

**China's African financial engagement, real exchange rates and trade
between China and Africa**

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Abstract

In the last decade China's trade with Africa increased faster than its overall foreign trade. This paper focuses on the role of real exchange rates in this growth. A "bilateral real exchange rate" augmented trade gravity model applied to China's trade with 49 African countries over the period 2000 to 2011 shows that the real appreciation of most African currencies relative to the renminbi favoured China's exports to these countries, but had no impact on China's imports from Africa. This real appreciation of African currencies is explained by three main factors: 1) the decision to peg them to other currencies (in particular to the euro), 2) the amount of export of raw materials from African countries, and 3) the amount of financial assistance from international donors including China. Thus, a kind of detrimental sequence exists in Africa's relationship with China: China's imports of raw materials and its economic cooperation are among the factors explaining the appreciation of African real exchange rates, which itself stimulates China's exports of manufactured goods, and so restricts Africa's own industrial development.

JEL Codes: F12, F14, F31, F35

Key Words: real exchange rate, trade, aid, China, Africa

1. Introduction

Since the “open door” policy launched in 1978, China has made big efforts around the world to secure the raw materials needed to sustain its high growth rate and to diversify its exports. This effort accelerated from 1999 when China adopted the “go out” policy. As part of this policy, China turned to Africa following the first *China/Africa Cooperation Forum* in 2000. Since then China’s trade with Africa has intensified: beginning at a very low level, it has increased at a higher rate than that of China’s total trade. The rapid growth of China’s imports from Africa is an immediate source of economic growth for Africa; however in the long term, since China’s imports are accompanied by a nearly equivalent amount of exports of manufactured products, China’s trade with African countries may prevent them from diversifying their own production towards manufactured goods.¹

In the last decade, on average the renminbi depreciated in real terms relative to the currencies of African countries, while on the contrary it strongly appreciated relative to those of its main trade partners². The few recent econometric analyses of China/Africa trade have focused on the role of China’s direct investments in Africa (e.g. Biggeri & Sanfilippo, 2010), or on the quality of African governance (e.g. De Grauwe *et al.*, 2012); no paper, to our knowledge, has analysed the impact of real exchange rates on trade between China and Africa, even though China’s exchange rate policy has played a key role in the overall development of its exports (see Garcia-Herrero & Koivu (2008) for a literature review).

This paper focuses first on the role played by the bilateral real exchange rates between China and African countries in the growth of their bilateral trade. In order to separate the effects of China’s actions from the effects of African and international actions, we also analyse the determinants of the specific changes in the real bilateral exchange rates of African countries relative to China.

To investigate the determinants of China’s trade with Africa, we add the bilateral real exchange rates to the traditional factors of trade plus those specifically identified by the literature on China/Africa trade, such as China’s “economic cooperation”, China’s direct investments and African governance. By using the panel data from 49 African countries over the period 2000 to 2011, the econometric investigation shows that China’s exports of

¹ Previous studies have assessed the merits and risks in China’s move to Africa (See Goldstein *et al.*, 2006; Kaplinsky *et al.*, 2009; Wang, 2007; Zafar, 2007; Asche *et al.* 2008 and Pilling, 2009 etc.).

² No African country is among China’s main trade partners.

manufactured goods to Africa, contrary to its imports of raw materials, are significantly influenced by the real bilateral exchange rates. The real appreciation of African currencies stimulates China's exports of manufactured goods.

Then the reasons for the appreciation of the real exchange rates of many African currencies relative to the renminbi are identified. These reasons are firstly the exchange rate regimes chosen by African countries (generally a peg), and secondly their big natural resources (particularly oil and metal), (potentially leading to "Dutch disease" (Collier and Gunning, 1999)). However we might assume that China also contributes to the real appreciation of African currencies. China does this by keeping its currency undervalued, pegged *de facto* to the dollar, by its big demand for oil and other natural resources from Africa and by its financial inflows. The econometric investigation based on cross-country data from 49 African countries, as well as a panel sample from these countries over the period 2000 to 2011, does not reject these hypotheses. China's big demand for raw materials and economic cooperation with Africa contribute to the real appreciation of African currencies.

So it seems that a kind of detrimental sequence exists for Africa's relationship with China: China's imports of raw materials and its linked economic cooperation are factors in the appreciation of African real exchange rates, this appreciation itself stimulates China's exports of manufactured goods and restricts African industrial diversification.

The rest of this paper is organized as follows: Section 2 compares the changes in trade to the real exchange rates between China and African countries. Section 3 studies the relationship between real exchange rates and China/Africa trade. Section 4 focuses on the determinants of real exchange rates. Economic and political implications are offered in the conclusion.

2. Comparison of trade and real exchange rates between China and Africa

The dramatic growth of China/Africa trade

According to the data of UN *UNCTADstat*³, China's exports to Africa increased from US\$ 5 billion in 2000 to US\$ 73 billion in 2011 with an annual average growth rate of 30%, which is much higher than that of China's total exports (22%). China's imports from Africa increased from US\$ 5.6 billion in 2000 to US\$ 93.2 billion in 2011, with an annual average growth rate of 34% versus 21% for China's total imports (Fig. 1).

³ <http://unctadstat.unctad.org/>

Since 2009 China has become the most important trade partner for African countries (13% of Africa's exports and 12% of Africa's imports in 2011 (Fig.1)). For certain African countries, China is the dominant trade partner, for example, according to UN Comtrade, Democratic Republic of Congo, Sudan, Mauritania, and Angola export to China respectively 66%, 56 %, 45% and 39% of their total exports; Benin, Eritrea, and Liberia import from China 34%, 30% and 28% of their total imports (Table 1). On the contrary, Africa is still a minor trade partner for China (only 3.8% of China's total exports and 5.3% of China's total imports in 2011 (Fig.1)).

Diversification of China's African partners

China's African export partners are more diverse than its import partners, and both became increasingly diverse between 2000 and 2011. In spite of this diversification, China's trade with Africa remains relatively concentrated. In 2011 China's exports to 22 African countries and its imports from 10 African countries represented 90% of its total exports to, and imports from, the African continent. In terms of exports, South Africa, Egypt and Nigeria remain China's three most important partners. In 2011, Angola, Cameroon, Senegal, Mozambique, Democratic Republic of Congo and Equatorial Guinea became significant export partners for China. As regards China's imports, South Africa, Angola and Sudan are the three most important partners. In 2011, Zambia and Democratic Republic of Congo were among the significant Chinese import partners; Burkina Faso, Malawi, Gambia, Eritrea, Cape Verde and Sao Tome & Principe became new partners. It appears that China has difficulty in gaining access to the principal oil-producing Sub-Saharan countries which export to developed countries. China trades more intensively with Sub-Saharan African countries than with North African ones because of the nature of its imports.

