Determinants of bilateral trade between BRICs and Sub Saharan Africa: what the gravity model tells us?

Laurent Didier and Jean-François Hoarau
CEMOI, University of La Reunion.

Abstract:

The aim of this article is to identify determining factors of bilateral trade flows between Sub-Saharan African [SSA] and BRICs (Brazil, Russia, India, China). Although, except may be for Russia, all these emerging economies have a place more and more important in the African trade, some heterogeneity appears into the whole group about the reasons underlying this renewed interest. Starting from this observation, we decide to estimate gravity models for bilateral exports and imports of 47 Africans countries relative to BRICs, considered both as a group and individually, on the period 2000-2010. The results confirm the negative impact of distance and geographical remoteness together with the positive effects of SSA and BRICs’ GDPs. Moreover, the “augmented” variables (terms of trade, natural resources, democracy) highlight obviously the specific role of China compared to other BRICs, essentially for African exports.

Key words: Sub-Saharan Africa ; BRICs ; trade ; panel data ; gravity model.

JEL classification: O55 ; F1 ; F14.
1. Introduction

A striking observation emerges over the recent period relative to the structure of international economic relations. A part of the developing world has gained momentum and competes today the old industrialized countries for the leadership of the world economy (Moghadam, 2011). Among this emerging group, the BRICs (Brazil, Russia, India and China) are predominant. Over the period 2000-2008, they accounted for half of the world economic growth while this latter still was largely generated by some developed countries (United States, Great-Britain, Germany, France, Canada and Italia) up to the end of the 20th century (De Vries and al., 2012). Moreover, recent studies forecast that these new “economic giants” will contribute to 61% of world GDP against only 13% for the industrialized countries over the period 2008-2014.

At the same time, many sub-Saharan African countries display an economic growth performance significantly higher that during the last three decades (Martinez and Mlachila, 2013). Despite its low weight in world production, this region seems to have developed a resilience capacity which enables it to cross the international crisis without major damages: since 2008 although the world is hurt by a global contraction of more than 2%, sub-Saharan Africa shows economic growth rates always above 2% (World Bank, 2010; Allen and Giovannetti, 2011).

These interesting changes raise the question of the link between the BRICs dynamics and the good economic performances of Sub-Saharan Africa. Indeed, the growing role of the major developing countries in trade, finance, investment and world governance, together with their rapid economic growth, has aroused the interest for South-South cooperation and stimulated the debates about the consequences for Africa’s development (UNCTAD, 2010; Renard, 2011). Then, even if some negative effects exist, the growing importance of these emerging economies has given a significant push to economic growth of most countries belonging to the subcontinent¹, what constitutes a crucial factor for a sustained economic development process in the long run² (Moghadam, 2011; He, 2013).

The sub-Saharan Africa’s economic dynamism resulting from these influent emerging economies results mainly from foreign trade³. To this regard, three elements must be discussed. Firstly, bilateral trade flows have strongly increased since the beginning of the 2000s due to narrow complementarities between comparative advantages of Africa and increasing energy needs from the productive sector of BRICs. Even if European Union and United States stay the main partners of Africa, their share in African trade decreased significantly and continuously in favor of the new giants of the world economy (Subramanian and Matthijs, 2007). Furthermore BRICs became the first trade partners of sub-Saharan Africa amongst the whole developing world. Secondly, the economic rise of BRICs created a good

¹ These good economic performances were also driven by the implementation of sound macroeconomic policies in many African economies over the recent period.
² Moghadam (2011) shows that the BRICs contribution to the sub-Saharan Africa’s economic growth, especially for raw goods exporters, also rose during the international financial crisis.
³ Productivity gains in BRICs and inward foreign direct investment flows coming from BRICs are other significant factors.
climate for African producers\(^4\) by improving terms of trade due to the increase in raw goods prices\(^5\) (Zafar, 2007; Wang, 2007). Thirdly, BRICs allow African consumers to benefit from cheaply imports.

Amongst this group, one country, namely China, largely differs from the others by its contribution to the global growth (1/4 of the world GDP growth) and its share in sub-Saharan trade. The new direction of the Chinese foreign policy (Gu and al., 2008; Brautigam, 2010), its dependence from energetic resources\(^6\) and the need to strengthen basic infrastructure in Africa led to a strong rise in China-Sub-Sahara Africa trade by a 168 factor for African exports and by a 5.4 factor for African imports over the period 1980-2009. China became today the most exporting country in Africa and the second importing country of African goods, just behind United States (De Grauwe and al., 2012). So it is not surprising that a large part of the literature focused on the specificities and the determinants characterizing trade relations between these Asian giant and sub-Saharan African countries (Zafar, 2007; Morissey, 2010; De Grauwe and al., 2012).

