An Empirical Analysis of the Africa-China Trade Puzzle: The Role of China's Trade Policies*

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Abstract

In the past two decades, China has maintained a high rate of economic growth. At the same time, we observe a rapid growth in the African export flows to China, even faster than those to the US and EU. We argue that the remarkable export expansion cannot be solely explained by China's rapid growing economy relative to the US and EU. By comparing the predicted trade pattern based on gravity model with the actual trade flows, we confirm the limited role of economic growth in explaining the rise in Africa-China trade flows, which is referred as the "Africa-China trade puzzle". In an attempt to explain the puzzle, we highlight the importance of China's preferential trade policies in promoting Africa-China trade flows.

Keywords: Africa-China Trade, Gravity Model, Zero-Inflate Poisson Regression, Trade Policies

JEL Classification: F13, F14, O24,

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1 Introduction

Since the Chinese economic reform in 1978, and especially after the end of the Cold War, China's economy has been growing rapidly. After joining the World Trade Organization (WTO), international trade entailed China to build closer ties with the rest of the world. Through trade, financial flows and aid, China expanded its global presence, especially to Africa. Meanwhile, African countries were willing to welcome China's move. Therefore, we observe a closer Africa-China relation and surging bilateral trade flows accordingly. In this paper, we are particularly interested in explaining the Africa-China trade dynamics in the past two decades.

China's fast economic growth since 1990s impresses the world. It is believed to be a main reason for the sharp rise of African exports to China. While, it seems that China's outstanding economic performance relative to the rest of the world cannot fully explain its striking surge of imports from Africa. The literature regarding Africa-China cooperation give hints that the trade policies designed by the Chinese government seem to be the hidden drivers for the surging trade dynamics (Zafar, 2007; Besada et al., 2008; De Grauwe et al., 2012). Naturally, we propose the conjecture that, on top of the China's rapid economic evolution, its favorable trade policies also contribute to the surging African exports to China. To testify the conjecture, we describe the general trade pattern by estimating a gravity model of a large sample consisting of 28 African exporters and 181 importers in 1990–2000. A comparison of the predicted export flows based on the estimated trade pattern for 2001–2010 with the actual flows confirms that solely gross domestic product (GDP) cannot thoroughly explain the large amount of Africa-China trade. We define the phenomenon as the "Africa-China trade puzzle", that the soaring Africa exports to China cannot be fully explained by China's fast growth. To further explore the puzzle, we include trade policy variables. The regression confirms that trade policies would to some extent be responsible for the surging trade flows.

This paper contributes to the literature in the following aspects: First, our paper adds to the scant literature that systematically and empirically analyze the Africa-China trade. Second, we find the Africa-China trade puzzle that China's fast development cannot fully explain the its soaring imports from Africa. Third, we quantitatively evaluate the role of China's trade policy in promoting trade.

The remainder of this paper is organized as follows. Section 2 reviews historical back-

ground and the trends in Africa-China trade relation. Section 3 reviews the methods and findings in the previous literature. Section 4 sets out the empirical methodology employed in this analysis. Section 5 presents our data sources and the descriptive summaries of the explanatory variables. Section 6 presents the estimated trade pattern from a general gravity model using Zero-Inflated Poisson regression. Section 7 compares the predicted exports with the actual ones and justifies the puzzle. Section 8 further discusses policy variables in a modified gravity model and tentatively explains the Africa-China trade puzzle. Finally, section 9 concludes the paper.

2 Historical Background and Stylized Facts

According to the Chinese historical records and archaeological discoveries in Egypt, the trade relation between China and Africa dates back to two thousand years ago (Gao, 1984). Through the famous "Silk Road", Chinese silk yarn and metal pots stretched across Central Asia and finally arrived in Egypt. Meanwhile, African products, such as elephant tusks, rhinoceros horn and incense, also found their way to China (Gao, 1984; Li, 2009). In the following centuries, along with the development of seamanship techniques and shipbuilding industry, ships were employed in the Africa-China merchant trade. Most Chinese products were shipped to the Middle East and then transported to Eastern Africa (Gao, 1984; Rotberg, 2008). In the Ming dynasty (A.D. 1368-1644), Chinese ships directly reached the Eastern Africa for the first time. The great Chinese navigator, Zheng He, set out three large-scale expeditions to not only Egypt, but also Somalia and Kenya. Gold, silk and porcelain were exchanged with local African products (Rotberg, 2008). Unfortunately, the Africa-China relation cooled down suddenly due to the change of China's dynasty. Unlike the Ming dynasty, the Ching dynasty (A.D.1644-1911) adopted a closed-door policy with regard to foreign relations, which cut down most China's trade association with other continents, including Africa (Gao, 1984). In the final phase of the Ching dynasty and the following half century, China had been suffering from the aggressive wars and civil wars. Thus, the relations between China and Africa were negligible during that period.

Since the foundation of the People's Republic of China (PRC) in 1949, the Africa-China relations became thriving again. The history of the modern Africa-China interaction could be divided into three periods. The first period starts from 1949 and ends before China's

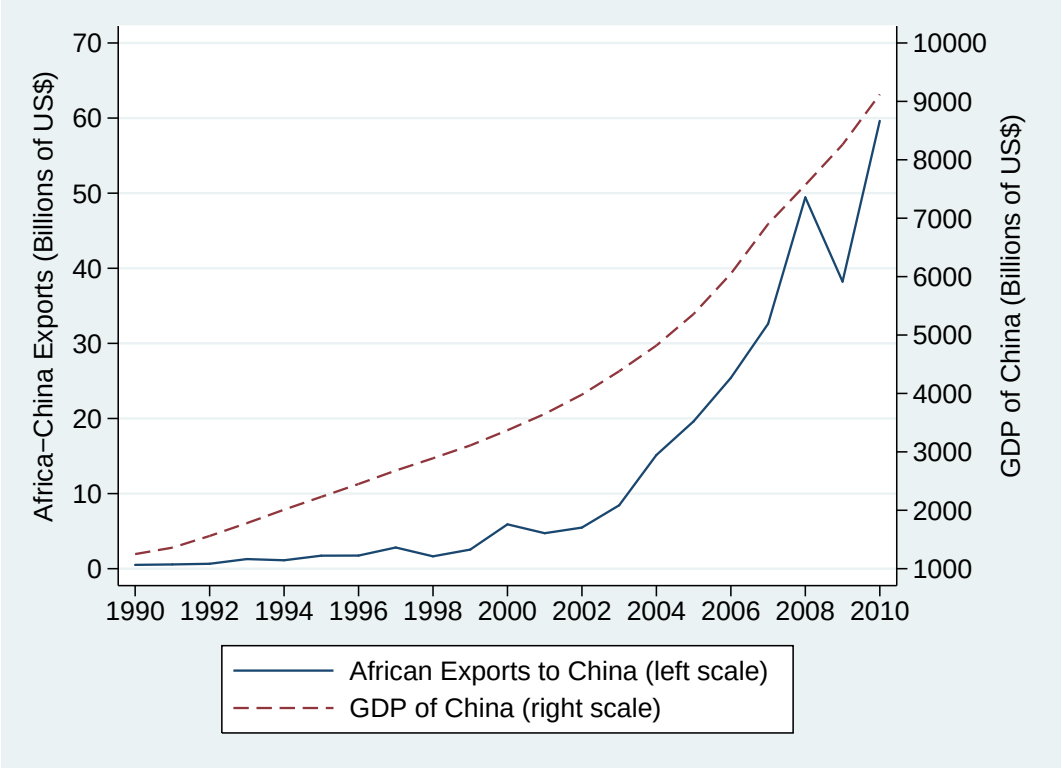
economic reform in 1978. During this post-colonial period, China established diplomatic relations with the independent African countries. Although bilateral trade was small, China kept granting unilateral economic assistance to those politically intimate African countries in fields of agriculture and infrastructure (Alden, 2009). China-Africa relations basically reflected China's ideological considerations and its foreign policy. The second period (1978–1989) starts from the beginning of China's reform until the end of the Cold War. Due to the stagnant domestic economy ruined by the Cultural Revolution (1966–1976), China dramatically shifted its focus to its domestic economy and cut down the volume of foreign aid. The third period starts in the early 1990s to present. During a visit to Africa in 1996, the Chinese previous president Jiang Zemin officially emphasized the importance of economic relations based on non-ideological footing between China and Africa. As a crucial platform for the Africa-China cooperation, the Forum on China-Africa Cooperation (henceforth, FOCAC) had been established in 2000 and hosts the ministerial conference every three years. In 2006, the Chinese government announced eight policies to support its economic activities with Africa, including encouraging investment, expanding the number of duty-free import products and establishing economic and trade cooperation zones, has been considered as a milestone for the Africa-China relation. In the same year, the Chinese government issued the "China's policies for Africa" to highlight the cooperation with African countries in economic fields, especially in trade and investment. All of these policies are expected to expand the breadth and depth of the cooperation between Africa and China. In the following, we briefly review the Africa-China trade relation.

During the past two decades, the magnificent economic growth of China has been widely acknowledged. Meanwhile, its fast development benefited its trading partners as well. Figure 3 exhibits China's fast economic growth and its imports from Africa. On the one hand, China has maintained an annual growth rate at 9.9 percent[1]. On the other hand, China has become the second largest export market for Africa. There is an apparently increasing trend in export values from Africa to China since 1990, especially since 2002. In 1990, China only accounted for 0.4 percent of African total exports. By 2010, this share increased to 12.9 percent[2]. The value of African exports to China rose from close to zero in early 1990s to around 60 billion

[1]The compound annual growth rate=$(\frac{GDP_{2010}}{GDP_{1990}})^{\frac{1}{2010-1990}} - 1$. Source: World Development Indicators 2012 (GDP, PPP (constant 2005 international $)).

[2]Source: The *UN Comtrade* database.