Nature of exported and imported goods

Always according to UN *UNCTADstat*, China's imports from Africa are dominated by raw materials (94% of the total in 2011), principally petroleum (64%) and ores & metal (26%). China's exports to Africa are dominated by manufactured goods (93% of the total in 2011), principally machinery and transport equipment (48%), followed by textiles and clothing (13%). The structure of trade between China and Africa corresponds closely to the conventional trade model of comparative advantage.

The changes in China's real effective exchange rate relative to African currencies

We now consider the development of China's trade with Africa and the changes in the real exchange rate between China and African countries⁴. Since 1980, China has practiced a very active exchange rate policy, which was marked by a big real depreciation relative to its main trade partners from 1980 to 1993, and, on average, a real appreciation from 1994 to 2011 (see Guillaumont Jeanneney & Hua, 2011). However, in the last decade, the change in the Chinese real effective exchange rate relative to the currencies of African countries has been different from that relative to the currencies of the rest of the world. After an appreciation in 2001 of 2.8% relative to African currencies and 4.3% relative to its main trade partners' currencies in the rest of the world, the Chinese real effective exchange rate relative to African countries depreciated more strongly than relative to the rest of the world (respectively by 27% and 12% over the period 2001 to 2005)⁵. Then, from 2006 to 2011, the Chinese real effective exchange rate relative to African countries depreciated by a further 6% while that relative to the rest of the world appreciated by 22%. Consequently, during the total period of our analysis, from 2000 to 2011, the renminbi depreciated by 29% relative to African trade partners in real terms, while it appreciated by 13% relative to the rest of the world. Conversely, on average, African currencies appreciated in real terms by 42% relative to the renminbi, and by 51% for the Sub-Saharan African countries. During the same period the currencies of China's main trade partners in the rest of the world depreciated by 11% relative to the renminbi (Fig. 2).

The wide diversity of African bilateral exchange rates

The changes in the real effective exchange rate of China relative to Africa hide a wide diversity in the changes in real bilateral exchange rates (Fig. 3). The currencies of 35 African countries appreciated in real terms relative to the renminbi, while those of 16 African

⁴ The real exchange rates, bilateral or effective, are calculated using consumer prices (which are obtained from *International Financial Statistics*, IMF) which are the only data available for all African countries.

⁵ Real effective exchange rates are averages of real bilateral exchange rates. They may be calculated versus main trade partners of China or only versus African countries. If calculated with reference to main trade partners the bilateral exchange rates are weighted by the share of China's exports to and imports from each trade partner in its total exports and imports with regards to its main partners; if calculated with reference to African countries they are weighted by the share of China's exports to and imports from African countries in the total of its exports and imports with Africa.

countries depreciated;⁶ the two extreme annual variations are the real appreciation of the kwanza of Angola by 10 % and the real depreciation of the franc of Democratic Republic of Congo by 6%. It is worth noting that the countries which experienced an appreciation of their real exchange rates relative to China are all Sub-Saharan countries, and are the 15 African countries which had the biggest Chinese share of their exports and imports in 2011 (Table 1).

It is likely that these changes in the bilateral exchange rates between African countries and China have affected China's trade with African countries in different ways. This point is reinforced by Fig 4 which represents the statistical relationship between trade and the real bilateral exchange rates of African countries relative to China. It shows that the real appreciation of African currencies seems to significantly increase China's exports to Africa, but seems to have little effect on China's imports from Africa. It thus appears that the geographical diversification of China's exports to Africa, contrary to its imports from Africa, may be partially explained by the changes in the real exchange rates of African countries.

3. Impact of real bilateral exchange rates on the trade between China and Africa

The theoretical basis

To understand the bilateral trade between China and Africa, it is useful to refer to gravity models which have the advantage of taking trade transaction costs into account (see Anderson (2011) for a literature review). However, it is also necessary to extend the model by adding the real exchange rates in the independent variables, as it is used in traditional trade models to estimate aggregate trade (Goldstein & Khan, 1985). This extension of the model was proposed by Bénassy-Quéré *et al.* (2003) and Kwack *et al.* (2007) for China's trade with Asian and developed countries.

According to traditional trade theory, the aggregate export supply of a country depends on its potential supply and the ratio of its export price to foreign prices for alternative tradable goods. In the same way, the total import demand of a country depends on its potential demand (measured by GDP) and the ratio of the import price relative to the price of domestically produced alternative tradable goods. In this model exporting countries are assumed to be "price maker", because the price of tradable goods is not the same in all

⁶ Libya and Somalia are excluded because of non-availability of data.

countries due to imperfect competition. For China's exports of manufactured goods this assumption is plausible. But it is not the same for China's imports of raw materials (petroleum and ore). The raw material prices are fixed on international markets and African countries are "price takers". The changes in the real exchange rates affect only the domestic costs of extraction relative to the international prices, and therefore the incitement to produce and to export but only marginally. As Fig 2 shows, we can assume that changes in the real exchange rates will have a smaller impact on African exports to China than on African imports from China, or even no impact at all on African exports.

We add the variable of relative price between trading countries to the traditional independent variables of gravity models to explain bilateral trade. The exports of a country i to a country j are represented by X_{ij} (which is symmetrical to the imports of the country j from country i , M_{ji}). X_{ij} depends on Y_i and Y_j (which determine the capacity of the exporting country to produce and the potential demand of the importing country), on transaction costs (τ_{ij}), on measures facilitating trade (ρ_{ij}) between the two countries, and on the relative price of tradable goods in the two countries (expressed in the same currency), in effect their bilateral real exchange rate ER_{ij} . $ER_{ij} = EN_{ij} * P_j / P_i$, where EN_{ij} is the nominal bilateral exchange rate between i and j , or the value of the currency of country j expressed in the currency of country i . P_i is the price of goods in exporting countries and P_j in importing countries.