Contrary to China, very few works have studied trade relations between sub-Saharan African economies and the three other BRICs (Moghadam, 2011). However, their share in world trade and in Africa grows sharply (World Bank, 2011). Thus it is also very crucial to identify what drives trade flows between sub-Saharan Africa and Brazil, India and Russia. Otherwise, BRICs do not constitute a homogeneous group in the international trade area (Cooper and Fues, 2008; Moghadam, 2011). In first place, as China, India and Brazil import mainly natural resources (oil, minerals, metals …), contrary to Russia which is well endowed in this domain. In second place, China exports almost exclusively manufactured and capital goods although the three others show a more diversified structure with notably a significant part for agricultural goods. So we cannot generalize the Chinese case to the other group members.

Then, this article aims at studying the role of BRICs in the evolution of sub-Saharan African countries’ foreign trade (Parikh and Shibata, 2004; Jenkins, 2006). Note that special attention will be placed on the Chinese case given its predominance. More precisely, we try to identify the underlying factors which permit to sustain the good trade performance of sub-Saharan Africa observed during the last decade. To this regard, we implement several “augmented” gravity models for bilateral trade flows between 47 sub-Saharan economies\(^7\) and BRICs over the period 2000-2010. In order to take into account the heterogeneity amongst the BRICs, we estimate one gravity model for each emerging economies. Alongside standard variables as

\(^4\) Note that the development of BRICs, and in particular of China, has also some adverse effects on the African productive sector. Indeed, Chinese exports in manufactured goods compete directly African industrial goods both on internal and external markets (Kaplinsky and Morris, 2008; Renard, 2011). In several African countries, infant industry in the textile and clothing sectors has been crowded out by the Chinese low cost imports (Subramanian and Matthijs, 2007).

\(^5\) The increase in world prices of raw goods results from a demand effect due to the rapid development of industrial activity and thus energetic needs in the new large emerging countries.

\(^6\) http://www.relooney.info/SI_Oil-Politics/Africa-China_52.pdf.

\(^7\) These ones are South Africa, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroun, Cap-Verte, Comoros, Congo, Ivory Coast, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Bissau Guinea, Equatorial Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Uganda, Central African Republic, Democratic Republic of Congo, Rwanda, Senegal, Seychelles, Sierra Leone, Somalia, Soudan, Swaziland, Tanzania, Chad, Togo, Zambia, Zimbabwe.
GDPs, population, GDP per capita, distance, remoteness, colonial past, terms of trade or WTO membership, we integrate other variables like democracy and endowments in natural resources (Anderson and Marcouiller, 2002; De Grauwe and al., 2012). Moreover, we run three panel data estimation methods robust to the presence of zero trade flows: (i) a standard log-linear specification but by arbitrarily adding a small positive number (1 in our case) to all trade flows in order to ensure that the logarithm is well-defined (Linders and De Groot, 2006), (ii) a censored on the left side regression by implementing a Tobit model (Martin and Pham, 2008), and (iii) a Pseudo Poison Maximum Likelihood [PPML] approach (Santos Silva and Tenreyro, 2006; Santos Silva and Tenreyro, 2011).

The rest of this paper is structured as follow. Section 2 presents stylized facts on the African trade with BRICs. Section 3 exposes the gravity specifications and the estimation methods retained. Section 4 shows and discusses the results. Section 5 concludes.

2. The stylized facts

The historical trade partners of SSA, namely European Union (EU) and the USA, still remain today the principal actors of the African external trade even if we observe significant erosion essentially for European countries. Effectively, between 1995 and 2010, the share of EU in African exports fell from 34.3% to 22% whereas for USA this one increased from 16.8% to 24%. However, this trade reallocation by the African countries has mainly benefited to the BRICs (Head and al., 2010; Moghadam, 2011).

Figure 1. Evolution of African trade balances with BRICs from 2000 to 2010

![Graph showing trade balances with BRICs](image)

Source: Unctad, author’s calculations.

Figure 1 reports that the time movement of SSA exports in the percentage of GDP follows closely that of the net exports between SSA and BRICs. This observation is particularly apparent for the trade with China and to a lesser extent with Brazil. From 2000 to 2010, the share of BRICs in the African exports has more than doubled from 10% in 2000 to 25% in 2000. In parallel the African imports from BRICs surged to 155%; the share of BRICs in SSA
imports increased from 7.5% in 2000 to 19.3% in 2010. Moreover, we see clearly that the “take-off” of trade with BRICs started since the beginning of the 2000s essentially driven by the two Asian economic leaders, namely China and India.

Several features characterize trade relations between SSA and BRICs. Firstly, we observe a geographical trade concentration phenomenon on a few African as it is already the case for the North-South trade. Indeed, South Africa, Nigeria, Angola but also Ethiopia and Uganda explain more than ¾ of overall bilateral trade. Secondly, this trade concentration also concerns the nature of traded products. According to their comparative advantages and intrinsically according to their factorial endowments (Figure 2), African economies export to BRICs principally raw goods (about 70%) composed by oil (52%), mineral (8%) and precious stones (4%). In the same vein, the imports from BRICs concentrate mainly on the manufactured products (Figure 4) as the miscellaneous manufactured articles (apparel, furniture …) and equipments (machinery and transport) which represent respectively 26% and 20% of the total imports, and on the chemical products (15%).