Figure 1: China's GDP and imports from Africa (1990-2010)



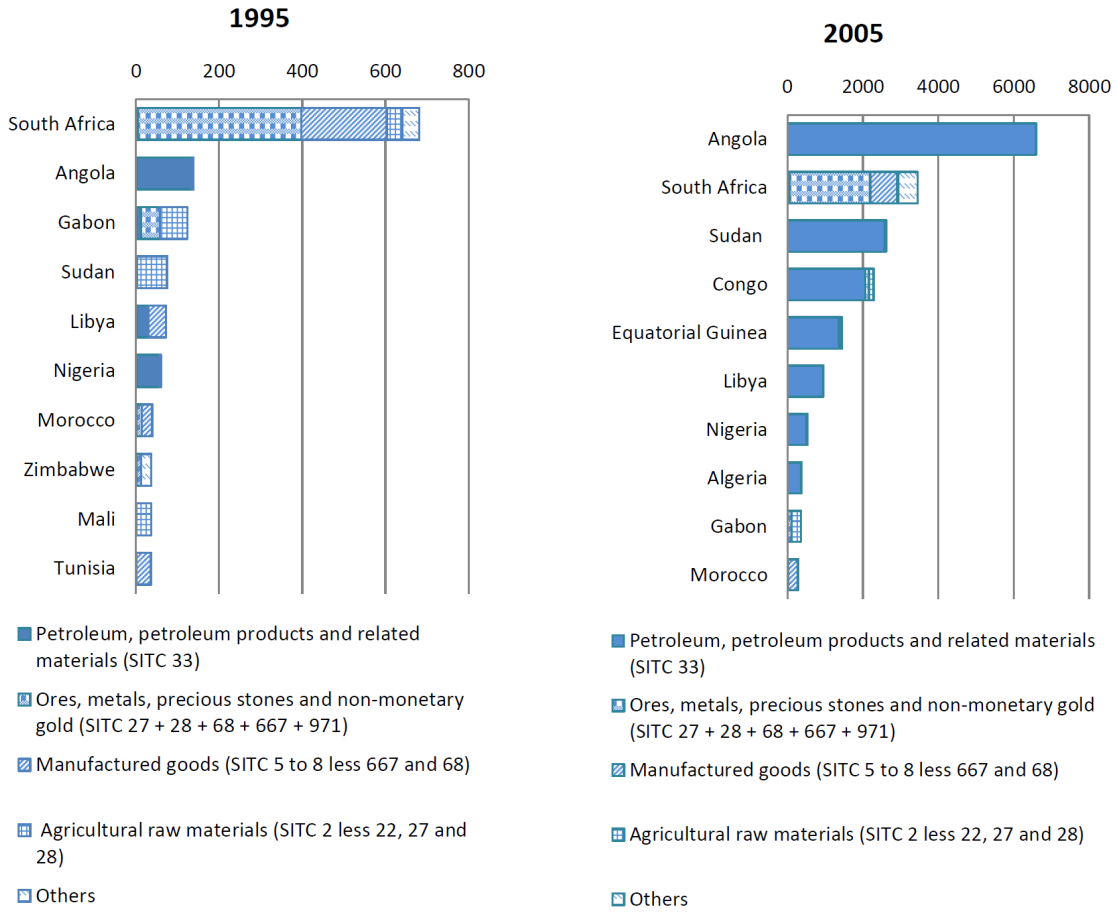
Source: The *UN Comtrade* database and World Development Indicators 2012 (GDP, PPP (constant 2005 international $)). The African exports to China has been adjusted by the US deflator (base year 2005).

US dollar in 2010. Though temporarily affected by the economic crisis in 2009, the African exports to China bounced back in 2010.

Figure 2 decomposes China's main African trading partners by export flows and by products in different periods. Though China has traded with most African countries (about 50 countries) since the 1990s, African exporters are heavily concentrated in a few oil-exporting and mineral-exporting countries. In 1995, the top 10 African exporters accounted for 91 percent of total African exports to China. South Africa ranked the largest one, which accounted for approximately half of the total African exports to China[3], of which metals and manufactured goods were the export primary products. The rest of the important exporters were oil-exporting countries (Angola, Libya and Nigeria) and agricultural producers (Gabon and Sudan). In 2010, the top 10 African exporters still played a decisive role in African

[3]Source: The *UNCTAD database*.

Figure 2: The top 10 African Exporters to China: by Country and Product (1995 & 2005)



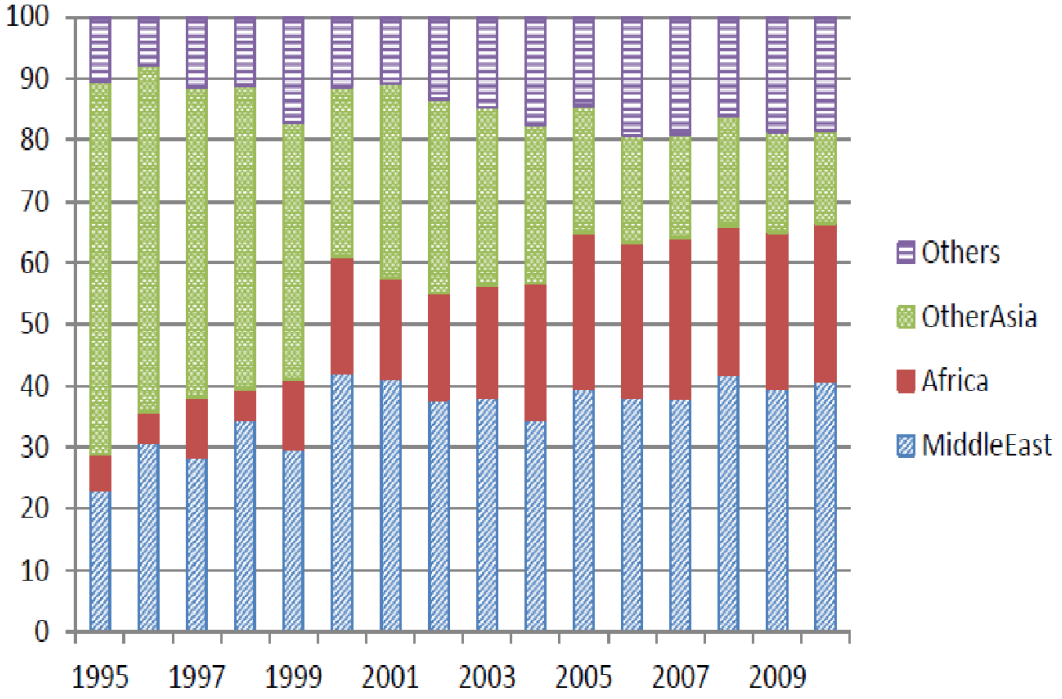
Source: The *UN Comtrade* database. The horizonal axis denotes the value of exports in unit of millions USD

exports to China (about 89 percent). Angola took over the position of the largest exporter and South Africa switched to the second position. Oil exporters (Angola, Sudan, Congo, Equatorial Guinea, Libya, Nigeria and Algeria) accounted for the majority of the Top 10 list. Oil became the chief product that Africa exported to China, accounting for roughly 70 percent of total African export flows.

Figure 3 exhibits the share of different sources of China's oil imports from 1995 to 2010. Initially, the OtherAsia was the main oil supplier for China, which accounted for more than a half of total Chinese oil imports[4]. Since the turning point in year 2000, the share of oil imports from the OtherAsia has declined from 28 to 15 percent. By contrast, the share of oil imports from the MiddleEast to China had increased from 23 percent in 1995 to 42 percent

[4]The OtherAsia refers to all Asian countries excluding China and the Middle East countries.

Figure 3: The share of oil imports for China (1995-2010)



Source: The *UNCTAD* database. SITC 33: Petroleum, Petroleum product and related materials.

in 2000 and been fluctuating around 40 percent in the past ten years[5]. Moreover, the share of oil imports from Africa increased markedly from 6 percent in 1995 to 26 percent in 2010, making Africa the second largest oil supplier for China in the past decade.

3 Literature

Since being proposed by Tinbergen (1962), the gravity model has become a workhorse model in empirical analysis of international trade. Despite its success in empirical applications, the theoretical foundation of the gravity model has been subject to disputes and has being elaborated gradually. Anderson (1979) made the first attempt to derive the gravity equation from a theoretical framework. Under the assumptions of complete specialization and homothetic preferences, the gravity equation is derived from an expenditure system. Since then, the literature on the theoretical foundation of the gravity model began booming.

[5]According to CIA World Factbook, the MiddleEast includes 19 countries, namely, Armenia, Azerbaijan, Bahrain, Gaza Strip, Georgia, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, West Bank and Yemen.

Generally, the gravity equation could be derived from the Heckscher-Ohlin (H-O) model, the increasing return to scale (IRS) model and the Ricardian model. The H-O model predicts that the relative factor abundance determines international trade. However, this theory is challenged by the Leontief Paradox (Leontief, 1954) [6]. Helpman and Krugman (1985) assert that the Heckscher-Ohlin model could only explain inter-industry trade. They incorporate monopolistic competition and increasing return to scale to assess intra-industry trade. Bergstrand (1985) applies the model of differential goods to derive the gravity equation. Helpman (1987) and Hummels and Levinsohn (1995) test the gravity equation version of the IRS model. Deardorff (1998) reconciles the two arguments and claim that the basic version of gravity model could be derived from both the H-O model and Helpman-Krugman approach. Recently, based on differences of technology, Eaton and Kortum (2001) develop a Ricardian model which delivers a structural version of gravity model.

Beyond the basic version of gravity equation of economic size and distance, additional variables are widely discussed theoretically and empirically in the literature. Rauch (1999) argues that colonial ties are important for differential products in the view of search and matching. Head et al. (2010) discuss the role of colonial ties in international trade, especially the effect of independence on trade in the post-colonial era. Foroutan and Pritchett (1993) present an empirical evidence that sharing a common language can increase trade by promoting communication. Melitz (2008) explores the channels through which a common language affects international trade. Anderson and Macrouiller (2002) find that strong institutions, especially characterized as effective contract enforcement and good protection of property, would encourage trade. Rose and van Wincoop (2001) argue that national money is a significant barrier to trade. Glick and Rose (2002) also find that common currency matters; countries which leave currency unions would experience a significant decline in international trade. The effect of regional trade agreement on trade flows has been studied since Viner (1950) distinguishes the trade creation effect and trade diversion effect. For a detailed discussion, see Soloaga and Winters (2001), Magee (2008). McCallum (1995), Helliwell (1996) and Anderson and van Wincoop (2003) estimate the effect of common border on bilateral trade. Limao and Venables (2001), Raballand (2003) pay specific attention to the impact of

[6] According to the prediction of the H-O model, as the most capital-abundant country in the world, US is expected to export capital-intensive products and import labor-intensive products. However, Leontief found empirical evidence of an opposite trade pattern for US, contradictory to the H-O model. This is called the Leontief Paradox.

being landlocked on trade.

Apart from the conventional literature on gravity equation, let us turn to the specific literature on the Africa-China relation. As the political and business connections between Africa and China are becoming closer and tighter, scholars and policymakers are paying more attention to China's move to Africa.

China's outward FDI, trade and aid are often analyzed in an integral framework (Wang, 2007; Besada et al. 2008). These three channels are believed to interact with one another (Kaplinsky et al, 2006). Biggeri and Sanllippo (2009) make the first empirical attempt to evaluate the interactions of the above-mentioned channels. They find that China's engagement in Africa is pushed by these interactions and pulled by resources endowment and market potentials of the African countries. Cheung et al. (2012) find that China's outward FDI in Africa is affected by trade ties as well as aid. Broadman (2007) concludes China's growing trade and outward FDI in Africa are mutually reinforcing. Markusen and Maskus (2002) use a theoretical model to justify that if the origin and destination countries are dissimilar in terms of relative factor endowment and size, then vertical FDI stimulates international trade. FDI from the origin countries can activate some specific under-used comparative advantage in destination countries and in return increase the exports from FDI host countries to origin countries (Zarotiadis, 2008). China and African countries have definitely different country sizes and relative factor endowment. Renard (2011) emphasizes that Chinese outward FDI has helped African countries building local capacity, transferring technology and raising exports. Large amounts of Chinese overseas investment flowing into natural resource sectors entailed a prospering resource extracting sector in Africa and promoting resource exports, benefiting both Africa and China.

Zafar (2007) and Besada et al. (2008) assess the effect of China's trade liberalization on its trade relations with Africa. Setting a duty-free import list for the least developed countries and reducing average tariff are expected to promote African exports to China. Minson (2008) find that China's preferential trade policies tend to facilitate Africa's export capacities, though the effects are modest. Berthelemy (2011) discusses the progress of the Economic and Trade Cooperation Zones (henceforth, ETCZs) in Africa.

