0.9124*	-2.2966***	1.0295*
	(0.4738)	(0.5485)	(0.4752)	(0.5494)
Both African and China presence after 2000	-0.0029	-0.3754***	0.0559	-0.2354***
	(0.043)	(0.0401)	(0.0445)	(0.0415)
Both African and China presence and reporter oil exporter	-1.1129***	-0.7166***	-1.1001***	-0.7050***
	(0.1234)	(0.1024)	(0.1233)	(0.1023)

Both African and China presence and reporter oil exporter after 2000	0.0344 (0.1366)	0.2465** (0.116)	0.0134 (0.1365)	0.2401** (0.1159)
Constant	-19.6826*** (0.2671)	-19.0597*** (0.2539)	-19.3501*** (0.2702)	-18.7660*** (0.2571)
Sigma	2.3133*** (0.0036)	2.2518*** (0.0034)	2.3106*** (0.0036)	2.2489*** (0.0034)
No. of Observations	219174	232798	219174	232798
Pseudo-R^2	0.2147	0.2199	0.2151	0.2203
F-statistic	$F(19, 219155)$ =28910.30	$F(19, 232779)$ =35941.94	$F(41, 219133)$ =13455.51	$F(41, 232757)$ =16708.91
Probability > F	0.0000	0.0000	0.0000	0.0000
Log pseudo-likelihood	-481817.91	-512676.78	-481580.13	-512389.86
Year Fixed effects	No	No	Yes	Yes
Test for year fixed effects:				
F-statistic			F(22,219133) = 22.23	F(22,232757) = 26.86
Probability> F			0.0000	0.0000

Notes: Robust standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

The signs for GDPs, populations, distance, remoteness, border, common language, and preferential trade agreement are the same as the PPML estimates and are consistent with theory. Tobit estimation gives a positive sign for the coefficient of colonial links which is in contrast with the results obtained in the PPML.[29]

Let us now look at the coefficients of the variables that we are interested in - the China and Africa specific variables. The results seem to suggest that non-oil exporting African countries actually trade more[30] than other countries with similar characteristics. These results are in contrast to the PPML estimates obtained above but are consistent with the findings of Rodrik (1998) and Coe and Hoffmaister (1999). The authors claim that given the geographic and economic characteristics of the African countries, there is no evidence that Africa is marginalized from world trade. An oil exporting country, on the other hand, seems to be marginalized from world trade for both exports and imports (39 and 33 percent lower volumes, respectively). These results seem counter-intuitive to the evidence that most of Africa's trade (especially exports) are accounted for by the resource-rich countries. This seems suggestive of the fact that a Tobit estimator may not

[29] These variables are not of primary concern for this paper. Hence, I have not included a comparison of the coefficients of these variables for the Tobit and PPML specification.

[30] Imports are higher by approximately 26 percent. The coefficient for exports is not significantly different from zero.

be suitable in this context. If we look at the intra-regional trade in Africa, the Tobit specification is consistent with the PPML results that African countries trade more with each other than what would be predicted by the gravity model.[31]

For the period 1990-1999, trade relations with China caused both oil exporting and non-oil exporting countries to export less to other African countries - decline of 96 and 89 percent respectively. These estimates suggest massive volumes of diversion of exports away from the continent to other countries. In contrast to the Poisson pseudo-maximum-likelihood estimates, the impact on imports is positive for both resource-rich and resource-poor countries. For example, the presence of China has led non-oil exporting countries to import more than double of what would be expected from other African countries. This again seems counter-intuitive, given the growing anti-China sentiment among African manufacturers and increasing demands for protection from cheap Chinese goods. The impacts for the post-2000 period are similar to the pre-2000 period, suggesting no significant effects of Chinese aid and investment programs.

These robustness checks show that our estimates are not entirely robust to the choice of estimation technique. However, one must keep in mind that the Tobit estimator has an obvious drawback - it assumes that the factors that determine whether two countries trade or not are the same as the factors that determine what the volume of bilateral trade will be. This may not be the case, given that China's engagement with Africa (in terms of trade, investment or aid) is largely driven by natural resource considerations. Political regimes and other factors may also affect whether a country trades with an African country or not, but these may not affect the volume of trade. Linders and de Groot (2006, p. 5) note that '*it is unclear which optimizing framework would justify negative desired trade, even if caused by randomly distributed factors not explicitly identified in the model. As a consequence, the Tobit model is not the appropriate model to explain why some trade flows are missing.*' Thus, even though the results are quite sensitive to the choice of estimation technique, it seems reasonable to prefer the PPML estimation over the Tobit due to some obvious disadvantages of the latter.