Figure 2. Composition of exports by products between SSA and BRICs

Source : Unctad, author’s calculations.

Otherwise, a more detailed analysis allows us to put forward a degree of heterogeneity into the BRICs group and this at least at two levels. On the one hand, China dominates widely the three others emerging countries and constitutes today the most important trade partner of the SSA among all the developing countries (Figure 1). This former has more than tripled it share in the African exports from 5% in 2000 to more 15 % in 2010. In fine, China contributed directly or indirectly to the improvement of Africa terms of trade stopping an ongoing process

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8 India has a structure of imports more diversified geographically because of its strategic position in the Indian Ocean.
since the start of decolonization (Table 1). Following Figure 3, we can see that the growth in African terms of trade follows remarkably the bilateral trade evolution between SSA and China during the latter decade.

**Table 1. The impact of China on the terms of trade of SSA**

<table>
<thead>
<tr>
<th>Potential winners (oil and metal producers)</th>
<th>Mixed (metal or mineral producers, oil importers)</th>
<th>Potential losers (agricultural or textile producers, oil importers)</th>
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</table>

16 17 15


**Figure 3. Trade expansion Africa-Chinese**

India comes in second position doubling it share on the same period to reach 7% of the African exports in 2010. Brazil arrives in third position displaying a modest share, 2% in 2010, but increasing continuously since 2000. Finally Russia shows a marginal share in the SSA exports. The same observation can be found concerning imports from BRICs. China remains the first supplier of SSA by representing 8% of African imports against 3.18% for India, 1.8% for Brazil and 0.4% for Russia. Note that except for this latter the three other countries saw their importance in the African imports growing strongly since the 2000s.

On the other hand, some significant differences arise at the level of the structural composition of traded products when one focuses on Brazil and Russia. On the exports side, Russia distinguishes markedly of other (Figure 2). Indeed contrary to other BRICs, it shows a
relatively diversified trade structure. Considering that this economy is rich in natural resources (oil, gas …), the complementarity property with African countries does not exist. Thereby the SSA economies export mostly to these European country food products (more than 40% in 2010), minerals (15%), beverages and tobacco (10%). Manufactured articles represent only less than 10%.

On the imports side (Figure 4), Brazil shows a certain singularity. In fact, being specialized in agrifood industry and contrary to the three other BRICs which export majority manufactured products, the first import post of the Brazilian products is food (more than 30%) then equipment (20%) and miscellaneous manufactured articles (15%).

Figure 4. Commodity composition of imports between SSA and BRICs

Source : Unctad, author’s calculations.

Finally the stylized facts identified above are consistent with those resulting from previous studies about the African region (Wang, 2007; Zafar, 2007; Luo and Zhang, 2010; Moghadam, 2011; De Grauwe and al., 2012). Furthermore the overwhelming weight of China and the relative heterogeneity within the BRICs group could indicate that the factors governing trade between SSA and BRICs are country specific. Consequently, a differentiated econometric analysis is needed.

3. The methodological approach: the “augmented” gravity specification

In order to estimate the ex-post impact of trade determinants, we use a traditional tool in international trade, namely the gravity model. The theoretical foundations of this model are already well known. Theses ones have evolved over time. Starting, from the application of Newton’s law of gravity in international trade (Tinbergen, 1962; Head and Mayer, 2013). They have progressively improved by integrating the microeconomic development as the
Armington hypothesis\(^9\) (Anderson, 1979), differences in factor endowments (Bergstrand, 1989; Deardorff, 1998), the new international trade theory\(^10\) framework (Helpman and Krugman, 1987; Anderson and van Wincoop, 2003) and the firms’ heterogeneity hypothesis (Melitz, 2003; Chaney, 2008; Melitz and Ottoviani, 2008).

### 3.1. The empirical specification of the gravity equations

Foremost, note that our empirical simulations are implemented by using panel data. Overall, there is a large consensus in the economic literature on the fact that the gravity equation estimation in panel samples is better effective than in cross-section (Matyas, 1997; Egger and Pfaffermayer, 2003). Specifically we use a log-linear version of an “augmented” gravity model based on variables widely used in the applied literature (Rose, 2004; De Grauwe and al., 2012) to characterize the trade intensity nature between SSA countries and BRICs \([IT_{ijt}]\).