The resource-seeking motive for China to involve in Africa has been discussed far and wide. Ademola et al. (2009) argue that China's rapid industrialization increases the demand

for natural resources. Besada et al. (2008) add that the stagnant domestic output of natural resources further urges China's move to resource rich African countries. Renard (2011) summarizes that China's imports and outward FDI are highly concentrated and dominated by a few resource-abundant countries.

Some authors are concerned with China's attitude towards the quality of African governance. Anderson and Marcouiller (2002) investigate the relation between trade and quality of governance and argue high quality of governance would reduce transaction costs and boost trade. By comparing China with Africa's Western trading partners, De Grauwe et al. (2012) find that China was the unique one which trades with poorly governed African countries. Renard (2011) claims that China, unlike Western countries, makes a distinction between business and politics in its engagement in Africa.

4 Empirical Methodology

Based on the stylized facts we observe and the previous literature, the following conjecture arises:

Conjecture: *Even we take into account China's fast economic growth, the soaring African export flows to China is still remarkable. The growing Chinese economy relative to the rest of the world cannot fully explain the story of China's rapidly increasing imports from Africa. We call it the "Africa-China trade puzzle".*

To test and explain the conjecture, we take the following methods. First, to assess the role of China's economic growth in explaining the Africa-China trade relation, we rely on the gravity equation. Using data in the first decade (1990–2000), we estimate the general trade pattern, which features the role of output, transportation costs and other institutional factors in determining the trade flows. Second, we employ the estimated trade pattern with data in the second decade (2001–2010) to predict the trade flows in the later ten years. The comparison of the predicted value of trade flows with the actual ones attempts to testify our conjecture. Third, if the conjecture is justified, we explore the puzzle by including China's preferential trade policies. This tentative attempt might better explain the Africa-China trade flows.

4.1 The Standard Gravity Model and Estimation Methods

In this section, we adopt the following specification of the gravity equation:

$$\begin{aligned} LnT_{ijt} =& \beta_1 LnGDP_{it} + \beta_2 LnGDP_{jt} + \beta_3 LnDist + \gamma_1 LnGDPpc_{it} + \gamma_2 LnGDPpc_{jt} + \boldsymbol{\alpha}' \mathbf{W}_{ij} \\ &+ \phi_j + \varepsilon_{ijt}, \end{aligned} \tag{1}$$

where T_{ijt} denotes the value of export flows from country i to country j in year t, GDP_{it} and GDP_{jt} are the national incomes measured by GDP, for country i and j in year t, respectively, $Dist$ denotes the time-invariant geographical distance between country i and j. In the basic version of the gravity model in Tinbergen (1962), the amount of trade is supposed to be increasing in the economic size of trading partners, measure by GDP_{it} and GDP_{jt}, and decreasing in the cost of transport, proxied by $Dist$. In this sense, the coefficients β_1 and β_2 are expected to be positive while the coefficient β_3 is expected to be negative. In the augmented gravity model, income per capita of both countries are included as additional measures of economic size. Here, $GDPpc_{it}$ and $GDPpc_{jt}$ denote GDP per capita for country i and j in year t, respectively. According to Bergstrand (1989), the coefficients γ_1 and γ_2 are expected to be positive. The vector $\mathbf{W}_{ij}$=($Colonial\ Ties$, $Language$, $Legal$, $Currency\ Union$, RTA, $Common\ Border$, $Landlocked_{origin}$, $Landlocked_{destination}$) contains other country-pair characteristics widely discussed in previous literature, where $Colonial\ Ties$ is a dummy variable taking value of 1 when there is colonial relationship between country i and j and zero otherwise, $Language$ is a dummy variable taking value of 1 when both country i and j share a common official and primary languages and zero otherwise, $Legal$ is a dummy variable taking value of 1 when both country i and j share a common legal origin and zero otherwise, $Currency\ Union$ is a dummy variable taking value of 1 when both countries belong to the same currency union and zero otherwise, RTA is a dummy variable taking value of 1 when both country i and j are under the same Regional Trade Agreement and zero otherwise, $Common\ Border$ is a dummy variable taking value of 1 when both countries share a common border and zero otherwise, $Landlocked_{origin}$ ($Landlocked_{destination}$) is dummy variable taking value of 1 when country of trade $origin$ ($destination$) is landlocked and zero otherwise. Anderson and van Wincoop (2003) and Mátyás (1997) suggest the inclusion of exporters and

importers fixed effects. To reduce the calculation burden, we adopt region fixed effects for both exporters and importers, respectively[7]. Since all African exporters belong to one region, the exporters fixed effect becomes degenerate. Therefore, we include only importers fixed effects ϕ_j. The parameter ε_{ijt} is an error term.

When making an attempt to estimate the aforementioned gravity model, we are confronting several econometric challenges: heteroscedasticity in the error term, zero value of dependent variable in the log-linear model, and the so-called "excess zero" problem.

Santos Silva and Tenreyro (2006) emphasize the inconsistency problem in estimating the log-linear form of the gravity model caused by the heteroscedasticity in the error term. They find evidence that the error term in the log-linear fashion of the gravity model is heteroscedastic and its variance depends on other regressors. As a consequence, the ordinary least square (OLS) estimation leads to inconsistent estimates of coefficients of interest.

Moreover, Santos Silva and Tenreyro (2006) analyze three possibilities for zero trade value in certain country pairs. First, some country pairs do not trade at all in a given period. For instance, it is not surprising to observe no trade between Chad and the Bahamas in 1990. In this case, the log-linear specification of gravity model per se is not well-defined. Second, rounding errors might generate zeros. In particular, the value of exports from small or poor countries could be so small that it sometimes cannot reach the minimal value of unit of measurement. Consequently, these values are automatically and literally recorded as zero in the dataset. These rounding errors, often occur for small and poor countries, relying on country characteristics and lead to inconsistent estimates. Third, zeros might be the result of measurement error. It is possible that when trade data are collected and compiled , some missing values are incorrectly recorded as zeros. This measurement error leads to selection bias and inconsistent estimates.

In addition, the fact that a considerable proportion of country pairs do not trade with one another leads to the 'excess zero' problem. Helpman et al. (2008) confirm that half of the country pairs never trade in a set of 158 countries. One common approach in the previous studies is to simply drop zero-trade country pairs from the dataset (Frankel, 1997; Anderson and van Wincoop, 2003). Helpman et al. (2008) argue that disregarding zero-trade country pairs would produce biased estimates and insufficiently exploit the information in the dataset

[7]All countries are grouped into eight regions: EU, US, China, Asia excluding China, South America, Oceania, Africa, and the other countries.

of both trading and nontrading country pairs. Other approaches, for instance, estimating the gravity model using $ln(T_{ijt} + 1)$ as the dependent variable, or employing Tobit regressions, generally lead to inconsistent estimates of coefficients (Santos Silva and Tenreyro, 2006).

To cope with the zero entries, Razin and Sadka (2007) compare the Heckman selection model with the Tobit model and conclude that the Heckman method is superior to the Tobit and OLS approaches because of its unbiased estimates. In line with the analysis of sample selection, Helpman et al. (2008) propose a two-step estimation procedure. In the first step, they estimate a Probit model which specifies the trade probability as a function of right-hand side variables in the gravity model. Based on the predicted probability, they estimate the log-linear form of the gravity model in the second step. They argue that the procedure corrects for the selection bias and ensures the consistency of parameters of interest. One drawback of this approach is its requirement for an excluded variable for identification in the second stage, which is difficult to find. Moreover, Santos Silva and Tenreyro (2006) argue that NLS estimation can be inefficient in presence of heteroscedasticity. They prefer the Poisson Pseudo-Maximum-Likelihood estimator (PPML), which is consistent if the conditional mean is in correct specifications. This is not a restrictive method since data need not be Poisson distributed and dependent variables need not be integers to obtain consistent estimates (Gourieroux et al., 1984). Garita and van Marrewijk (2008) and Brakman et al. (2008) use the two-step procedure of Zero-Inflated Negative Binomial regression (ZINB) based on the zero-inflated approach which was originally proposed to handle data with excess zeros by Lambert (1992). This approach assumes two zero-generating processes and two latent groups of observations. An observation in the passive group has the value of zero with probability of 1 while an observation in the active group has a positive probability to have non-zero value. They adopt a logistic regression to model M&A selection in the first stage and a negative binomial regression to model M&A flows in the second stage.

To estimate the general trade pattern in the first decade, by combine Helpman et al.'s two-step procedure with Santos Silva and Tenreyro's Poisson regression, we adopt the Zero-Inflated Poisson regression (ZIP) in this paper. Though Zero-Inflated Negative Binomial regression (ZINB) is an alternative method used in literature, it is particularly targeted at count data. The ZIP is applicable for non-count data, such as the trade value analyzed in this paper. The Vuong (1989) test favors the ZIP model as well. In general, the approach

of the Zero-Inflated Poisson regression (ZIP) has the following merits. First and foremost, it provides consistent estimates of the coefficients of interest in the gravity model, correcting for sample selection bias and heteroscedasticity in the trade data. Second, it applies even when the trade data do not follow a Poisson distribution and the dependent variables are positive but non-count data.

The estimation is developed in two stages. In the first step, as the latent group membership is not directly observable, we estimate a Logit regression which models the group membership as a function of the observed characteristics in equation (1).

$$Passive_{ijt} = \begin{cases} 1 & \text{if } T_{ijt} = 0 \\ 0 & \text{if } T_{ijt} > 0 \end{cases}, \tag{2}$$

where the binary variable $Passive_{ijt}$ is an indicator of membership for country pair ij in the Passive Group in year t ($Passive_{ijt} = 1$) or in the Active Group in year t ($Passive_{ijt} = 0$). By definition, the trade value for a country pair in the Passive Group is always zero. While for a country pair in the Active Group, the trade value is likely to be positive, though the probability of being zero is positive. In the second step, we run a Poisson regression using the PPML estimator as in Santos Silva and Tenreyro (2006) for observations in the active group only. The value of exports has been modeled as a function of the observed characteristics in the first stage[8]. Equation (3) executes the PPML estimation with error term ϵ_{ijt}.

$$\begin{aligned} T_{ijt} =& exp[\beta_1 LnGDP_{it} + \beta_2 LnGDP_{jt} + \beta_3 LnDist + \gamma_1 LnGDPpc_{it} + \gamma_2 LnGDPpc_{jt} + \boldsymbol{\alpha'}\mathbf{W_{ij}} \\ & + \phi_j]\epsilon_{ijt}, \ \text{ if } \ Passive_{ijt} = 0 \end{aligned} \tag{3}$$

4.2 The Comparison of Predicted Pattern with the Real World

Given the estimated coefficients of the Active Group in the standard gravity equation during 1990–2000 in section 4.1, combined with the known value of each explanatory variable in equation (3) during 2001–2010, we calculate the predicted values of African export flows to its major trading partners, EU27[9], US, China and the rest of the world as a whole (ROW)

[8]Though the observed characteristics in the first and second stage need not be the same, we use the same observed characteristics as in equation (1) for fear of omitted variable bias.