7. LIMITATIONS AND SCOPE FOR FURTHER RESEARCH

As noted by Bergstand (1989) and Anderson (1979), the gravity model estimation of bilateral trade lacks strong theoretical foundations as it is not based on optimization behavior of economic agents. Efforts have been made to improve the theoretical foundations but it is still far from adequate. This leads us to the first limitation of this study. However, one must also keep in mind that the gravity model has performed quite well in empirically explaining bilateral trade volumes, and given the aim of this study - to understand whether Chinese intervention has distorted patterns of intra-regional trade

[31] The results are significant only for exports.

in Africa - a gravity model framework seems to be the most suitable.

Second, the results are sensitive to the choice of estimation technique. But as argued in Section 5, PPML estimation has several advantages over other techniques (particularly with regard to problems of zero trade flows and heteroskedasticity) and seems the most reasonable approach for estimating the traditional gravity model.

The paper explores the impact of 'Chinese presence' on patterns of trade - that is whether a country has trade relations with China in a given year or not. It does not look at the intensity of the Chinese engagement. This leads us to the main limitation of this study - it only looks at the extensive margin of Chinese engagement. However, since most of China's trade and investment is concentrated in resource-rich countries, the inclusion of a dummy for oil exporter and its interaction with a Chinese presence dummy could successfully provide an indication of how the (distortions in) trade patterns vary with intensity of Chinese involvement. Similarly, since the rapid growth of Chinese engagement is only a recent phenomenon, the inclusion of a dummy for post-2000 period (with suitable interactive terms) could provide an indication of how the intensity of Chinese involvement affects trade patterns. It must be noted, however, that these will only be imperfect indicators. It would be interesting to study the effects of Chinese presence on patterns of trade of resource-rich countries vis-à-vis the rest of Africa, taking into account the intensity of Chinese engagement (volume of trade, aid and investment as a percentage of GDP etc.). It would also be interesting to study the relative importance of these different channels.

This paper suggests that the key mechanism through which increased Chinese presence may have led to improvements in intra-African trade in the post-2000 period is improvements in infrastructural and administrative capacity. However, this hypothesis could not be tested in the present study due to time constraints. Given more time and resources, I would like to include some measures of infrastructure quality in the country, quality of institutions (as a proxy for administrative capacity) and the amount of Chinese aid and investment allocated to different projects[32] to test these claims.

8. CONCLUSIONS

This paper estimates a modified version of the traditional gravity model to study the effects of Chinese presence in Africa on the intra-regional trade. This study shows that Chinese presence has a negative effect on intra-African trade. That is, African trade is indeed distorted by Chinese involvement in the continent. These distortions are larger for an oil exporting country and are much more evident for imports, supporting the view that cheap imports from China have diverted imports away from other African countries and the preferential tariff treatment awarded to African countries has diverted exports

[32] Aid Data website has data for Chinese aid to Africa at country-year-sector level.

away from African countries to China (and other countries). Over the past decade, however, these distortionary effects have become less negative, especially for the case of exports. This suggests that improvements in infrastructure and other administrative constraints achieved with the help of increasing Chinese investment and 'aid for trade' packages have offset these distortions partly and enabled African countries to trade more with each other. These offsetting effects are quite small at present but one must keep in mind that infrastructure investments are long-term investments and it takes a decade (or possibly more) for them to show their full effects. Thus, one could expect further improvements in intra-regional trade in Africa as higher volumes of Chinese aid and FDI continues to flow into Africa.

African consumers benefit from cheap manufactured goods from China and manufacturers in the natural resource sectors benefit from the growing demands for imports from China. Even though some import-competing sectors have been hurt by China's presence, it seems reasonable to assume that cheaper consumption goods along with investments in infrastructure, capacity building projects and the like have benefitted African countries. However, one must look at not just the *static* effects but also the *dynamic* effects of Chinese engagement.

The analysis shows that the benefits from the involvement of China are being achieved at the expense of lower intra-African trade. As emphasized by the Doha round, growth of intra-African trade is crucial for the development of the continent as whole. Taking this into account, the long term effects of Chinese influence do not seem to be as positive. The African countries need to take advantage of the improvements in infrastructure and institutional capacity to promote intra-Africa trade. Though there have been some positive trends in this direction in the last decade (allowing these countries to benefit from scale economies in production as well), it is very important to ensure that the benefits of Chinese presence are harnessed properly. Policymakers must take steps to ensure that appropriate skills and productive capacity are developed over time that will allow African countries to diversify their export base and to prevent this from becoming yet another story of Dutch Disease.