The bilateral trade equation can be written as follows:

$$X_{ij} = M_{ji} = e_0 Y_i^{e_1} Y_j^{e_2} ER_{ij}^{e_3} \tau_{ij}^{e_4} \rho_{ij}^{e_5} \quad (1)$$

An increase in ER_{ij} means that the currency of exporting country i depreciates in real terms, or conversely that the currency of importing country j appreciates. We now have a real bilateral exchange rate augmented trade equation, in which the volume of exports or imports depends on the traditional variables of a gravity model plus real exchange rates. We apply this model to bilateral trade between China and African countries. In this case X_{ij} (or M_{ji}) represents the real exports of China i to an African country j (or the imports of this African country from China), M_{ij} (or X_{ji}) represents China's real imports from an African country j (or the exports of this African country to China), Y_i represents the real GDP of China, Y_j represents the real GDP of African country j , ER_{ij} represents the real bilateral exchange rate between China and an African country (an increase corresponds to a real appreciation of the

African currency versus the renminbi), τ represents transaction costs, ρ represents trade facilitation between China and an African country.

Econometric estimation

The estimation is made in logarithms so that:

$$\ln X_{ijt} = \ln M_{ijt} = \ln e_0 + e_1 \ln Y_{it} + e_2 \ln Y_{jt} + e_3 \ln ER_{ijt} + e_4 \ln \tau_{ijt} + e_5 \ln \rho_{ijt} \quad (2)$$

and

$$\ln M_{ijt} = \ln X_{ijt} = \ln e_0 + e_1 \ln Y_{it} + e_2 \ln Y_{jt} + e_3 \ln ER_{ijt} + e_4 \ln \tau_{ijt} + e_5 \ln \rho_{ijt} \quad (3)$$

Three disturbance terms (unobserved individual effects fixed over time, temporal effects, and error terms) are added into the equations 2 and 3 in order to be estimated empirically. The estimations with and without fixed effects and time effects are made to compare the results. China's GDP is dropped down once time trend is included because it does not vary between African countries and its effect is captured by the time fixed effects.

In traditional gravity models the transaction costs are generally approximated by the distance between each pair of trading countries; in our estimation they are also assumed to depend on whether a country is landlocked or not, and on the quality of institutions.⁷ Anderson & Marcouiller (2002)) suggested that bad governance increases transaction costs and is detrimental to external trade; this assumption was applied with success by De Grauwe *et al.* (2012) to the trade between China and Africa. We use the same assumption. The actions which facilitate trade are seen in China's special economic zones in Africa, which have the objective of developing manufacturing activities in African countries (see Bräutigam & Tang, 2011), and may reduce the imports of manufactured goods by African countries from China, or may even permit some exports. The trade facilitation actions are also seen in China's economic cooperation and direct investments in Africa, as shown by Biggeri & Sanfilippo (2010). China's economic cooperation in Africa mainly concerns infrastructure projects covered by an agreement between a Chinese firm and an African country. This economic cooperation has increased a lot recently with China now winning 25% of World Bank

⁷ The quality of infrastructure is also used in trade gravity models. We included in the estimations the African transport index (issued by the African Development Bank), and the number of telephone lines per 100 inhabitants reported by World Bank *World Development Indicator*, but the results are not statistically significant.

construction project bids, 50% of the contracts financed by the African Bank of Development (see Brautigam (2011)), and all of the projects financed by the Chinese government⁸. Economic cooperation facilitates the exports of machinery and transport equipment needed for the infrastructure projects. In 2010, these exports represented 43% of China's total exports to Africa. Concerning China's direct investments, they aim to secure access to overseas energy resources and raw materials (Asche & Schüller, 2008; Kaplinsky & Morris, 2009; among others).⁹ China's economic cooperation is introduced into the export equation, and its direct investment in African countries is introduced into the import equation.¹⁰

The econometric analysis of China's exports is applied to the panel data for 49 African countries over the period 2000 to 2011. Libya, Sao Tome and Principe, Somalia, and Zimbabwe are excluded because of lack of data. The period studied begins in 2000 because that year marked the launch of the first China/Africa Cooperation Forum, and the beginning of China's exports towards four new countries (Botswana, Lesotho, Namibia, and Swaziland). Data is available for several African countries only from 2000. As regards the econometric analysis of China's imports, the period of estimation is shortened to 2003-2011, because China published the data on foreign direct investment only for this period; also the sample is reduced by 2 to 47 countries as China does not invest in Burkina Faso and Swaziland. The sample is unbalanced, with some countries having more observations than others for some variables. The means and standard deviations of the variables are provided in Table 2, and their definitions and sources are given in Appendix 1.

⁸ China's foreign economic cooperation is not an outward foreign direct investment (OFDI) activity, because Chinese contractors neither risk their own equity capital nor control any foreign affiliate (World Bank, 2008). It is an agreement between a Chinese contractor and a host government which assigns to the contractor the responsibility to undertake a project and to secure the required capital against the management rights and the resulting profits for a pre-determined period before transferring the rights to the host government (Cheung *et al.*, 2012).

⁹ In the literature it is argued that regional trade agreements may have an impact on trade (e.g. Carrère, 2004). We estimated the effects of five African trade agreements and the African trade agreements with European countries and the United-States, which might curb China/Africa trade. But the results are not statistically significant and are not reported in the table of results.

¹⁰ It might be possible that China's direct investments increase its exports to African countries and that its economic cooperation increases China's imports. We have tested this assumption, but the results are not statistically significant.

Three econometric methods of panel data analysis are applied to control unobservable individual heterogeneity¹¹ (Wooldridge, 2002; Hsiao, 2003; Baltagi, 2005). The fixed effects model uses within estimator, and deals with individual specific effects across African countries by including a dummy variable for each country, but has the weakness that the time invariant independent variables (such as distance or landlocked countries) are lost from the estimation. The random effects model permits keeping the time-invariant variables in the independent variables. Since it captures the individual heterogeneity in error terms, it creates a strong assumption, contrary to the fixed effects estimator, that individual effects are not correlated to the independent variables. The Hausman-Taylor (1981) estimator overcomes these drawbacks by instrumenting the endogenous variables in a random effects model. In the present estimation, several variables are suspected to be endogenous: real bilateral exchange rate, real GDP of African countries, China's economic cooperation, and direct investments, but not the governance of African countries, distance from China, or landlocked countries.