Trade is thus analyzed in its double dimension, i.e. exports \([X_{ijt}]\) and imports \([M_{ijt}]\). Otherwise insofar we showed that trade can differ depending on the BRICs considered, the gravity equation is applied with temporal fixed effect \([Crisis_t]^{11}\) both on the whole sample and on each BRICs taken individually. Then:

\[
\ln IT_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln DGDP_{ijt} + \beta_4 \ln D_{ij} + \beta_5 \ln TOT_{it} + \beta_6 REMOT_{it} + \beta_7 RES_{it} + \beta_8 DEMO_{i} + \beta_9 COL_{ij} + \beta_{10} WTO_{ijt} + Crisis_{t} + \mu_{ijt}
\]

Equation (1) contains several types of explanatory variables. Firstly, it includes variables which depend on time and partners’ countries that is the economic weight given by GDPs \([GDP_{it}, GDP_{jt}]\), a specialization indicator proxied by the absolute value of the GDP per capita differential \([DGDP, pc_{ijt} = |GDP_{pc_{it}} - GDP_{pc_{jt}}|]\) and the terms of trade \([TOT_{ijt}]\). The first variable acts as an attractor impacting trade positively. The second variable is used to test differences in factor endowments (Frankel and al., 1995). The expected effect is ambiguous depending on the nature of trade in presence. A positive estimated coefficient would signify the existence of inter-industry trade according to the HOS theory. On the contrary, a negative coefficient would support the Linder theory (1961) whereby similar GDPS per capita is the sign of an intra-industry trade. The last variable, in accordance with the well-known “Marshall-Lerner” effect, is supposed to exert a negative impact on exports and a positive one on imports.

Secondly, this gravity specification takes into account the geographical distance \([D_{ij}]\), a non time-varying variable but depending on trade partners. This one should exert a repulsion force (trade costs proxy) and influences trade negatively.

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\(^9\) That is homogenous goods, good differentiation by demographic sources, imperfect substitute goods.

\(^{10}\) This framework is based on monopolistic competition, economies of scale, increasing returns, transport costs.

\(^{11}\) We used the Hausman test to choose between a fixed effects model and a random model. The test rejects the null hypothesis supporting then the fixed effects model. So, temporal fixed effects \((Crisis_t)\) are included to take into account the world economic recession starting in 2008 but also the time-varying unobservable characteristics which are common to all countries. Formally, this effect is introduced via a dummy variable for the year 2009.
Thirdly, equation (1) includes specific dummy variables independent of both time and trade partners identity:

- The remoteness variable \([\text{REMOT}_i]\) which takes 1 if the country \(i\) is landlocked or insular and 0 otherwise. To be landlocked or insular is obviously impediments to the international trade so a negative effect is expected (Lima and Venables, 1999; Portugal-Perez and Wilson, 2008).

- The resource variable \([\text{RES}_i]\) which takes 1 if country \(i\) is richly endowed in natural resources and 0 otherwise. This determinant aims at testing whether the African economies which most trade with BRICs also corresponds to those which have important oil reserves. Then a positive coefficient is required.

- The democracy variable \([\text{DEMO}_i]\) which takes 1 if country \(i\) has a democratic electoral system and 0 otherwise. The theoretical results state that good governance has a positive effect on trade (Mansfield and al., 2000; Anderson and Marcouiller, 2002). Indeed, country characterized by a bad governance shows high transaction costs resulting in insecurity for trade then limiting its trade capabilities.

- The colonization variable \([\text{COL}_{ij}]\) which takes 1 if countries \(i\) and \(j\) have in common the same colonizer, and 0 otherwise. This determinant, especially relevant for developing countries, reflects the fact that a common colonial past affects positively bilateral trade. However, note that this variable is not included in individual Chinese and Russian specifications because these ones never had colonial link with African countries.

Finally, our gravity model incorporates dummy variables varying both in time and partners. It is the case for formal participation in WTO multilateral agreements \([\text{WTO}_{ijR}]\) which equals 1 if countries \(i\) and \(j\) have the right to vote in the WTO and 0 otherwise. We introduced this latter to study if the multilateral trade liberalization process benefited to African countries over the 2000-2010 period\(^{12}\). The theoretical expected effect is of course positive (Subramanian and Wei, 2003; Tomz and al., 2007; Chang and Lee, 2011).

3.2. The data

Our panel includes 188 cross-section over the period 2000-2010 (2068 observations for the global sample) against 47 individuals cross-sections for each individual BRICs sample over the same time period (517 observations). To estimate these gravity equations between SSA countries and BRICs we used the Unctad database (UnctadStat) for the dependent variables and some independent variables. We extracted the exports and imports values (in thousands of US dollars) from the trade goods matrix by partners and products. We retained desegregated trade products as explicative variable. The main source of these data comes from UN DESA Statistic Division and UN COMTRADE with the standard classification for international trade (SCIT). Regarding real GDPs (in millions of US dollars) and real GDPs per capita, the Unctad Secretariat based on the UN DESA Statistic Division and the National Accounts Main Aggregate Database was chosen.