[9]As of 2007, the European Union is composed of 27 sovereign member states.

in the later ten years, according to the following equation:

$$\begin{aligned}\hat{T}_{ijt} &= E(T_{ijt}) \\ &= exp[\hat{\beta}_1 LnGDP_{it} + \hat{\beta}_2 LnGDP_{jt} + \hat{\beta}_3 LnDist + \hat{\gamma}_1 LnGDPpc_{it} + \hat{\gamma}_2 LnGDPpc_{jt} + \boldsymbol{\hat{\alpha}'W_{ij}} \\ &\quad + \phi_j]\end{aligned} \tag{4}$$

where $\hat{T}_{ijt}$ denotes the projected trade values for country pair ij in year t, $t = 2001, \cdots, 2010$ for all explanatory variables, and $\hat{\beta}_1$ to $\boldsymbol{\hat{\alpha}}$ are the estimated coefficients of the Active Group in the first decade. [10] Availability of the values of export flows in the second decade enables us to further compare the projected export values with the actual ones by calculating the percent deviation, defined as:

$$\begin{aligned}Percent\ \ Deviation =& \frac{T_{ijt} - \hat{T}_{ijt}}{\hat{T}_{ijt}} \times 100\% \\ =& \frac{Actual\ \ Exports - Predicted\ \ Exports}{Predicted\ \ Exports} \times 100\%\end{aligned} \tag{5}$$

where $t = 2001, \cdots, 2010$. This term assesses the prediction power of the standard gravity model and essentially the role of China's economic development, since it quantitatively presents the deviation of the actual African exports from its corresponding predicted values. A significant deviation from the forecasted trade pattern would cast doubts on the accuracy of the standard gravity model and justify the puzzle that solely China's economic growth cannot plot the whole picture of the Africa-China trade.

4.3 The Modified Model with Trade Policies

If the empirical results reveal a significant underestimation in Africa-China trade pattern, compared with other trade relations, then the conjecture is justified. To better understand the Africa-China trade puzzle, we modify the standard gravity model by integrating China's specific trade policies with African resources. In general, we assess the role of China's five trade

[10] A rationale to adopt a Poisson regression instead of the OLS on the log-linear specification of the gravity equation is to circumvent the problem of the Jensen's inequality which indicates $E(lny \neq lnE(y))$. Put differently, Poisson regressions guarantee the consistency of the expectation of the predicted value of export flows.

policies[11]. First, China's outward FDI in Africa is expected to have an influence on African exports to China. Second, China is speeding up the pace of trade liberalization by getting rid of trade barriers. We are concerned with the impact of duty-free list on promoting African exports. Third, the Economic and Trade Cooperation Zones are established to expand trade flows. Fourth, China's *business and politics separation policy* might explain China's large number of imports from African countries with bad governance. Finally, we take into account China's resource-seeking motive embedded in trade policies.

We estimate the following equation that combines output and trade policies in an integral framework:

$$\begin{aligned} T_{ijt} =& exp[\eta_1 LnGDP_{it} + \eta_2 LnGDP_{jt} + \eta_3 LnDist + \eta_4 Landlocked_i + \delta_1 LnFDI_{i(t-1)} \\ &+ \delta_2 DF_{it} + \delta_3 Detcz_{it} + \delta_4 RL_{it} + \delta_5 CC_{it} + \delta_6 Doil_{i(t-1)} + \delta_7 Dmineral_{i(t-1)} + \phi_i]\zeta_{ijt}, \end{aligned} \tag{6}$$

where i refers to African country i, j refers to the unique export destination, China, and $t = 2004, \cdots, 2010$[12]. ϕ_i is the individual unobserved effect for African country i. The vector $\boldsymbol{\eta} = [\eta_1, \cdots, \eta_4]$ measures the effects of the traditional gravity variables, especially the economic size. While the vector $\boldsymbol{\delta} = [\delta_1, \cdots, \delta_7]$ evaluates the effects of the added policy variables.

During the period of 2004–2010, China traded with every African countries in our sample. Therefore, the two-stage estimation procedure seems unnecessary and we only estimate the second step. Because the White test shows that heteroscedasticity is still present, we prefer a Poisson regression. To control for unobserved heterogeneity, we employ a fixed effect Poisson regression. The fixed effect estimator manages the unobserved heterogeneity that is allowed to be correlated with all regressors [13]. To avoid the problem of endogeneity, we lag the FDI variable by one period.

Compared with the standard gravity model in section 4.1, we omit several dummy variables, because China shares no colonial ties, no common languages, no legal origins, no common currencies, no regional trade agreements, no common borders with African countries.

[11]Though aid is treated as an important factor in explaining trade, we cannot incorporate aid in our empirical analysis, restricted by lack of China's aid data.

[12]Limited by data availability of China's outward FDI, we are only able to estimate for the period of 2004–2010

[13]In section 4.1, regional fixed effects capture some unobserved heterogeneity.

Besides, China has access to seas, so the landlocked dummy for China becomes degenerate. Moreover, since China is the unique export destination, we observe a high correlation between China's GDP and its GDP per capita. Due to the perfect collinearity between China's GDP and its GDP per capita, we omit China's GDP per capita (see correlation table A11). For symmetry, we omit GDP per capita of African countries as well. In the end, we retain $LnGDP_{it}$ and $LnGDP_{jt}$ which measure the economic size of the trading partners, and $LnDist$ and $Landlocked_i$ which capture transportation costs.

The newly added trade policy variables are as follows: $LnFDI_{i(t-1)}$ is the logarithm of the stocks of Chinese outward foreign direct investment in African country i. DF_{it} is the share of the value for duty-free goods in total exports from African country i to China in year t. This indicator captures the effect of diminishing trade barriers. $Detcz_{it}$ is a dummy variable taking value 1 when China establishes an Economic and Trade Cooperation Zone (ETCZ) in country i in year t and zero otherwise. We take into account the quality of governance of African countries. RL_{it} is the indicator of rule of law for country i in year t and CC_{it} is the indicator of control of corruption for country i in year t (see section 5 for detailed information). As to the resource seeking motive, we incorporate African resource endowments. $Doil_{i(t-1)}$ is a dummy variable taking value 1 if country i is deemed as being abundant in oil resources. $Dmineral_{i(t-1)}$ is a dummy variable taking value 1 if country i is deemed as being abundant in mineral resources.

In order to evaluate the contribution of the newly included trade policy variables, we also estimate the corresponding gravity model for Africa-China trade relation as follows:

$$T_{ijt} = exp[\eta_1 LnGDP_{it} + \eta_2 LnGDP_{jt} + \eta_3 LnDist + \eta_4 Landlocked_i + \phi_i]\nu_{ijt}, \tag{7}$$

Since equation (6) and equation (7) are nested models, we are able to compare Pseduo R^2s and conduct a likelihood ratio test. Alternatively, to correct the effect of GDP, we reestimate a corrected version of equation (6) as follows:

$$\begin{aligned}\tilde{T}_{ijt} =& exp[\eta_3 LnDist + \eta_4 Landlocked_i + \delta_1 LnFDI_{i(t-1)} + \delta_2 DF_{it} + \delta_3 Detcz_{it} \\ &+ \delta_4 RL_{it} + \delta_5 CC_{it} + \delta_6 Doil_{i(t-1)} + \delta_7 Dmineral_{i(t-1)} + \phi_i]\varsigma_{ijt},\end{aligned} \tag{8}$$

where $\tilde{T}_{ijt} = T_{ijt} - \hat{\beta}_1 LnGDP_{it} - \hat{\beta}_2 LnGDP_{jt}$, $\hat{\beta}_1$ and $\hat{\beta}_2$ are elasticities of trade to output

estimated in equation (3). To take a step further, we correct all variables in the gravity equation (7) by subtracting them from export values. We reestimate the effects of the newly added trade policies on the corrected trade values as a robustness check. The model is as follows:

$$\begin{aligned}\check{T}_{ijt} =& exp[\delta_1 LnFDI_{i(t-1)} + \delta_2 DF_{it} + \delta_3 Detcz_{it} + \delta_4 RL_{it} + \delta_5 CC_{it} + \delta_6 Doil_{i(t-1)} \\ &+ \delta_7 Dmineral_{i(t-1)} + \phi_i]\varrho_{ijt},\end{aligned} \tag{9}$$

where $\check{T}_{ijt} = T_{ijt} - \hat{\beta}_1 LnGDP_{it} - \hat{\beta}_2 LnGDP_{jt} - \hat{\beta}_3 LnDist - \hat{\alpha} Landlocked_i$, $\hat{\beta}_1$ to $\hat{\alpha}$ are estimated coefficients in equation (3).

5 Data

5.1 Data Source

Our sample for the general trade pattern covers 28 African exporters and 181 worldwide importers.[14] Therefore, our data set consists of 105,840 observations of bilateral export flows (28×180 country pairs and 21 years). The list of the African exporting countries is reported in the table A1 in the appendix, while the list of the importing countries is reported in the table A2 and A3 in the appendix. Data on African exports come from the *UN Comtrade* Database, adjusted by the US GDP deflator (base year 2005) from the *World Development Indicators* (WDI, 2012). Data on GDP PPP (constant 2005 international $) and GDP per capita PPP (constant 2005 international $) come from the World Bank's (2012) *World Development Indicators*. Data on distance and dummies indicating contiguity, common language and colonial ties are constructed from the *CEPII database-GeoDist*. The dummies for common currency union and common legal origin are from the *CEPII database-Gravity dataset* (2006). The dummy for sharing the same Regional Trade Agreement (RTA) is constructed from the *CEPII database-Gravity dataset* (2006), complemented with data from

[14] For country list, please refer to Appendix A1 to A3.
There are totally 57 African countries in 2010 (United Nations, 2011). However, not every country is important in African exports. Hence, we set requirements for our sample as follows. First, the countries of which population is greater than one million in 2010 are considered more important in African trade activities than those of less population. Second, we select the countries with more than 10 years annual data, which are well-distributed during the period from 1990 to 2010. At the same time, the countries' total exports values should rank top 20 in Africa in 1990, 2000 and 2010, respectively. In the end, 28 African countries are included in this sample.

the WTO[15]. The information on landlocked countries is constructed from the CIA's *World Factbook*[16].

The sample for analyzing Africa-China trade is also constructed from multiple data sources. Unfortunately, there is no existing database for relevant Chinese data. In most cases, we have to collect data from the government bulletins and other informal data sources.

The official data of China's outward FDI that comply with the IMF standard are available only after 2003. We obtain the China's outward FDI stocks in Africa from the *2010 Statistical Bulletin of China's Outward Foreign Direct Investment*, issued by the Ministry of Commerce of the PRC. Since the depreciation issues of FDI stocks has been taken into account when compiled, we simply adjust the data with the US GDP deflator (base year 2005) from the *World Development Indicators* (WDI, 2012).

The information regarding China's list of duty-free import products is constructed from the bulletins published by the General Administration of Customs of the PRC[17]. Combined with HS 8-digit data from the *China Customs Statistics Yearbook*, we further calculate the share of the value for duty-free products in total exports for particular African countries to which the duty-free policy applies. Due to data collection problem, we lack the information in year 2009.

The dummies of Economic and Trade Cooperation Zones (ETCZs) are constructed from the official websites for the Ministry of Commerce of the People's Republic of China (MOFCOM) and those for each Economic and Trade Cooperation Zone individually.