Econometric tests and results

Before making the econometric regressions of the equations, we need to know if the variables are stationary at an absolute level to avoid fallacious results. Levin-Lin-Chu (2002) and Im-Pesaran-Shin (2003) panel data unit-root tests are thus applied in which time trend and panel-specific means (fixed effects) options are used; the variables are lagged one period. The mean of the series across panels is subtracted from the series to mitigate the impact of cross-sectional dependence (Levin, Lin, and Chu, 2002). The results reported in appendix 3 allow us to reject the null hypothesis that all the panels contain a unit root. Thus, we can accept the alternative hypothesis that the variables are stationary at an absolute level. Therefore the estimations of the equations are not spurious¹².

The econometric results of the three methods are presented in Table 3, successively for China's exports and China's imports. The results of the three econometric methods are very similar. The comments are focused on the results of the Hausman-Taylor model with time-fixed and country-fixed effects. Concerning the exports equation, it appears that the gravity

¹¹ The results of the Breusch-Pagan Lagrange Multiplier (LM) test ($p=0.0000$) show the presence of individual specific effects across African countries.

¹² Thus, we cannot use vector error correction model to capture the dynamic effects of real exchange rates. To try to capture the last, we introduced real exchange rate lagged one period, but it is insignificant in all estimations. The results are not reported in the tables.

variables are statistically significant and conform to the expected results. A 1% increase in an African country's GDP leads to an increase in China's exports to this country of 0.86%¹³. Good governance of African countries has a positive effect on China's exports. China's economic cooperation in Africa promotes its exports. The special economic zones created by China in Africa in order to transmit its experience, and to help African countries to develop their industries, decrease its exports to Africa. The fact of being landlocked African countries decreases China's exports. The distance separating China and African countries has a negative sign, but is not statistically significant. This distance is probably not significant, because as the present estimations are only focused on the bilateral trade between China and Africa, the differences in distance between the various African countries and China are small. The dummy variable for landlocked countries captures the relative higher cost of transport and communication for these countries.

As expected, the real appreciation of the African currencies exerts a positive effect on China's exports with the estimated coefficient of 0.29 (column 6). Not only is this coefficient significant, but also the elasticity value shows that the results are economically relevant. During the period 2000 to 2011, thanks to a real appreciation of African currencies of 4.2% per year on average, China's exports to Africa increased by 1.2% ($4.2\% \times 0.29$) per year on average. For the countries which experienced the biggest appreciation and the strongest depreciation of their real exchange rates relative to China, the impact is more pronounced but different. For example, during this period the real appreciation of Angola's currency of 10% per year on average stimulated an increase in Angola's imports from China by 2.9% ($10\% \times 0.29$) per year, while the real depreciation of the franc of Democratic Republic of Congo of 6% per year on average decreases its imports from China by 1.7% ($6\% \times 0.29$). China's imports¹⁴ are positively influenced by the GDP of African countries, China's direct investments, and the special economic zones created by China in African countries. China imports more from African countries which have bad governance, as shown in De Grauwe *et al.* (2012), either because China faces difficulties in buying oil and minerals from the main producers which are traditional partners of developed countries, or because the African

¹³ The results of Hausman test ($p=0.8488$) do not allow rejecting the null hypothesis: difference in coefficients of fixed effects and random effects are not systematic. The results for time-fixed effect ($p=0.0000$) show that the null hypothesis (all years coefficients are jointly equal to zero) can be rejected.

¹⁴ The results of Hausman test ($p=0.0017$) and time-fixed effect test ($p=0.0145$) show that the null hypothesis can be rejected.

countries rich in natural resources tend to have bad governance. Finally, the real exchange rate (its coefficient is normally negative) does not have a significant impact on Chinese imports, contrary to exports. This result was expected because Chinese imports from African countries are almost exclusively raw materials.

4. Determinants of real bilateral exchange rates between African countries and China

Theoretical basis

We now look at the real appreciation of most African currencies relative to the renminbi described previously. Since the pioneering book by Edwards (1989) a large numbers of papers have been published about the determinants of real effective exchange rate. Sebastian Edwards made a distinction between the long run factors which determine an equilibrium exchange rate, and the short run factors which lead to a movement from the equilibrium exchange rate. The long-run factors, often called the “fundamentals”, are the relative level of GDP per capita (due to the Balassa-Samuelson effect), and the structural determinants of the balance of payments, notably the international terms of trade and the financial balance. It has been widely documented that an increase in external resources due to a big expansion of exports of raw materials, or of net capital inflows, can induce an increase in the demand for non-tradable goods (which cannot be imported), thus leading to a real appreciation of the exchange rate. The short-run factors are the macroeconomic policies, principally the nominal exchange rate policy and domestic or foreign monetary shocks.

The real exchange rates of African countries relative to China depend on the same factors as relative to the rest of the world, but also on the exchange rate policies chosen by African countries (see Appendix 2), and that chosen by China, and even those practiced in the United-States and the euro countries. It is worth noting that many African countries have pegged their currency to the euro (without devaluing during the last decade). The renminbi is *de facto* pegged to the dollar (with the hard pegging periods from 2000 to 2004, and since then some revaluations). The euro appreciated relative to the dollar by 35% during the hard pegging periods of the RMB which was maintained stable relative to the US \$ (8.28 yuans/\$) and it continued to appreciate in the second period from 2005 to 2011, but at a less level than the renminbi appreciation. In total, the Euro appreciated by 51% over the period 2000 to 2011; and during the same period the renminbi appreciated only by 28% relative to the dollar (figure 5).

The countries which peg their currency to the euro are Cape Verde¹⁵ and fifteen African countries of the Franc Zone; these are the Comoros, and the fourteen African countries belonging to either the West African Economic and Monetary Union (WAEMU) (Benin, Burkina Faso, Côte d'Ivoire, Guinea Bissau, Mali, Niger, Senegal, & Togo), or the Central African Economic and Monetary Community (CEMAC) (Cameroon, Central African Republic, Chad, Republic of the Congo, Gabon, & Equatorial Guinea). All these countries, which have met a relative stable inflation, have experienced a real appreciation of their exchange rates relative to China (Fig. 3).

For the countries which peg their currency to the dollar, only the Djiboutian franc is hardly pegged to the US dollar. Other countries peg their currencies to the US dollar only for several years, sometimes in order to control the high domestic inflation. It was the case of the Angolan Kwanza pegging to the US dollar during the period from 2004 to 2009, the Egyptian Pound during the period from 1992 to 2002, the Eritrean Nacka since 2002 and the Gambian Dalasi during the 2004-2006. The *Moroccan* Dirham is pegged to the US dollar since 2005. All these countries experienced a small real depreciation or stability except for Angola and Eritrea which met big appreciations. In the cases of the three countries (Lesotho, Swaziland and Namibia) which peg their currencies to the rand of South Africa (whose rate of exchange versus the dollar is floating and relatively stable), their currencies appreciated moderately.