\(^{12}\) Only China and India established non-reciprocal trade agreements with SSA countries, essentially LDCs. So, we preferred to concentrate on the multilateral liberalization with WTO rather than preferential agreements.
Concerning the distance, remoteness and colony variables we relied on the Cepii database\textsuperscript{13}. More precisely for the distance, we chose the classical geodesic distance calculated from the great circle formula using latitudes and longitudes of the most important cities and agglomerations in terms of population.

The terms of trade have been extracted from the Word development indicators (WDI) database established by the World Bank. This one “is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000”.

To characterize whether or not the African countries considered have established an electoral democratic system, we opted for the Freedom House\textsuperscript{14} database. This indicator has five components: (i) type of elections (type of vote, majority or proportional …); (ii) fair elections; (iii) the course of the election campaign; (iv) the possibility of political change; (v) transparency of political financing.

Then to determine the WTO membership we use the official WTO list\textsuperscript{15} about member states together with constructive remarks from earlier empirical works in the domain (Subramanian and Wei, 2003; Tomz and \textit{al.}, 2007; Chang and Lee, 2011).

Finally, following the work of Collier and O’Connell (2009), a country is considered to be well endowed in natural resources when two conditions are met: (i) the value of the energy sector rents must at least represents 5% of the gross national income; (ii) the share of raw goods in exports must exceed 20% during at least five years from the reference period.

3.3. Log-linear specification limits

Traditionally the gravity model is estimated using the log-linear form (Equation 1) with the Ordinary Least Squares [OLS]. Nevertheless at least three main methodological problems results from this approach (Burger and \textit{al.}, 2009; Gomez Herrera, 2013; Arvis and Shepherd, 2013): (i) the “adding-up” bias created by the logarithmic transformation\textsuperscript{16}; (ii) the violation of the homoskedastic errors assumption; (iii) the presence of zero trade flows in trade data. Among these ones, the latter is probably the most detrimental and debated today. Indeed the log-linear form is unable to deal with zero trade flows because the logarithm of zero is undefined. Some authors proposed to conserve the log-linear form but deleting these observations or substituting them by a low positive value as 0.5 or 1 (Bénassy-Quéré and \textit{al.}, 2005). If these flows reflect sometimes measurement problems or the lack of data, zero flows can also give precious information about the real absence of trade relations between countries. Then removing the null observations is not a good strategy in an economic viewpoint. The

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\textsuperscript{14} American NGO since 1972 produces several indicators about civil and politic rights for all countries of the world. http://www.freedomhouse.org/report/countries-crossroads-2012/methodology.

\textsuperscript{15} http://www.wto.org/french/thewto_f/whatis_f/ftorg6_f.htm.

\textsuperscript{16} According to the Jensen inequality, $lnE(Z) \neq Eln(Z)$, with the OLS, the sum of trade flows estimated for each exporter or importer exceeds systematically the total of observed exports or imports of each countries (Arvis and Shepherd, 2011).
second method is no more suitable in the extent that the chosen value is determinate arbitrarily and does not rely on empirical and conceptual foundations (Linders and De Groot, 2006).

Accordingly, we apply two alternative estimations methods\textsuperscript{17}.

On the one hand, the Tobit model is a mix between a Gaussian model, equivalent to a linear model, and a Probit model, that is a censored regression by maximum likelihood (Coulibaly and Fontagné, 2006; Linders and De Groot, 2006; Anderson, 2011). The Tobit has the advantage to explicitly recognize the existence of zero flows by treating them as unrecorded trade flows while normalizing the error term distribution. However, the appropriateness of this approach to solving the zero trade issue has been questioned. The Tobit model reflects a situation where some observations are censored (unobservable) and recorded as zero. The model applies to situations where small values of trade are rounded to zero or actual zero trade might reflect “desired” negative trade. The censoring of trade flows below some positive value is a plausible assumption for some countries but it is hard to believe for other countries for which trade data are reported at a very high degree of accuracy. Therefore, from this perspective the use of a Tobit estimation can only be partially justified. With regard to the second hypothesis, Linders and De Groot (2006) noted 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.

On the other hand, we also implement the Pseudo Poisson Maximum Likelihood (PPML). This estimator is applied to the trade intensity variable taken in level (not in log) which allows us to estimate directly the multiplicative form of gravity equation and thus preserving the zero flows. This method provides two other decisive advantages. Firstly, it is robust to the presence of heteroskedasticity (Santos Silva and Tenreyro, 2006; Santos Silva, 2011). Secondly, PPML resolves the “adding-up” problem. Note that the Poisson model is vulnerable to the problem of over-dispersion and excess zero flows. Then, it could be preferable to use negative binomial or zero-inflated Poisson (ZIP) estimators (Burger and al., 2009). However, the number of zero flows being relatively limited in our sample (7 % for exports and 2 % for imports), we retained the standard PPML method.

4. The empirical results

Tables 2 and 3 report the results of the estimations for exports and imports respectively, both for the BRICs group and for each emerging country taken separately. A preliminary analysis puts forward several similarities with the seminal work of Santos Silva and Tenreyro (2006).