APPENDIX

1. List of Countries

Albania	Comoros	Honduras	Mongolia	Tanzania
Algeria	Congo, Dem Rep.	Hong Kong, China	Morocco	Thailand
Angola	Congo, Rep.	Hungary	Mozambique	Togo
Argentina	Costa Rica	Iceland	Nepal	Trinidad and Tobago
Australia	Cote d'Ivoire	India	Netherlands	Tunisia
Austria	Cyprus	Indonesia	New Caledonia	Turkey
Bahamas, The	Denmark	Iran, Islamic Rep.	New Zealand	Uganda
Bahrain	Djibouti	Ireland	Nicaragua	United Arab Emirates
Bangladesh	Dominican Rep.	Israel	Niger	United Kingdom
Barbados	Ecuador	Italy	Nigeria	United States
Belize	Egypt, Arab Rep.	Jamaica	Norway	Uruguay
Benin	El Salvador	Japan	Oman	Venezuela
Bhutan	Equatorial Guinea	Jordan	Pakistan	Vietnam
Bolivia	Ethiopia	Kenya	Panama	Yemen
Brazil	Fiji	Kiribati	Papua New Guinea	Zambia
Brunei	Finland	Korea, Rep.	Paraguay	Zimbabwe
Bulgaria	France	Lao PDR	Peru	Russian
Burkina Faso	Gabon	Lebanon	Philippines	Federation
Burundi	Gambia, The	Madagascar	Poland	Rwanda
Cambodia	Germany	Malawi	Portugal	Saudi Arabia
Cameroon	Ghana	Malaysia	Romania	Spain
Canada	Greece	Maldives	Senegal	Sri Lanka
Central African	Guatemala	Mali	Seychelles	St. Kitts and Nevis
Rep.	Guinea	Malta	Sierra Leone	Sudan
Chad	Guinea-Bissau	Mauritania	Singapore	Suriname
Chile	Guyana	Mauritius	Solomon Islands	Sweden
China	Haiti	Mexico	South Africa	Switzerland
Colombia				Syrian Arab Rep.

2. Calculations for the Effect of Chinese Presence (Pre-2000 and Post-2000)

The gravity equation estimated in the paper can be written as follows:

$$T_{ijt} = \delta X_{ijt} + \beta_1 D_1 + \beta_2 D_1 D_2 + \beta_3 D_3 + \beta_4 D_3 D_4 + \beta_5 D_3 D_4 D_5 + \beta_6 D_3 D_4 D_2 + \beta_7 D_3 D_4 D_5 D_2,$$

where,

X_{ijt} includes the variables described in Equation (1),

$D_1 = 1$ if reporter is African,

$D_2 = 1$ if reporter is oil exporter,

$D_3 = 1$ if both countries are African,

$D_4 = 1$ if either country traded with China,

$D_5 =$ if year ≥ 2000 .

Impact of Chinese presence on bilateral trade:

$$\frac{\partial T_{ij}}{\partial D_4} = \beta_4 D_3 + \beta_5 D_3 D_5 + \beta_6 D_3 D_2 + \beta_7 D_3 D_5 D_2 .$$

Impact of Chinese presence on intra-African trade:

$$\left(\frac{\partial T_{ij}}{\partial D_4} \middle| D_3 = 1 \right) = \beta_4 + \beta_5 D_5 + \beta_6 D_2 + \beta_7 D_5 D_2 .$$

Impact of Chinese presence on intra-African trade (pre-2000):

$$\left(\frac{\partial T_{ij}}{\partial D_4} \middle| D_3 = 1, D_5 = 0 \right) = \beta_4 + \beta_6 D_2 .$$

Impact of Chinese presence on intra-African trade (post-2000):

$$\left(\frac{\partial T_{ij}}{\partial D_4} \middle| D_3 = 1, D_5 = 1 \right) = \beta_4 + \beta_5 + \beta_6 D_2 + \beta_7 D_2 .$$

The following table summarizes the coefficients we are interested in:

	Pre-2000	Post-2000
Oil Exporter	$\beta_4 + \beta_6$	$\beta_4 + \beta_5 + \beta_6 + \beta_7$
Non-Oil Exporter	β_4	$\beta_4 + \beta_5$

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