Finally for those countries which have adopted a managed floating or crawling peg during all the studied period, the real bilateral exchange rates relative to China have depreciated or have been stable. There are some exceptions – Democratic Republic of Congo, Angola and Zimbabwe (which have experienced hyperinflation, due to inflationary fiscal and monetary policies)¹⁶, Nigeria, Sudan, and Zambia which have suffered from the “Dutch disease” phenomenon and significant inflation episodes (see below).

Thus, into the variables which explain the bilateral real exchange rates of African currencies relative to the renminbi, we introduce two dummy variables of exchange rate regimes, respectively representing the currencies pegged to the euro, and the currencies pegged to the US dollar or the South African rand. The residual category is composed of managed floating or crawling pegs (see Ilzetzi *et al.*, 2011 and Appendix 2). To capture

¹⁵ Cape Verde since 1998 and Sao Tome & Principe since 2009 have signed an agreement with Portugal which strengthens the parity of their currency against the euro.

¹⁶ Zimbabwe is excluded because of lack of data.

possible effects of exogenous exchange rate variations from the US dollar against the euro,¹⁷ two variables are added: on the one hand the nominal exchange rate of the euro relative to the US dollar as its variations may influence the nominal bilateral exchange rate between African currencies and the renminbi whatever the exchange regime of the African Countries is; on the other hand an euro appreciation dummy variable (which is the product of the euro pegging dummy variable multiplied by a dummy variable equal to one for the 2003-2008 period of the euro appreciation relative to the dollar in nominal terms) in order to capture the specific effect on the currencies pegged to the euro. Finally, in order to check if the large real exchange rate variations shown in Figure 4 are largely driven by the inflation differentials or the exchange rate regimes chosen by African countries, we add a dummy variable for African countries which are equal to 1 if the countries met hyperinflation¹⁸ and zero for the rest.

The other variables are the traditional ones used to explain real exchange rate changes. Many African countries are large exporters of raw materials, what is a factor of real appreciation and potentially of a “Dutch disease” phenomenon, i.e. an appreciation detrimental to the exports of manufactured goods. This seems the case (see Fig. 3) for the currencies of Angola, Sudan, Nigeria, Equatorial Guinea, Republic of Congo, and Gabon (listed by decreasing level of real appreciation), which are the main Sub-Saharan African oil exporters, as well as Zambia which exports copper and cobalt. Two countries have been affected less, Botswana which exports ores (notably diamonds), and Mauritania which exports iron ore. An exception is Algeria whose real exchange rate appreciated from 2000 to 2008, but then depreciated by 13% from 2008 to 2011, due to the nominal depreciation of 19% of the Algerian dinar versus the renminbi. Two variables may capture the effect of raw material exports on real exchange rates: a dummy variable representing the exporting countries of oils and metals (a volume effect), and the international terms of trade (a price effect). Aid flows are another source of real appreciation¹⁹. To separate the specific effects of China’s policies,

¹⁷ We are grateful to the referee for the suggestion.

¹⁸ After simulations, the countries are considered as suffering from hyperinflation when their annual inflation is superior to 110% per year, which is the threshold from which the dummy variable becomes statistically significant. It concerns Democratic Republic Congo and Angola for 2000 and 2001.

¹⁹ Private inflows are less likely to cause a real appreciation as they are generally compensated by imports and implicated in tradable activities, while aid finances more the demand for domestic goods. Foreign direct investments appear insignificant in our estimation.

we make a difference between the activities of China's economic cooperation²⁰ and the official development aid (ODA) of the main international donors²¹ (the 23 DAC industrial countries, the multilateral institutions, and the 22 non-DAC countries²²). Finally the Balassa-Samuelson effect is captured by the ratio of per capita real GDP of each African country relative to China in log form.

Econometric estimations

The impact of the above factors on real exchange rates can be modeled in logarithms as following:

$$\ln ER_{ijt} = a_0 + a_1 D_{\text{€}} + a_2 D_{\text{\$}} + a_3 D_{\text{\$€}} + a_4 NR_{\text{\$€}} + a_5 INF_{jt} + a_6 \ln CEC_{ijt} + a_7 \ln ODA_{ijt} + a_8 OIL_{jt} + a_9 \ln TOT_{jt} + a_{10} \ln YK_{ijt} \quad (4)$$

Where ER represents the real bilateral exchange rates of African countries relative to China; a rise of the indicator means an appreciation of the exchange rate of African countries. D€ and D\$ are two dummy variables with values equal to 1 when the currencies are pegged on the one hand to the euro, on the other hand to the dollar or the South-African rand, and 0 for the others. D\$€ is the dummy variable of the euro appreciation relative to the dollar, which is the product of the euro pegging variable multiplied by the dummy variable of the euro nominal appreciation versus the dollar (equal to one if appreciation and zero for the rest). NR\$€ is nominal exchange rate of the euro versus the dollar (a rise means the appreciation of the euro relative to the dollar); INF is inflation dummy variable for African countries and for the years (equal to one if high inflation and zero for the rest). CEC is the amount of China's economic cooperation in constant terms. ODA is the official development aid of all international donors in constant terms. OIL is a dummy variable with value equal to 1 for oil and metal producers. TOT is international terms of trade for African countries. YK is the ratio of real GDP per capita of African countries relative to China in log form. The signs of all variables are expected to be positive.

As all the variables are expressed in logarithms except for dummy variables, the coefficients of the non-dummy variables represent the elasticity of the real exchange rate for

²⁰ China has economic cooperation in all African countries, but concentrates its activities in raw material producers such as Angola, Algeria, Equatorial Guinea, Nigeria and Sudan etc. In 2011, these four countries received more than a half total economic cooperation in Africa.

²¹ However the two concepts are not identical as China does not participate in OECD and DAC (Development Assistance Committee). For a definition of China's Economic cooperation see above the text and note 8.

²² China is not among the 22 non-DAC countries.

these variables. The econometric tests and methods are the same as previously. As all variables are stationary at an absolute level (see appendix 3 for the unit root results), the estimations of equation 4 are pertinent. Three disturbance terms (time-fixed and countries-fixed effects and error terms) are added as previously. The presence of individual effects is particularly relevant, because the levels of the real exchange rates are not comparable from one country to another, since the base year (2000) can correspond to a bigger or smaller overvaluation or undervaluation depending on the country. The random and the Hausman-Taylor models of estimation are preferred to the fixed effects because they permit retention of the “peg to euro” and oil and metal dummy variable which do not vary with time.