\textsuperscript{17} Concerning the statistical treatment of zero flows, a third method, the Heckman method (1979), exists in the literature. This latter allows to take into account of zero flows two-steps procedure. In the first step, a qualitative model is estimated in accordance with the Probit approach. In a second step, a regression on the positive data with OLS or GLS is implemented by introducing the inverse of the Mills ratio as an explicative variable. Nevertheless, this method has two limits: the non-correction of heteroskedasticity and it suitability mainly for micro-firms data. Operationally, this approach is relevant when the zero flows due to a deliberate choice of enterprises or countries to not export or import. A quickly overview of our sample suggests that zeros rather come from measurement of problems.
Firstly, the OLS ad hoc and the Tobit methods give relatively the same coefficients. Secondly, the coefficients resulting from PPML are often much lower than the ones estimated by OLS and Tobit. This is especially true for traditional variables as GDPs and distance. These gaps seem to come from the non-robustness of OLS and Tobit estimators in presence of heteroskedasticity\(^\text{18}\). Then, the determining variables effects are not independent of the economic approach chosen. Thus in order to take into account the possibility of heteroskedasticity, we give more importance to the results from PPML.

### 4.1. The exports

We focus first on estimations about the BRICs group. The results for the traditional variables are statistically significant and consistent with the theory. The distance appears to be a strong impediment to bilateral trade between African countries and BRICs. So, the more the distance is high between trade partners the more trade is penalized. For the GDP of exporters and importers, the results also support the theory, so that the more the economic size is great the more trade is important.

Concerning the “augmented” variables, results are also interesting. Firstly, being richly endowed in natural resources has a positive effect on African trade with BRICs but the coefficient is not significant. Secondly, the coefficients of the terms of trade and colonial links are significantly positive. For the terms of trade, this effect is counter-intuitive except if we consider the particular nature of the traded products. Normally, an improvement in terms of trade should lead to diminish exports because the country loses in price competitiveness. This surprising finding could be justified by the concentrated nature of the traded products. Indeed, SSA economies export towards the BRICs essentially material raw (oil, mineral, diamond …). Thirdly, having a democratic electoral system in SSA lead to reduce bilateral trade with BRICs. This complies with the stylized facts since the main African exporters to BRICs as Angola, Uganda or Ethiopia are also the less democratic countries in this developing region.

Then we discuss the results relative to BRICs taken individually. As previously, whatever the BRIC considered, the GDP of African exporters are significantly positive. However, concerning the GDPs of importing countries, only the GDPs of Brazil and India conform to the theory. Moreover, the proxies of transport costs, namely distance and geographical remoteness, always exert a negative effect on trade. The coefficients from the GDP per capita differential are all non-significant for Brazil, Russia, India and China. Two explanations can be invoked: (i) the fact that trade is relatively diversified with Russia and India; (ii) the strong difference in terms of development levels allowing the coexistence between intra and inter-trade links in the case of the trade with Brazil and China.

Otherwise, the “augmented” variables underline several sizeable differences in the African trade structure according to the emerging partner considered. Unsurprisingly, China makes clearly the difference with the other BRICs.

\(^{18}\) We applied the Breusch-Pagan test in order to detect heteroskedasticity in OLS and Tobit estimations. The null hypothesis of homoskedasticity is clearly rejected.
On the one hand, African exports to China are significantly and positively influenced by the natural resources of SSA. This result corroborates our stylized facts developed before stating that oil countries as Angola and Nigeria are the main African exporters to China. Moreover in accordance with the surprising finding relative to the whole group, an improvement in terms of trade relative to China and Russia seems to affect positively SSA exports. Once again the argument of trade concentration can be raised.

On the other hand, the presence of a democratic electoral system in SSA impacts significantly only the trade with China: the effect is surprisingly negative. Thus, the relation between democracy and trade leads to reduce African exports to China. Indeed, this result contrasts with the theory but consistent with the recent papers of De Grauwe and al. (2012) and Hanusch (2012). It is also in line with the political principles of the “Beijing consensus” (Ramo, 2004). Contrary to the global level, the WTO variable is significant at the individual one. More precisely, participating to WTO positively affects African bilateral trade with China and India and negatively with Brazil. Finally our study highlights the importance of colonization where a distinction is made between Brazil and India. The coefficient for the former is negative but non-significant whereas for the latter it is significantly positive. One can explain this by the difference of the colonization strategy: Portugal opted for a settlement colonization while Great-Britain established a deep institutional colonization then promoting the development of former English colonies. In other words, in the first case, the colonies were considered essentially for their extractive resources exclusively consumed by the colonizer. In the second case, they inherited the cultural, political and economical practices of the colonizer which foster their development and ability to trade (Acemoglu and al., 2001; Acemoglu and Robinson, 2010). China and Russia are not concerned by this factor because there is no formally common colonial past.