We use the quality of governance indicators from the *Worldwide Governance Indicators database*, conducted by Kaufmann, Kraay and Mastruzzi (2010). They report estimated values for six indices indicating six aspects of the quality of governance for each country. Each index ranges from -2.5 to 2.5, where a higher value indicates better governance. In this paper, the control of corruption and the rule of law, which have a fundamental influence on international trade, are adopted as proxies for governance quality.

The information on resource abundance for each African country is compiled from the *UNCTAD Stat database*. We adopt the criteria of resource abundance as being a major

[15]http://rtais.wto.org/UI/PublicAllRTAList.aspx

[16]http://www.cia.gov/library/publications/the-world-factbook/fields/2060.html#ay

[17]Source: General Administration of Customs of the People's Republic of China, website http://www.customs.gov.cn/publish/portal0/. The duty-free policy started since 2005 for certain sectors in the least developed countries.

player in the global export market of certain natural resource. In other words, we rule out the resource-rich countries with little resource exports restricted by limited production capacity or large domestic resource consumption. Thus, a country is treated as being abundant in oil or mineral resource if it ranks top 50 worldwide in terms of net exports in a given year. In particular, the oil and mineral refer to petroleum, petroleum products and related materials (SITC 33), ores and metals (SITC 27+28+68), respectively.

5.2 Descriptive Statistics

Appendix table A8 and A9 present the descriptive statistics for the full sample and Africa-China sample. Correlation tables are given in Appendix table A10 as well as A11.

6 Basic Regression Results for the Standard Gravity Model

Table 1 presents the estimation results for two basic specifications of the standard gravity model. The Basic I specification estimates equation (1) without region fixed effects while the Basic II specification includes these fixed effects. The results are substantially unchanged when including the region fixed effects in terms of signs and significance, except that common legal origin and sharing common border no longer determine the probability of one observation being in the passive group. Since region fixed effects are widely adopted in previous studies, we restrict our discussion below to the estimates of the Basic II specification.

In general, the dummies indicating landlocked importers and RTA determine whether country pairs ever trade but have no influence on the volume of trade. On the contrary, colonial ties, currency union, common border and legal origin which have significant effects on the volume of African exports, play no role in determining the probability of bilateral trade.

To interpret the economic effect of the estimated coefficients, we rely on odds ratio and incidence rate ratio (IRR) as in Garita and van Marrewijk (2008). In the Logit model, the odds ratio measures the probability of an observation being in the passive group relative to the probability of being in the active group. If b denotes the estimated coefficient, and σ denotes a standard deviation for continuous variables and a unit change for dummy variables, respectively, then the $odds\ ratio = e^{b\sigma}$, indicating the odds of being in the Passive Group

Table 1: Basic regression results, Zero-Inflated Poisson regression, 1990-2000

	(1)	(2)	(3)	(4)	(5)
A. Passive group, Logit.	Basic I		Basic II		Std Dev
$Ln(GDP_{origin})$	-0.326***	[-33]	-0.354***	[-36]	1.24
$Ln(GDP_{destination})$	-0.650***	[-77]	-0.662***	[-78]	2.26
$Ln(GDPpc_{origin})$	0.057***	[6]	0.065***	[6]	0.95
$Ln(GDPpc_{destination})$	-0.293***	[-31]	-0.276***	[-30]	1.28
$Ln(Dist)$	0.445***	[36]	0.057**	[4]	0.69
Colonial Ties	-0.269		0.034		0.08
Language	-0.946***	[-61]	-0.874***	[-58]	0.42
Legal	0.046*	[5]	0.008		0.49
Currency Union	-0.076		-0.136		0.13
RTA	-1.332***	[-74]	-1.371***	[-75]	0.22
Common Border	0.263***	[30]	-0.018		0.15
$Landlocked_{origin}$	0.151***	[16]	0.152***	[16]	0.41
$Landlocked_{destination}$	0.345***	[41]	0.397***	[49]	0.41
B. Active group, Poisson.	Basic I		Basic II		St Dev
$Ln(GDP_{origin})$	0.722***	[145]	0.734***	[148]	1.24
$Ln(GDP_{destination})$	0.868***	[611]	0.897***	[659]	2.26
$Ln(GDPpc_{origin})$	0.302***	[47]	0.308***	[26]	0.95
$Ln(GDPpc_{destination})$	0.302***	[33]	0.183***	[34]	1.28
$Ln(Dist)$	-0.523***	[-30]	-0.331***	[-20]	0.69
Colonial Ties	0.521***	[68]	0.200**	[22]	0.08
Language	0.381***	[46]	0.523***	[69]	0.42
Legal	0.334***	[40]	0.330***	[39]	0.49
Currency Union	2.205***	[807]	2.134***	[745]	0.13
RTA	0.023		-0.040		0.22
Common Border	0.567***	[76]	0.767***	[115]	0.15
$Landlocked_{origin}$	-0.535***	[-41]	-0.590***	[-45]	0.41
$Landlocked_{destination}$	-0.046		0.017		0.41
Observations	49,519		49,519		
Nonzero obs.	21,971		21,971		
Region fixed effects	No		Yes		
Wald Chi	7029.11		8165.81		

Notes:
Dependent variable is the value of African export flows (constant 2005 international $). ***, ** and * denote significance at 1, 5 and 10 percent level, respectively. Column (1) and (3) show the estimated coefficients. For variables significant at least 10 percent level, the coefficients could be interpreted as elasticities. Column (2) and (4) show the incidence rate ratio in brackets, which indicate the percent change in odds ratio (passive group) or in the expected values of trade flows (active group) if a regressor alters by one standard deviation, ceteris paribus. The incidence rate ratio (IRR) is calculated as follows: for continuous variables, $IRR = 100 \times [exp(coefficient \times Std\ Dev) - 1]$; while for dummy variables, $IRR = 100 \times [exp(coefficient) - 1]$ due to a discrete change from 0 to 1. Column (5) shows the standard deviation of each variable. Std Dev= standard deviation.

versus that of being in the active one in the Logit model[18]. It measures a change in odds of being in the passive group corresponding to a σ-size shock to certain variable, ceteris paribus. In the second step, we report $IRR = 100 \times (e^{b\sigma} - 1)$, which measures the percent change in the expected value for a σ-size shock to certain variable, holding other regressors constant.

6.1 Passive Group (first stage, Logit)

The estimation results for the first stage Logit regression are presented in Panel A. Most regressors are statistically significant and important in determining the membership of Passive Group as well as Active Group, with the exception of colonial ties, legal origin, currency union and contiguity.

Generally speaking, larger economies measured by larger GDP, no matter exporters or importers, are less likely to be in the Passive Group. This effect is particularly large for importers, of which a standard deviation size reduction in importer's GDP would increase the probability of falling in Passive Group by 78 percent. In other words, the likelihood of bilateral trade between the two countries would decrease remarkably. As for economic development, the signs of coefficients of GDP per capita for exporters and importers are opposite. It might be surprising at first glance that the economic development imposes a positive effect on the likelihood of being in the Passive Group. However, the economic magnitude of exporter's GDP per capita is so small that it is almost negligible. As for geographic factors like distance and landlocked conditions, we find significant effects as expected. In particular, countries far away or having no access to sea are less likely to trade. Finally, countries sharing common language and Regional Trade Agreement are less probably to belong to the Passive Group.

6.2 The Active Group (second stage, Poisson)

We are more interested the estimated results of second stage Poisson regression for the Active Group presented in Panel B. Most regressors are statistically significant and important in determining the value of export trade, with the exception of landlocked condition of importers and RTA.

We are pleased to see both GDP and GDP per capita of both exporters and importers are imposing positive and statistically significant effects on the value of exports. It is worth

[18]In table 1, we report $100 \times (e^{b\sigma} - 1)$, that is the percent change in odds.

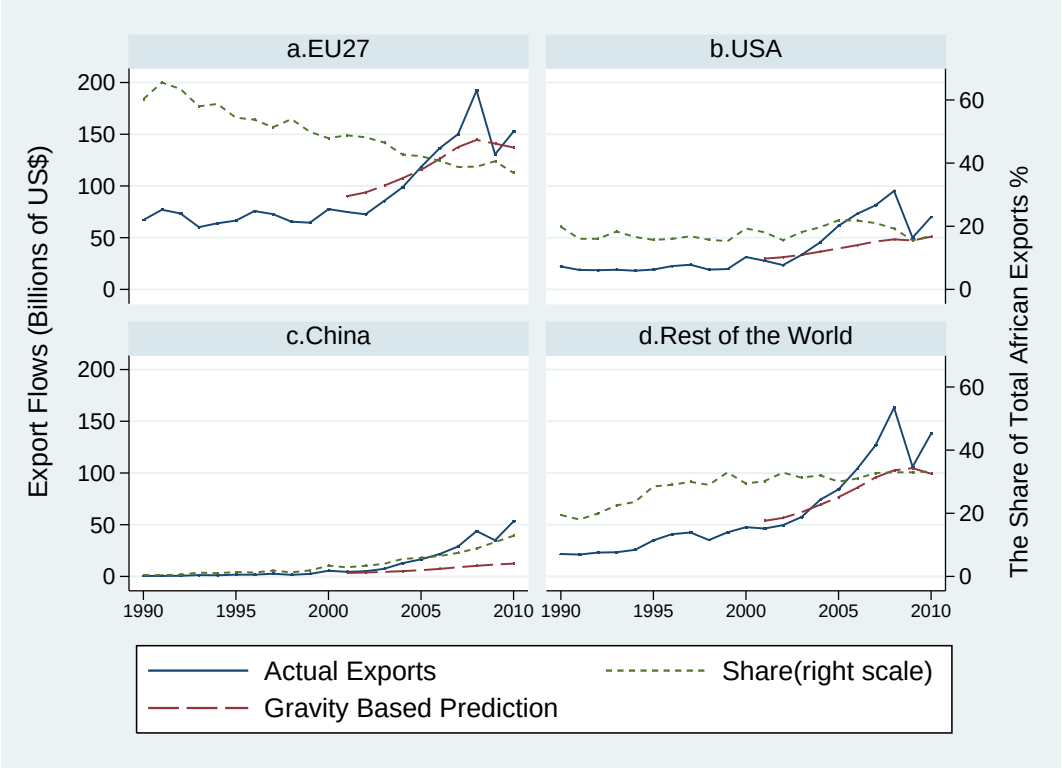
noting that the importer's GDP has a substantial effect on the value of exports. In particular, if the importer's GDP increases by one standard deviation, then the final volume of exports from African exporter would increase by 659 percent. Therefore, we would further expect that importing countries which undergo fast economic growth would observe huge flows of exports coming from African countries. Particularly, it is reasonable to expect that China, which maintained around 9.9 percent annual growth rate of GDP in the first decade, would attract booming African exports accordingly. As for geographical variables, long distance between trading partners and exporters' being landlocked reduce the trade values, while sharing a common border has an opposite effect. Besides, trading partners which have previous or current colonial relation, or which share common language or legal origin, would trade more in terms of exports value. In the end, being within a currency union generates a substantial, positive effect on bilateral trade value. The country pairs that share the same currency union generally have 745 percent higher trade values than those using different currencies.