Another way to take different levels of overvaluation or undervaluation into account is to estimate a cross-country regression for the change in the log of the real bilateral rate for 2000 to 2011 against the changes in the logs of terms of trade, of African GDP per capita relative to China, of China’s economic cooperation, and of ODA from all international donors, as well as the dummy variables of exchange rate regimes, of high inflation countries and oil and metal producers.²³

Table 4 shows that the results of three kinds of estimation (fixed effects, random effects and Hausman Taylor models) are very similar. Concerning the panel data estimation all variables are significant except for the ratio of GDP per capita of African countries relative to China when time fixed effect is taken into account. The Balassa-Samuelson effect seems to be captured by the time fixed effect as the relative GDP per capita is statistically significant when time fixed effect is not included in the estimations. The real appreciation of African currencies is effectively explained by the exchange rate regimes that African countries have chosen, and by the flows of foreign currencies (potentially “Dutch disease” phenomenon).

Pegged African currencies to the euro or to the dollar experience a real appreciation against the renminbi contrary to floating currencies; the appreciation is almost three times higher for the euro pegged currencies than for the US dollar and South African rand pegged currencies (according to the positive coefficients of the dummies $D_{\text{€}}$ and $D_{\text{\$}}$, i.e. 0.22 and 0.08 respectively). This appreciation is globally increased during the period when the euro is appreciating versus the dollar (positive coefficient of $NR_{\text{\$€}}$); it is even more important for the African countries which peg their currencies to the euro; these countries suffer specifically from the appreciation of this currency (with a positive coefficient of the dummy $D_{\text{\$€}}$ of 0.11).

²³ We thank Professor Michael Bleaney for the suggestion.

The coefficients for the oil metal dummy variable, for the terms of trade, for aid from industrial countries, and for China's economic cooperation activities are also all positive as expected. The elasticity of the real exchange rate of African countries to the aid from international donors is 0.04, which is higher than that relative to China's economic cooperation at 0.02. Both are moderate. However, since the rate of growth of China's economic cooperation is high (on average 36% per year, see table 2), the impact of this variable is economically significant. On average China's cooperation increases African real exchange rates by 0.72% ($36\% \times 0.02$) per year, i.e. 8.2% over the period 2000 to 2011, thus explaining 20% ($8.2/42$) of the 42% real appreciation of African currencies. The impact is much higher for the countries which receive the biggest amounts of China's economic cooperation. This is the case for Angola where China's economic cooperation has increased on average by 123% per year, which has stimulated the real exchange rate to increase by 2.46% ($123\% \times 0.02$) per year, i.e. 30.6% over the period 2000 to 2011. China's economic cooperation accounted for 20.4% ($30.6/150$) of the 150% real appreciation of the Angolan Kwanza relative to the renminbi.

As regards the results of the cross-country data, all the variables, except for the oil dummy variable and the ratio of the GDP per capita of African countries relative to China, are statistically significant. The results are similar to those for the panel data.

5. Conclusion

This study contributes to the literature by estimating the role of bilateral real exchange rates in China/Africa trade, and the determinants of these real exchange rates over the period 2000 to 2011.

The study shows that the bilateral real exchange rates between China and African countries have a significant impact on China's exports to these countries. It also shows that China's financial assistance (economic cooperation) to African countries tends to favour its exports, which are on the contrary slowed down by the special economic zones created by China in Africa. As is the case for other countries, China tends to export its manufactured goods to those African countries which have lower transaction costs. However, China tends to import from those countries which have bad governance and receive China's direct investments. These imports are not affected by the bilateral real exchange rates.

The study also suggests that the real appreciation of African currencies relative to the renminbi can be explained by the pegging of some African currencies to major world currencies (in particular to the euro, which is overvalued relative to the renminbi), by the amount of exports of raw materials (oil and metal), by the favourable international terms of trade of African countries, by the amounts of financial assistance from international donors and from China as well as the difference of productivity between African countries and China.

The African countries which are abundantly endowed with natural resources, notably oil and ore in Sub-Saharan Africa, have profited from a strong growth in their exports of these products to China. In Africa Chinese economic cooperation has improved the infrastructure. Both raw material exports and Chinese economic cooperation are certainly immediate sources of economic growth for Africa. However in the long term, they may become a disadvantage for African countries when they want to diversify their production towards manufactured goods. Raw material exports and Chinese economic cooperation contribute to the real appreciation of African currencies relative to the renminbi, which increases China's exports of manufactured goods competing with domestic production.

These conclusions have significant political implications for some African countries, as we have seen that diverse are the evolutions of the African bilateral real exchange rates relative to China. Firstly, many Sub-Saharan African countries peg their currency to the euro, which is historically justified by their strong commercial and financial relationships with Europe, and by the agreements with France in the framework of the Franc Zone. But as China *de facto* pegs the renminbi to the US dollar (in spite of some revaluation of its currency versus the US dollar), and as the dollar is undervalued relative to the euro, these African countries are handicapped when competing against China's manufactured goods. It is also the case but in a lesser extent for countries pegging their currency to the US dollar. The world financial equilibrium and the relative position of the main currencies (dollar, euro, renminbi) are very important for the development of African countries. However, Africa is marginalized in international forums. With the exception of South Africa (whose level of development is not representative of the other Sub-Saharan African countries, and whose currency has not appreciated much versus the renminbi during the last decade), African countries do not participate in the G20, the composition of which gives an excessive weight to industrial and emerging nations. It would be desirable for "Least Development Countries", which are mainly African countries, to participate more actively in world governance.

Second, since foreign aid inflows are a factor in currency appreciation (and potentially of “Dutch disease”), it is very important that they contribute to increasing productivity, especially in the tradable goods sector. This is a concern for the countries which receive much foreign aid per capita, which are generally small low-income countries, as for instance Cape Verde, Sao Tome and Principe which respectively received 491 US\$ and 446 US\$ per capita from international aid in 2011, as well as Equatorial Guinea, Botswana and Angola in which China’s economic cooperation represented 2501 US\$, 771 US\$ and 323 US\$ per capita in the same year.