4.2. The imports

At the global level of BRICs, we see that all explicative variables are significant except for the terms of trade and democracy. We note that the signs of traditional variables do not change compared to exports. So, the economic size of trade partners and the proxies of transport costs are both an engine and a barrier for trade. Moreover, the fact that African countries are richly endowed in natural resources acts negatively on bilateral imports. This result is surprising because Angola, Nigeria and South Africa are the ones that import most with the BRICs countries.

On the whole, the same results are found at the individual level, with few exceptions concerning some independent variables. The profile of the relations with Brazil and India largely follows the group. Notwithstanding we point out a difference concerning the democracy variable which affects negatively and significantly the African imports from Brazil. For China and Russia, fewer variables are significant (GDP of African countries, distance, remoteness, resource) but the coefficients remain consistent with those associated with the whole group.

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19 This result must be taken with caution because the improvement in terms of trade does not affect uniformly the countries richly endowed in natural resources (Roache, 2012; Villoria, 2012).
### Table 2. The exports results

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>Tobit</th>
<th>PPML</th>
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<tbody>
<tr>
<td></td>
<td>BRICs</td>
<td>Brazil</td>
<td>China</td>
</tr>
<tr>
<td>ln (GDP_t)</td>
<td>1.44***</td>
<td>2.34***</td>
<td>1.46***</td>
</tr>
<tr>
<td>(0.074)</td>
<td>(0.163)</td>
<td>(0.126)</td>
<td>(0.129)</td>
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<tr>
<td>ln (GDP_r)</td>
<td>3.26***</td>
<td>0.73</td>
<td>1.41</td>
</tr>
<tr>
<td>(0.266)</td>
<td>(0.281)</td>
<td>(0.927)</td>
<td>(1.017)</td>
</tr>
<tr>
<td>ln (DGDP:pc_t)</td>
<td>-0.34***</td>
<td>0.05</td>
<td>-0.02</td>
</tr>
<tr>
<td>(0.040)</td>
<td>(0.128)</td>
<td>(0.09)</td>
<td>(0.058)</td>
</tr>
<tr>
<td>ln (Distance_t)</td>
<td>-0.78</td>
<td>-3.43***</td>
<td>-6.49***</td>
</tr>
<tr>
<td>(0.483)</td>
<td>(1.047)</td>
<td>(1.398)</td>
<td>(0.827)</td>
</tr>
<tr>
<td>Remoteness_t</td>
<td>-0.42***</td>
<td>-0.026</td>
<td>-0.75***</td>
</tr>
<tr>
<td>(0.089)</td>
<td>(0.187)</td>
<td>(0.15)</td>
<td>(0.149)</td>
</tr>
<tr>
<td>Resource_t</td>
<td>0.10</td>
<td>0.19</td>
<td>0.75***</td>
</tr>
<tr>
<td>(0.101)</td>
<td>(0.208)</td>
<td>(0.175)</td>
<td>(0.172)</td>
</tr>
<tr>
<td>ln (TOT_t)</td>
<td>0.81*</td>
<td>-0.62</td>
<td>2.96***</td>
</tr>
<tr>
<td>(0.355)</td>
<td>(0.66)</td>
<td>(0.563)</td>
<td>(0.536)</td>
</tr>
<tr>
<td>Democracy_n</td>
<td>-0.15</td>
<td>-0.003</td>
<td>-0.5**</td>
</tr>
<tr>
<td>(0.09)</td>
<td>(0.191)</td>
<td>(0.154)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>WTO_br</td>
<td>0.06</td>
<td>-0.95***</td>
<td>0.45*</td>
</tr>
<tr>
<td>(0.094)</td>
<td>(0.26)</td>
<td>(0.192)</td>
<td>(0.221)</td>
</tr>
<tr>
<td>Colony_t</td>
<td>0.69***</td>
<td>-0.25</td>
<td>0.36*</td>
</tr>
<tr>
<td>(0.137)</td>
<td>(0.289)</td>
<td>(0.152)</td>
<td>(0.152)</td>
</tr>
<tr>
<td>Crise_t</td>
<td>0.04</td>
<td>0.18</td>
<td>0.003</td>
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<tr>
<td>(0.03)</td>
<td>(0.096)</td>
<td>(0.002)</td>
<td>(0.0009)</td>
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<tr>
<td>Constant</td>
<td>-45.03***</td>
<td>-11.27</td>
<td>-4.56</td>
</tr>
<tr>
<td>(2.68)</td>
<td>(33.37)</td>
<td>(13.36)</td>
<td>(12.361)</td>
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Notes: ***, ***, * exponents denoting significance at the 0.1%, 1%, 5% and 10% level, respectively. Standard errors are in parentheses.
Table 3. The imports results