7 The Africa-China Trade Puzzle

To test the explanation and prediction power of the gravity model, we use the estimated trade pattern in the first decade (the coefficients of the Active Group) to predict the value of export flows in the second decade. Then we compare the predicted values with the virtual ones.

Figure 4 graphically presents the predicted export flows (long dash line, 2001–2010) and the actual export flows (solid line, 1990-2010) for African exporters with their major trading partners, EU27, US, China and the rest of the world as a whole (ROW). US seems to maintain a pretty stable position in the past two decades. The share of EU27 in African exports has been continuously declining since the 1990s. On the contrary, China is considerably lifting its importance as a major trading partner of Africa. On top of the distinct trends in the share of exports for different regions, We observe a clear trend in all trade relations that the actual African exports to all destinations increased rapidly since the beginning of the new century until reaching the peak in 2008, when the financial crisis started to severely affect the real economy. The African trade saw a temporary contraction in 2009 while bounced back in 2010. However, the predicted trade values for this period change modestly. To take one step further, we observe underestimation of similar absolute magnitudes in all groups. The systematic underestimation would be the result of dynamics of memberships of the Passive Group and

Figure 4: The predicted and actual export flows from Africa to its main trading partners



Source: *UN Comtrade* database.

the Active Group. To put it another way, in fact, some passive country pairs became active in the second period, while the static prediction is based on the fixed active country pairs in the first period. Thus, an underestimation might occur. It is worth noting that, among all deviations, the Africa-China trade relation displays the largest underestimation in terms of relative magnitude

To quantitatively describe the accurate deviation from the model prediction, we report the percent deviations in table 2. We find initial overestimations and subsequent, mild underestimations for EU27, US and the rest of the world. When comparing China with other African trading partners, we find that Africa-China trade has been continuously underestimated over the decade. In terms of magnitude, the deviation displays a rising trend. If the deviations of prediction for other African trading partners is treated as lying within a reasonable interval, then that for China seems exceptional and abnormal. We even find a deviation of 330 percent in 2010, which no doubt casts doubts on the explanatory power of the general gravity model

Table 2: Percent Deviation

Year	EU27	USA	China	ROW
2001	-16.9	-6.8	32.3	-13.9
2002	-22.5	-24.5	33.5	-12.3
2003	-14.7	-0.2	66.3	-7.5
2004	-8.2	24.7	150.5	6.8
2005	2.4	55.5	173.7	9.8
2006	8.1	70.7	197.4	21.2
2007	9.1	75.8	226.0	32.4
2008	33.1	96.7	326.7	59.1
2009	-7.4	5.7	203.4	1.3
2010	11.4	37.4	330.1	38.9

and the credibility of China's fast growth in fully explaining Africa-China trade.

Why would not the trade pattern featured by the standard gravity model precisely describe the Africa-China trade pattern as those in other cases like Africa-EU27 and Africa-US in the latter ten years? We focus on the changes over the decade. The set of time-invariant dummies plays no role here because they do not change over time and they do not even exist in the Africa-China relations. Naturally, China's rapid growing economy would be a candidate for the deviation. However, according to the trade-to-output elasticities in the gravity model, the growth of the Africa-China trade goes beyond what the economy size could explain. In particular, though China's growth is faster than EU27 and US and it is reasonable to observe a corresponding faster growth of African exports to China than African exports to other regions, it is surprising that the growth of African exports to China is even faster than the prediction based mainly on China's growing economy size and experience of the rest of the world. This justifies our conjecture that solely China's rapid economic growth cannot explain the entire story of the Africa-China trade.

8 Policy Explanations for the Puzzle

Since African exports flowing to China is proved to be growing far more rapid than the prediction of standard gravity model based on the experience of the rest of the world and China's fast economic growth, then what would be the hidden power that drives this dynamic process? To tackle the puzzle, we turn to China's specific trade policies. After a brief review

of several aspects of Africa-China relation, we proceed to the empirical results.

Stimulated by the the "Going Global" strategy proposed in 2002, China has accelerated its overseas investment. In particular, Chinese investment to Africa has been booming since 2000, especially since 2006 (see figure 5). Though Africa accounts for a small proportion (4.1% in 2010) of all China's outward FDI, its rapid growth is worth attention. In 2010, Africa attracted 13 billion US dollar of China's outward FDI stocks, which was 26.5 times of that in 2003. From 2003 to 2010, the Chinese FDI stocks in Africa had an annual growth rate of 60 percent[19]. Despite the slowdown of the FDI flows affected by the 2008 financial crisis, the growth of FDI stocks retained. By 2010, China has invested in 50 African countries, covering 85 percent of all countries on the continent. The primary destinations of China's outward FDI stocks include South Africa, Nigeria, Zambia, Algeria, the Democratic Republic of Congo, Sudan, Niger, Ethiopia, Angola and Egypt, which absorbed 76 percent of the entire stocks in Africa in 2010. A distinct feature of the China's investment in Africa is the vital roles of the state-owned enterprizes (SOE) and the state-owned financial institutions. Kaplinsky and Morris (2009) point out that most of the Chinese firms investing in oil, mineral and construction sectors are state-owned. These firms obtain subsidies or low-cost loans from the state-own banks, such as China Export-Import Bank and China Development Bank.

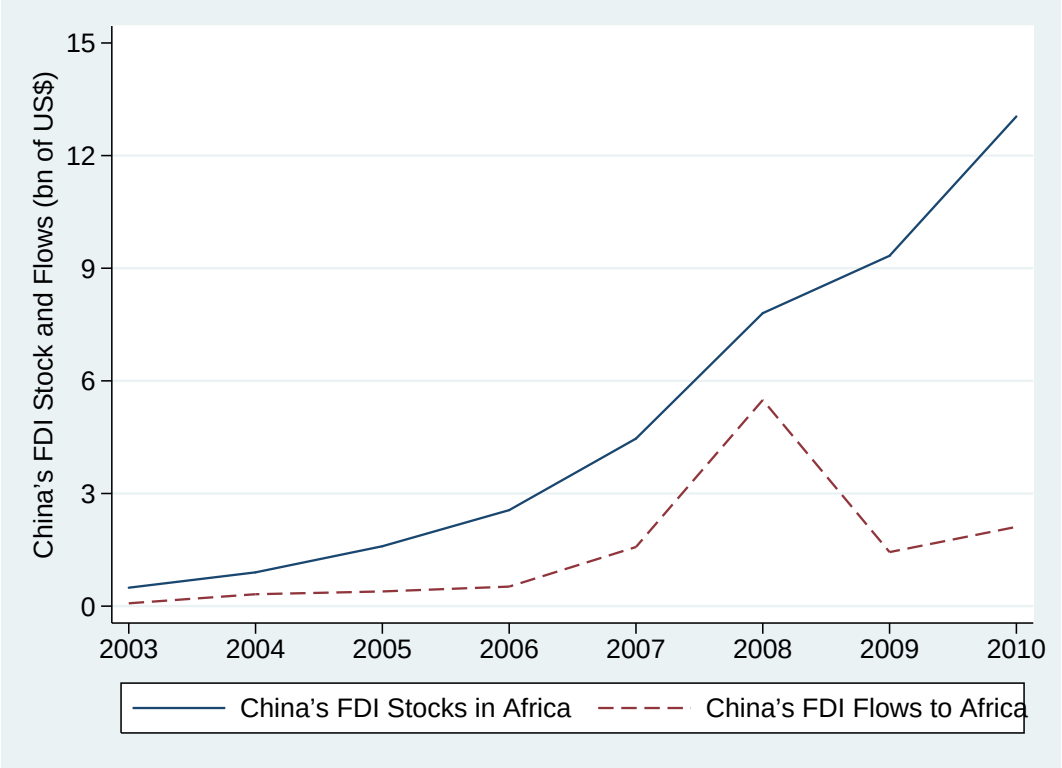
China has accelerating the pace of trade liberalizations over the past twenty years. The turning point is the entry to the WTO in 2001, forcing China to get rid of a couple of trade barriers. To open market for Africa, the Chinese government started setting up a list of duty-free African exports (including 190 products in 8-digit sector in HS1996 [20]) for certain least-developed African countries since 2005. The duty-free list further expanded to cover 444 import sectors in 2007 and even 4762 sectors in 2010. By the end of 2010, the duty-free products cover all 2-digit sectors of HS1996 and account for 60 percent of all African export sectors. In addition, Chinese government commited to expand the duty-free list to 95 percent of all African export products in the near future. This duty-exemption policy is expected to contribute to the rise of African exports to China and thereby stimulating the development of African economy.

During the Beijing summit of the Forum on China-Africa Cooperation (FOCAC) in 2006, the Chinese government committed to strengthen economic cooperations with Africa

[19]The compound annual growth rate=$(\frac{FDI_{2010}}{FDI_{2003}})^{\frac{1}{2010-2003}} - 1$

[20]Source: General Administration of Customs of the People's Republic of China.

Figure 5: China's outward FDI in Africa: stocks and flows (1990-2010)



Source: The 2010 Statistical Bulletin of China's Outward Foreign Direct Investment.

by establishing several Economic and Trade Cooperation Zones (ETCZs) in Africa. The goals of the ETCZs are to cultivate production capacities, particularly export potentials, and to enhance agglomeration of industries that creates positive externalities. Firms in the ETCZs are entitled to tax-exemption, favorable-pricing land and duty-waivers. Up to 2010, located in Zambia, Nigeria (including two ETCZs), Ethiopia and Egypt, five ETCZs had been constructed and put into use. In addition, ETCZs in Mauritius, Algeria and Botswana are supposed to be established by 2012 (see Appendix table A7 for more details).

China has been constantly holding the *business and politics separation policy* towards Africa. The core of this doctrine is to do business without any political restrictions. Unlike the Western countries which set political requirements for trade and aid to African countries, China offers unconditional aid to them. Likewise, China has been seeking to build closer economic ties with the African countries which are isolated from the Western world because of their bad governance, for instance, Sudan and Zimbabwe. Now, China is the largest buyer

of Sudan's crude oil.

China's involvement in Africa apparently reflects its quest for raw materials, especially natural resources. First, China had become the second largest oil consumer in the world by 2005.[21] Similarly, China's foreign dependence of mineral has also risen significantly. Both the declining domestic oil and mineral outputs and instable geopolitical situation are urging China to seek reliable supply of natural resources. Second, Africa seems to be the last main oil and mineral reserves which is not completely managed by Western companies. Therefore, it is reasonable to see China investing billions of dollars in African resource sectors and importing a great amount of crude oil, metals, timber and cotton from Africa.

In the following, we present the regression results for equation(6) to equation (9) which estimate the effects of policy variables in the Africa-China trade.

8.1 A Comprehensive Framework

Column (1) in table 3 presents the estimation of the modified gravity model of equation (6). Consistent with the previous estimation, the coefficient of GDP for exporters is positive and significant, indicating that great economic size and local production capacity sustain a great volume of exports to China. On the other hand, the positive coefficient of China's GDP implies its fast economic expansion explains the rapid growth in its imports from Africa as well. Since we adopt fixed effect estimators, time invariant distance and landlocked condition of exporters are not reported.