Thirdly, a risk of overvaluation of the exchange rate similarly exists for natural resources exports, where responsibility lies mainly with African governments. The opposite extreme cases of Angola whose currency was pegged to the dollar for the period from 2004 to 2009 and which met real appreciation against the renminbi and of Democratic Republic of Congo whose currency is floating and met real depreciation evidence the difficulty in combining large oil or metal exports with a fixed exchange rate regime.

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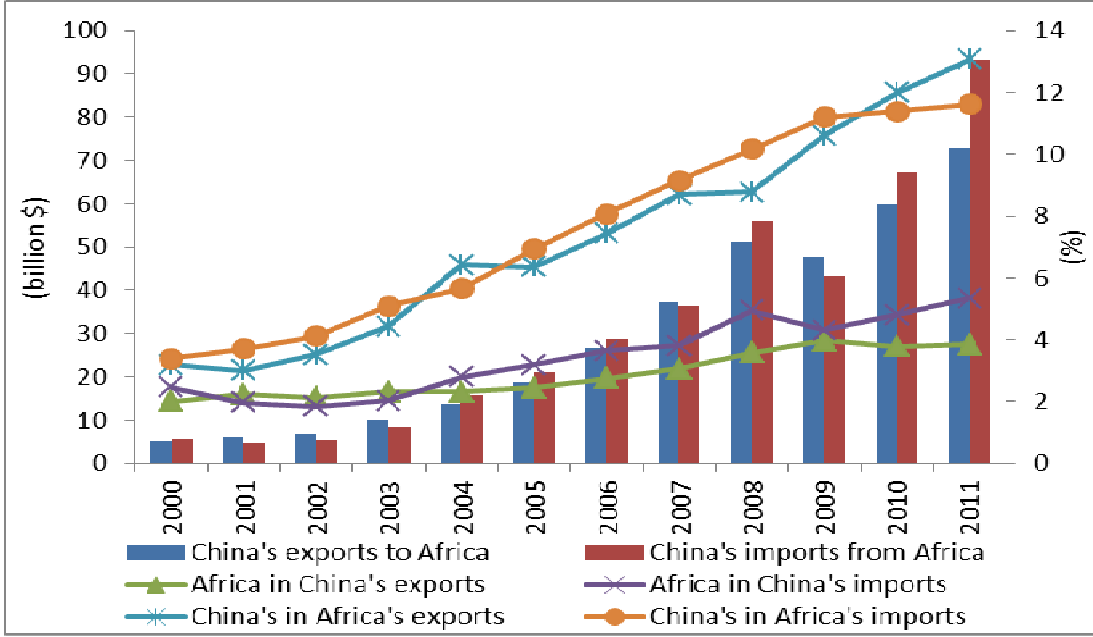
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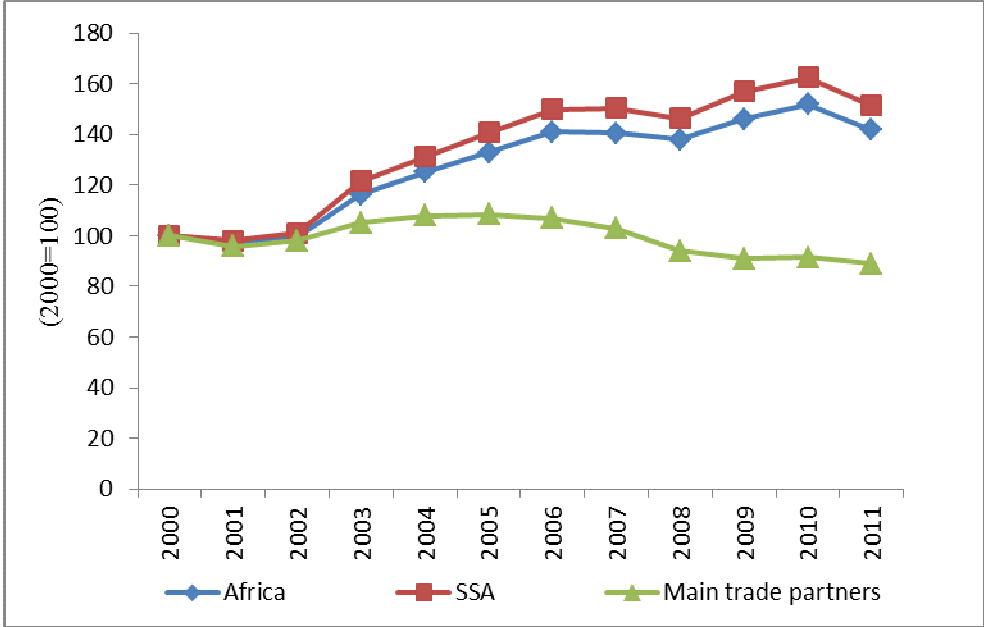
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Figure 1. The growth of China/Africa trade (Billions US\$) and its share (%) of Chinese and African imports and exports



Source: UN UNCTADStat.

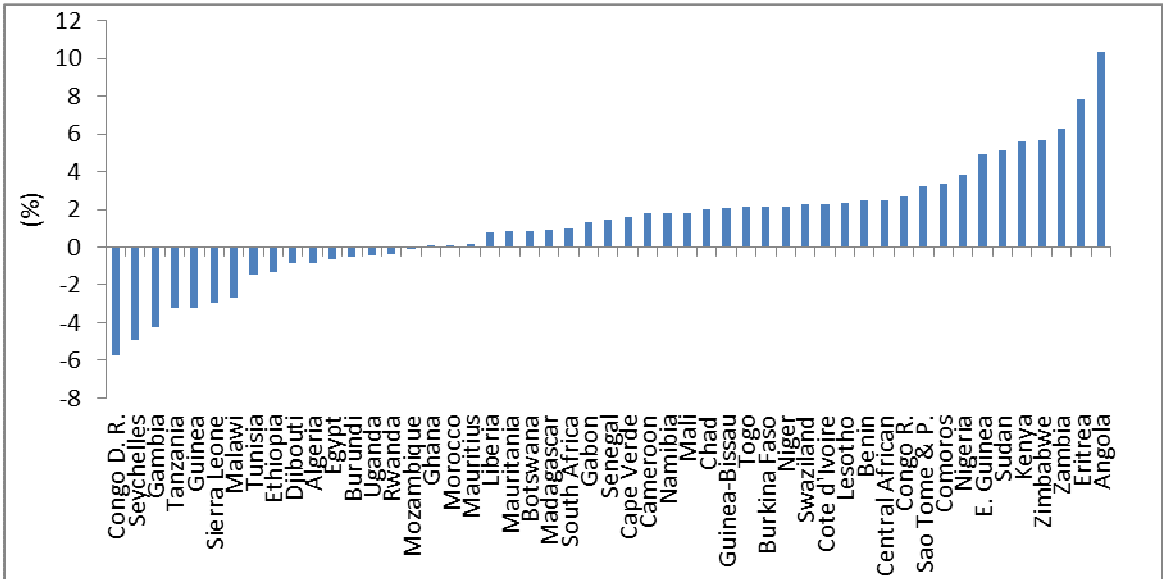
Figure 2. China’s real effective exchange rates relative to its main trade partners and to its African and Sub-Saharan African (SSA) trade partners