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>Tobit</th>
<th>PPML</th>
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<tbody>
<tr>
<td></td>
<td>BRICs</td>
<td>Brazil</td>
<td>China</td>
</tr>
<tr>
<td>ln (GDP₀)</td>
<td>0.84*** (0.045)</td>
<td>0.93*** (0.05)</td>
<td>0.80*** (0.049)</td>
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<tr>
<td>ln (GDP₁)</td>
<td>3.43*** (0.152)</td>
<td>5.52*** (0.648)</td>
<td>2.2*** (0.252)</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>ln (DGDP,pc_m)</td>
<td>-0.18*** (0.024)</td>
<td>-0.08* (0.044)</td>
<td>-0.04 (0.036)</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>ln (Distance_m)</td>
<td>-2.26*** (0.288)</td>
<td>-1.34*** (0.363)</td>
<td>-0.90 (0.537)</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Remoteness</td>
<td>-0.61*** (0.054)</td>
<td>-0.72*** (0.064)</td>
<td>-0.39*** (0.058)</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>Resource</td>
<td>-0.41*** (0.0621)</td>
<td>-0.43*** (0.072)</td>
<td>-0.28*** (0.067)</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>ln (TOT₀)</td>
<td>0.32 (0.201)</td>
<td>0.32 (0.229)</td>
<td>0.14 (0.217)</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>Democracy</td>
<td>-0.07 (0.055)</td>
<td>-0.14* (0.066)</td>
<td>0.106 (0.059)</td>
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<td></td>
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<tr>
<td>WTO₂t</td>
<td>0.54*** (0.056)</td>
<td>-0.57*** (0.090)</td>
<td>0.08 (0.074)</td>
</tr>
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</tr>
<tr>
<td>Colony</td>
<td>0.74*** (0.083)</td>
<td>0.02 (0.100)</td>
<td>0.37*** (0.06)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Crisis</td>
<td>-0.03 (0.09)</td>
<td>0.03 (0.105)</td>
<td>0.05 (0.101)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-35.93*** (1.547)</td>
<td>-62.36*** (7.646)</td>
<td>-23.56*** (3.92)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| R² (pseudo-R²)     | 0.47 (14.70)         | 0.59 (7.57)           | 0.55 (6.57)          | 0.56 (6.57)          | 0.39 (6.57)          | 0.47 (14.70)         | 0.59 (7.57)          | 0.55 (6.57)          | 0.56 (6.57)          | 0.39 (6.57)          |
| Observations       | 2068                 | 517                   | 517                  | 517                  | 517                 | 2068                 | 517                   | 517                  | 517                  | 517                 |
| Fixed effects      | Yes                  | Yes                   | Yes                  | Yes                  | Yes                 | Yes                  | Yes                   | Yes                  | Yes                  | Yes                 |

Notes: ***, **, * denote significance at the 0.1%, 1%, 5% and 10% level, respectively. Standard errors are in parentheses.
5. Conclusion

As suggested by De Grauwe and al. (2012), it is very interesting to know if the trade determinants between Africa and China would significantly differ to those relative to other developing areas. This is the main goal of the present work in the specific case of bilateral trade between SSA and BRICs. At first, a descriptive analysis allows us to identify three major stylized facts: (i) a increasingly weight of BRICs in the foreign trade of SSA since the beginning of the 2000s in the detriment to Europeans countries; (ii) a double concentration phenomenon concerning both the nature of traded products and the geographical location; (iii) the uncontestable leadership of China within the BRICs group. Then we note clearly a reorientation of African trade even if this South-South trade presents very similar characteristics to those observed for the North-South trade.

Thereafter, we estimated several “augmented” gravity equations in panel for a recent period 2000-2010 to put forward the determinants of the bilateral trade between SSA and BRICs economies. Six results emerge. (i) the distance and geographical remoteness in SSA continue to be high trade barriers; (ii) the empirical evidence of a relatively diversified trade with Russia and India but not with China and Brazil; (iii) the positive effect of the endowment in natural resources of African economies on the bilateral trade with China; (iv) improvement in African terms of trade impacts positively exports (principally in the case of trade with China) due to the exports concentration in raw goods; (v) the negative relation between trade and democracy for Brazil and China; (iv) the positive role of colonial links for the trade between the former English colonies and India.

Consequently, the “Chinese peculiarity” has been empirically proved compared to the other BRICs. However, this South-South trade is not so different from North-South trade in the extent that China as well as developed countries exploit the same comparative advantages of African countries (De Grauwe et al., 2012). For instance, in the two cases we observe the double trade concentration phenomenon. Finally, China, and to a lesser extent the other BRICs, maintain also the SSA economy in their economic specialization with the recurrent problem of the natural resource curse (Arezki and Gylfason, 2013; Sala-i-Martin and Subramanian, 2013).
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MARTIN (W) & PHAM (C.S), « Estimating the gravity model when zero trade flows are frequent », Deakin University, Faculty of Business and Law, Economics Series n° 3, 2008, 47 p.