As for China's policy variables, we find a positive and statistically significant coefficient of the China's outward FDI, consistent with Biggeri and Sanfilippo (2009). A considerable proportion of the China's outward FDI flows to African infrastructure and resource sectors, which spills over to other sectors and eventually enhances the aggregate local production capacity in African recipients. The negative and significant coefficient of the share of duty-free products seems counterintuitive at first glance. However, it is plausible when you take into account that this policy is specifically targeted at certain sectors of the least developed African countries. Put differently, on one hand, some important exporters are excluded from this favorable policy, such as South Africa, Libya, Algeria and Nigeria. On the other hand, the major components of China's imports, for instance oil, timber and cotton, were out of the

[21] Source: NationMaster.com

Table 3: The Africa-China trade, 2004–2010

Dependent variables	(1) T	(2)	(3) T	(4) $\tilde{T}$	(5) $\check{T}$
$Ln(GDP_{origin})_t$	0.914***	[149]	0.356***		
	(0.000)		(0.000)		
$Ln(GDP_{China})_t$	1.415***	[312]	1.862***		
	(0.000)		(0.000)		
$Ln(FDI_{origin})_{(t-1)}$	0.012***	[1]		0.077***	0.077***
	(0.000)			(0.017)	(0.018)
$Duty\ \ Free_{origin(t)}$	-0.019***	[-2]		-0.135	-0.049
	(0.000)			(0.407)	(0.455)
$Detcz_{origin(t)}$	0.425***	[53]		0.924***	0.971***
	(0.000)			(0.230)	(0.210)
$Rule\ \ of\ \ Law_{origin(t)}$	-0.911***	[-60]		-0.839*	-0.709**
	(0.000)			(0.340)	(0.421)
$Control\ \ of\ \ Corruption_{origin(t)}$	-0.640***	[-48]		-1.287***	-1.359***
	(0.000)			(0.446)	(0.483)
$Doil_{origin(t)}$	0.329***	[39]		0.406**	0.420**
	(0.000)			(0.189)	(0.191)
$Dmineral_{origin(t)}$	0.558***	[75]		0.571***	0.585***
	(0.000)			(0.097)	(0.121)
Observations	174		188	174	174
Number of country pairs	27		27	27	27
McFadden R^2	0.039		0.020	0.020	0.021

Notes:
In column (1) and (3), dependent variables are the value of African export flows (constant 2005 international $). Column (2) reports the IRR in brackets. In column (4), dependent variable is $T - 0.734 \times Ln(GDP_{origin}) - 0.897 \times Ln(GDP_{China})$. In column (4), dependent variable is $T - 0.734 \times Ln(GDP_{origin}) - 0.897 \times Ln(GDP_{China}) + 0.331 \times Ln(Dist) + 0.590 \times Landlocked_{origin}$. ***, ** and * denote significance at 1, 5 and 10 percent level, respectively. We drop Zimbabwe because of no reliable data for its real GDP, due to its hypo inflation since 2000.

duty-free product list during 2005 to 2009. Until the July, 2010, oil and timber were added into the duty-free list, but cotton was still excluded. Therefore, it is reasonable to observe the least developed countries with a great share of the duty-free products export less than those developing counterparts which rely on high valued non-duty-free goods. In a nutshell, the duty-free policy seems not a suitable variable in explaining African exports. Though being set up recently, the Economic and Trade Cooperation Zones (ETCZs) have being proved functioning well and imposing a positive and significant effect on promoting African exports. Consistent with De Grauwe et al. (2012), we find that China trades more with countries

with bad rule of law and corrupt governments. This is an interesting phenomenon because the Western countries have a preference to trade with African countries of better governance. We could attribute this phenomenon to China's doctrine in the *separation of business and politics*. Another plausible reason is that the majority of Chinese trading entities are state-owned enterprizes which are less risk-averse. These companies are not reluctant to trade in countries featured high political and legal risks because of the back from Chinese government. In the analysis of De Grauwe et al. (2012), EU has a strict requirement on the governance quality of its trading partners. They reward countries that meet the conditions and leave out those of bad governance. In contrast, China is expanding imports from these isolated countries. This substitution effect is creating external markets for the countries labeled as bad governance. Cheung et al. (2012) also find an interesting fact that law and order risk and corruption risk in Africa tend to encourage Chinese investment. All coefficients of the resource dummies are positive and significant, implying that China imports more goods from resource-abundant African countries. This is evidence for the resource-seeking motive for China, consistent with the finding in De Grauwe et al. (2012) that African countries with plentiful oil and mineral resources export more to China.

Column (2) reports the calculated IRRs in brackets. According to the magnitude of the IRR for each regressor, though national incomes are still principal factors in explaining African exports, other policy variables are also crucial. Additionally, we calculate the McFadden R^2s. Unfortunately, Pseudo R^2 cannot be interpreted independently (Cameron and Trivedi, 2005). In other words, it cannot tell the proportion of variation in dependent variable explained by the variations in explanatory variables, as in the case of R^2 in linear regressions. Thus, we cannot directly evaluate the explanatory power of the model, let alone the contribution of the newly added policy variables. However, Pseudo R^2s are useful and valid in assessing nested models. Therefore, we estimate the gravity version of the equation (6). The results of equation (7) are displayed in column (3). The comparison of McFadden R^2s reveals a slight decline in McFadden R^2, indicating the comprehensive framework combining GDP and policy variables fits better than that of economic size alone. Moreover, we conduct a likelihood ratio test of the two nested models. The test reject the null hypothesis that policy variables are not jointly significant, lending a support for the specification of equation (6).

8.2 Correcting for the GDP Effects

It is worth noting that the estimated coefficients of GDP expand a lot compared with those in the standard gravity model of the Active Group in section 6. If we treat the elasticities estimated in the standard gravity model as a general pattern, here we might attribute too many export flows to GDP factors. This effect may bias the estimation of all other variables. In other words, GDP factors may take away lots of explanatory power of the rest of the variables. Therefore, we turn to trade flows corrected for the GDP effects. Regression outputs in column (4) show that all magnitude of the coefficients of trade policy variables swell. If we correct for not only GDP but also distance and landlocked conditions, we have similar results in column (5). China's outward FDI and setting up Economic and Trade Cooperation Zones significantly stimulate African exports to China. We are cautious to conclude that tariff exemption does not matter; perhaps the effects are still relatively weak. We find consistent evidence that China does not evade business partners that have bad records of governance and rule of law. The goal to guarantee safe and stable supply of natural resources has been confirmed as well.

9 Conclusion

This paper investigates the dynamics and determinants of African exports to China in the past two decades. Along with the rapid growth of Chinese economy, an even more rapid expansion in China's imports from Africa has attracted widespread concerns. Now, China is Africa's second largest export market. Based on this phenomenon, we propose the conjecture that China's fast development is an important factor driving surging imports from Africa, but cannot explain the whole story. On the basis of estimation of a standard gravity model which features the role of economic size, we compare the predicted export flows with the actual ones. The comparison displays underestimation of the traditional gravity variables and confirm our conjecture. In a tentative attempt to cope with the trade puzzle, we highlight the roles of trade policies. We confirm that China's preferential trade policies towards Africa also contribute to the prospering Africa-China trade.

Our results have direct policy implications. Driven by the "Going Global" strategy, China has been expanding its outward FDI, especially to Africa. State-owned enterprizes and State-

owned financial institutions play a crucial role in this process. Our analysis shows indirect evidence that China's investment facilities local production and export capacities for African countries, further reinforcing African development and growth. The promotion effect of the tariff-exemption for certain imports from the LDCs seems weak. It is expected to be effective in a gradual way. The Economic and Trade Cooperation Zone seems successful and reaches its original goal of promoting exports. China's tight economic relation with poorly governed countries may hinder the improvement of the institutional quality of these countries. Indeed, these countries benefit from a large export market like China. However, considering the bad governance, the benefits of exports and growth may not profit everybody equally. Finally, African countries are becoming China's stable suppliers of raw materials and natural resources. This may to some extent reshape the structure of global markets of resources.

Future research could quantitatively incorporate China's aid into analysis, whenever data issues are resolved. Development aid has been treated as a crucial channel through which trade and investment relations are affected. Another direction would be investigating African trade relations with other emerging economies (Brazil, India for instance) and then making a comparison to see whether China is still unique.

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APPENDIX

Table A1: List of the African Exporting Countries

Algeria	Libya	South Africa
Angola	Madagascar	Sudan
Cameroon	Malawi	Tanzania
Cote d'Ivoire	Mali	Togo
Egypt, Arab Rep.	Mauritania	Tunisia
Ethiopia	Mauritius	Uganda
Gabon	Morocco	Zambia
Ghana	Mozambique	Zimbabwe
Guinea	Nigeria	
Kenya	Senegal	

Table A2: List of the Importing Countries

Afghanistan	Ghana	Oman
Albania	Greece	Pakistan
Algeria	Grenada	Palau
Angola	Guatemala	Panama
Antigua and Barbuda Guinea	Papua	New Guinea
Argentina	Guinea-Bissau	Paraguay
Armenia	Guyana	Peru
Australia	Haiti	Philippines
Austria	Honduras	Poland
Azerbaijan	Hong Kong SAR, China	Portugal
Bahamas, The	Hungary	Qatar
Bahrain	Iceland	Romania
Bangladesh	India	Russian Federation
Barbados	Indonesia	Rwanda
Belarus	Iran, Islamic Rep.	Samoa
Belgium	Iraq	Sao Tome and Principe
Belize	Ireland	Saudi Arabia
Benin	Israel	Senegal
Bhutan	Italy	Seychelles
Bolivia	Jamaica	Sierra Leone
Bosnia and Herzegovina	Japan	Singapore
Botswana	Jordan	Slovak Republic
Brazil	Kazakhstan	Slovenia
Brunei Darussalam	Kenya	Solomon Islands
Bulgaria	Kiribati	South Africa
Burkina Faso	Korea, Rep.	Spain
Burundi	Kuwait	Sri Lanka
Cambodia	Kyrgyz Republic	St. Kitts and Nevis
Cameroon	Lao PDR	St. Lucia

Table A3: List of the Importing Countries (Continued)

Canada	Latvia	St. Vincent and the Grenadines
Cape Verde	Lebanon	Sudan
Central African Republic	Lesotho	Suriname
Chad	Liberia	Swaziland
Chile	Libya	Sweden
China	Lithuania	Switzerland
Colombia	Luxembourg	Syrian Arab Republic
Comoros	Macao SAR, China	Tajikistan
Congo, Rep.	Macedonia, FYR	Tanzania
Costa Rica	Madagascar	Thailand
Cote d'Ivoire	Malawi	Timor-Leste
Croatia	Malaysia	Togo
Cyprus	Maldives	Tonga
Czech Republic	Mali	Trinidad and Tobago
Denmark	Malta	Tunisia
Djibouti	Mauritania	Turkey
Dominica	Mauritius	Turkmenistan
Dominican Republic	Mexico	Uganda
Ecuador	Micronesia, Fed. Sts.	Ukraine
Egypt, Arab Rep.	Moldova	United Arab Emirates
El Salvador	Mongolia	United Kingdom
Equatorial Guinea	Morocco	United States
Eritrea	Mozambique	Uruguay
Estonia	Myanmar	Uzbekistan
Ethiopia	Namibia	Vanuatu
Fiji	Nepal	Venezuela, RB
Finland	Netherlands	Vietnam
France	New Zealand	Yemen, Rep.
Gabon	Nicaragua	Zambia
Gambia, The	Niger	Zimbabwe
Georgia	Nigeria	
Germany	Norway	

Table A4: Variable Descriptions and Sources

Variable	Description	Sources
$Exports_{ijt}$	The volume of exports flow from exporter i to importer j, adjusted by US GDP deflator (base year 2005).	*UN Comtrade* Database.
$GDP_{origin(t)}$	Gross domestic products PPP (constant 2005 international $) of the exporting country i (in logs).	The World Bank's (2012) *World Development Indicators*.
$GDP_{destination(t)}$	Gross domestic products PPP (constant 2005 international $) of the importing country j (in logs).	The World Bank's (2012) *World Development Indicators*.
$GDPpc_{origin(t)}$	Gross domestic products per capita PPP (constant 2005 international $) of the exporting country i (in logs).	The World Bank's (2012) *World Development Indicators*.
$GDPpc_{destination(t)}$	Gross domestic products per capita PPP (constant 2005 international $) of the importing country j (in logs).	The World Bank's (2012) *World Development Indicators*.
Dist	The distance (in km) between exporter i's and importer j's capitals (in logs).	The*CEPII database-GeoDist*.
Common Border	A binary variables equals one if exporter i and importer j are neighbors that meet a common physical boundary, and zero otherwise.	The*CEPII database-GeoDist*.

Table A5: Variable Descriptions and Sources (continued)

Variable	Description	Sources
$Landlocked_{origin}$	A binary variables equals one if exporter i has no coastline or direct access to sea, and zero otherwise.	The CIA's World Factbook .
$Landlocked_{destination}$	A binary variables equals one if importer j has no coastline or direct access to sea, and zero otherwise.	The CIA's World Factbook .
Colonial Ties	A binary variables equals one if exporter i ever colonized importer j or vice versa, and zero otherwise.	The*CEPII database-GeoDist.*
Language	A binary variables equals one if exporter i and importer j share a common language, and zero otherwise.	The*CEPII database-GeoDist.*
Legal	A binary variables equals one if exporter i and importer j share a common legal origin, and zero otherwise.	The*CEPII database-Gravity dataset* (2006).
Currency Union	A binary variables equals one if exporter i and importer j use the same currency or if within the country pair money was interchangeable at $1:1$ exchange rate for an extended period of time, and zero otherwise.	The*CEPII database-Gravity dataset* (2006).
RTA	A binary variables equals one if exporter i and importer j belong to a common regional trade agreement, and zero otherwise.	The*CEPII database-Gravity dataset* (2006) and World Trade Organization (WTO).

Table A6: Variable Descriptions and Sources (continued)

Variable	Description	Sources
$Ln(FDI)_{origin(t-1)}$	China's outward Foreign Direct Investment (FDI) in African country i, adjusted by US GDP deflator (base year 2005), in logs, lagged by one period.	The *2010 Statistical Bulletin of China's Outward Foreign Direct Investment.*
$Duty\ Free_{origin(t)}$	The share of the value for duty-free export products in total export flows for country i.	The *China Customs Statistics Yearbook* and the bulletins published by the General Administration of Customs of the PRC.
$Detcz_{origin(t)}$	A binary variables equals one if China establishes an Economic and Trade Cooperation Zone (ETCZ) in country i.	The official websites for the Ministry of Commence of the PRC and those for each ETCZ individually.
$Rule\ of\ Law_{origin(t)}$	The governance indicator measuring the level of rule of law in country i. It ranges from -2.5 to 2.5, where a higher value indicates better governance.	The World Governance Indicators database.
$Control\ of\ Corruption_{origin(t)}$	The governance indicator measuring the level of control of corruption in country i. It ranges from -2.5 to 2.5, where a higher value indicates better governance.	The World Governance Indicators database.
$Doil_{origin(t)}$	A binary variables equals one if exporter i is oil-abundant in terms of exporting petroleum, petroleum products and related materials in year t.	The *UNCTAD Stat database.*
$Dmineral_{origin(t)}$	A binary variables equals one if exporter i is mineral-abundant in terms of exporting ores and metals in year t.	The *UNCTAD Stat database.*

Table A7: China's ETCZSs in Africa

Country	Name	Date of Establishment	Principal Sectors	Planned Investment (USD million)
Zambia	ZCCZ	2007	Copper products	800
Nigeria	Lekki FTZ	2007	Real estate development and logistics	330
Nigeria	Ogun State FTZ	2009	Electronic industry and furniture manufacturing	2500
Egypt	Suez SETZ	2009	Textile, petroleum, automotive and electrical appliance	460
Ethiopia	Dukem Industrial Park	2007	Textile, leather and construction equipment	849
Mauritius	Tianli ETCZ	2012	Logistics	220
Algeria	Mostaganem ETZ	2012	Automotive industry, construction materials and electronic industry	550
Botswana	Phalalane Industrial Park	2012		52

Source: We compile the information from the official websites for the FOCAC and Berthelemy (2011).

Table A8: Descriptive Statistics (Full Sample)

Full Sample	N	Max	Min	Median	Mean	Std. Dev.
Exports	105,840	3.6e+10	0.00	1310.82	4.1e+07	4.2e+08
$Ln(GDP_{origin})$	100,260	26.88	21.72	23.92	24.05	1.24
$Ln(GDP_{destination})$	102,735	30.21	18.71	23.99	24.09	2.26
$Ln(GDPpc_{origin})$	100,260	9.65	5.93	7.29	7.53	0.95
$Ln(GDPpc_{destination})$	102,651	11.25	4.94	8.62	8.56	1.28
$Ln(Dist)$	102,735	9.90	4.66	8.75	8.66	0.69
Common Border	105,840	1.00	0.00	0.00	0.02	0.15
$Landlocked_{origin}$	105,840	1.00	0.00	0.00	0.21	0.41
$Landlocked_{destination}$	105,840	1.00	0.00	0.00	0.21	0.41
Colonial Ties	105,840	1.00	0.00	0.00	0.01	0.08
Language	105,840	1.00	0.00	0.00	0.23	0.42
Legal	105,840	1.00	0.00	0.00	0.39	0.49
Currency Union	105,840	1.00	0.00	0.00	0.02	0.13
RTA	105,840	1.00	0.00	0.00	0.05	0.22

Table A9: Descriptive Statistics (Africa-China Sample)

Africa-China Sample	N	Max	Min	Median	Mean	Std. Dev.
Exports	224	2.1e+10	9348.02	1.1e+08	9.8e+08	2.8e+09
$Ln(GDP_{origin})$	215	26.88	22.22	24.23	24.34	1.22
$Ln(GDP_{China})$	224	29.84	29.11	29.50	29.48	0.25
$Ln(GDPpc_{origin})$	215	9.64	6.26	7.41	7.68	0.96
$Ln(GDPpc_{China})$	224	8.83	8.13	8.50	8.49	0.23
$Ln(Dist)$	224	9.47	8.93	9.30	9.25	0.15
$Landlocked_{origin}$	224	1.00	0.00	0.00	0.21	0.41
$Ln(FDI)_{origin(t-1)}$	196	21.74	12.35	17.26	17.16	1.77
$Duty\ Free_{origin}$	210	1.00	0.00	0.00	0.10	0.23
$Detcz_{origin}$	224	1.00	0.00	0.00	0.06	0.24
$Rule\ of\ Law_{origin}$	224	1.06	-1.82	-0.60	-0.62	0.60
$Control\ of\ Corruption_{origin}$	224	0.67	-1.48	-0.68	-0.63	0.48
$Doil_{origin}$	224	1.00	0.00	0.00	0.35	0.48
$Dmineral_{origin}$	224	1.00	0.00	0.00	0.33	0.47

Table A10: Correlation Matrix for the Full Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) *Exports*	1.000													
(2) $Ln(GDP_{origin})$	0.124	1.000												
(3) $Ln(GDP_{destination})$	0.169	0.016	1.000											
(4) $Ln(GDPpc_{origin})$	0.089	0.516	0.011	1.000										
(5) $Ln(GDPpc_{destination})$	0.099	0.018	0.465	0.010	1.000									
(6) $Ln(Dist)$	-0.037	-0.060	0.025	-0.027	0.204	1.000								
(7) *Common Border*	0.012	0.006	-0.045	-0.018	-0.146	-0.415	1.000							
(8) $Landlocked_{origin}$	-0.044	-0.266	0.001	-0.453	0.001	0.026	0.012	1.000						
(9) $Landlocked_{destination}$	-0.038	0.001	-0.130	0.002	-0.271	-0.159	0.062	-0.006	1.000					
(10) *Colonial Ties*	0.162	0.023	0.129	0.021	0.089	-0.044	0.035	-0.014	-0.042	1.000				
(11) *Language*	0.022	0.025	-0.193	0.017	-0.090	-0.139	0.147	0.063	-0.035	0.104	1.000			
(12) *Legal*	0.026	-0.016	-0.043	0.022	-0.080	-0.109	0.078	-0.031	-0.111	0.079	0.392	1.000		
(13) *Currency Union*	-0.003	-0.060	-0.076	0.011	-0.119	-0.258	0.197	-0.017	0.055	0.009	0.216	0.159	1.000	
(14) *RTA*	0.082	0.070	0.003	0.044	-0.084	-0.416	0.291	-0.033	0.026	0.045	0.079	0.047	0.176	1.000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

Table A11: Correlation Matrix for the Africa-China Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)*Exports*	1.000													
(2)$Ln(GDP_{origin})$	0.322	1.000												
(3)$Ln(GDP_{China})$	0.184	0.094	1.000											
(4)$Ln(GDPpc_{origin})$	0.297	0.509	0.060	1.000										
(5)$Ln(GDPpc_{China})$	0.184	0.094	1.000	0.060	1.000									
(6)$Ln(Dist)$	0.154	-0.374	-0.000	-0.203	0.000	1.000								
(7)$Landlocked_{origin}$	-0.154	-0.253	0.000	-0.448	-0.000	-0.052	1.000							
(8)$Ln(FDI)_{origin(t-1)}$	0.243	0.374	0.524	0.158	0.524	-0.056	-0.074	1.000						
(9)$Duty\ Free_{origin}$	-0.091	-0.180	0.247	-0.347	0.247	-0.100	0.387	0.117	1.000					
(10)$Detcz_{origin}$	-0.030	0.193	0.243	-0.085	0.244	-0.118	0.225	0.365	0.290	1.000				
(11)$Rule\ of\ Law_{origin}$	-0.156	0.014	-0.029	0.301	-0.029	-0.217	-0.024	-0.107	-0.007	-0.025	1.000			
(12)$Control\ of\ Corruption_{origin}$	-0.168	0.019	-0.052	0.253	-0.052	-0.060	-0.135	-0.011	-0.032	-0.032	0.887	1.000		
(13)$Doil_{origin}$	0.260	0.468	0.038	0.478	0.038	-0.183	-0.382	0.103	-0.292	0.044	-0.351	-0.441	1.000	
(14)$Dmineral_{origin}$	-0.015	-0.167	-0.003	0.008	-0.003	0.439	-0.048	0.177	0.023	-0.027	0.021	0.163	-0.300	1.000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)