NB: The real effective exchange rate of China relative to its African trade partners was calculated by the authors; the real effective exchange rate relative to its main trade partners is directly drawn from IMF *International Financial Statistics*. An exchange rate rise means a real depreciation of the renminbi and *vice-versa*.

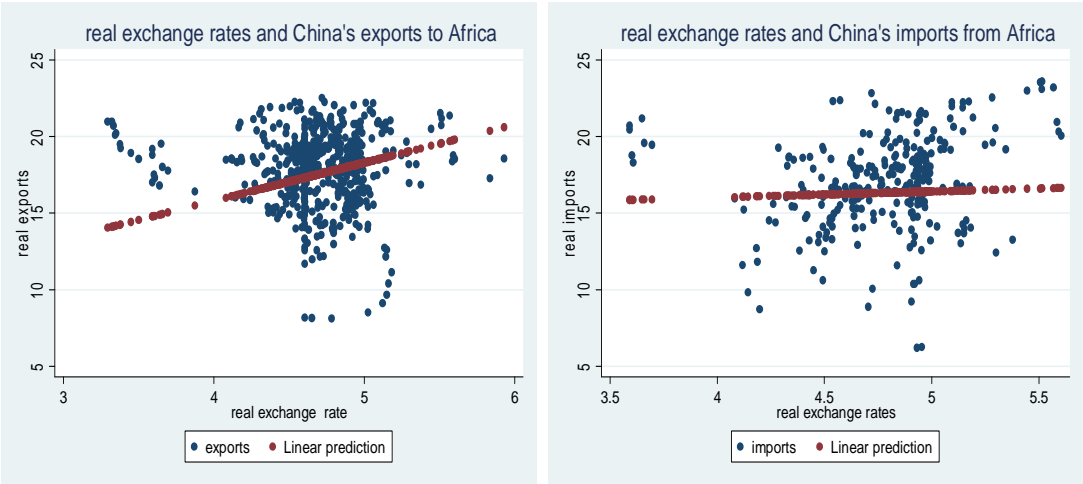
Sources: *China Statistical Yearbook*, IMF *International Financial Statistics*.

Figure 3. Annual average change (%) of African bilateral real exchange rates relative to the renminbi, 2000-2011



Note: A positive value means a real appreciation of African currencies relative to the renminbi.
 Source: calculation by the authors using the data from IMF *International Financial Statistics*.

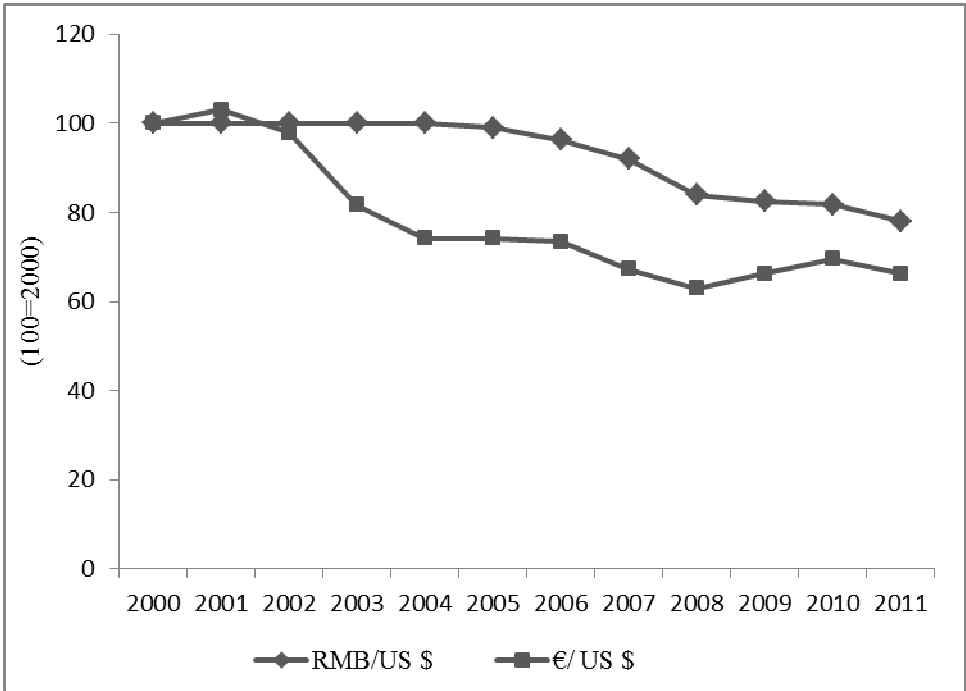
Figure 4. Relationship between real bilateral exchange rates and China’s bilateral trade with Africa, 2000-2011



NB: An increase means a real appreciation of African currencies vis-à-vis the renminbi.

Source: Authors’ calculation using the data from IMF *International Financial Statistics* and UN *Comtrade*.

Figure 5. Evolution of the nominal exchange rates of the renminbi and the euro relative to the US \$



Sources : *International Financial Statistics*, International Monetary Funds.

Table 1. Top 15 African countries by China's share in their imports and their exports, 2011

| | China's share in African countries' imports (%) | | China's share in African countries' exports (%) |
|-------------|---|-------------------|---|
| Benin | 33.50 | D. R. Congo | 66.46 |
| Eritrea | 29.57 | Sudan | 56.1 |
| Liberia | 28.04 | Mauritania | 45.76 |
| Togo | 26.45 | Angola | 39.23 |
| Gambia | 26.23 | Zambia | 34.75 |
| D. R. Congo | 21.06 | Congo | 34.54 |
| Madagascar | 19.54 | Gambia | 30.14 |
| Ghana | 19.39 | South Africa | 18.00 |
| Ethiopia | 19.31 | Central African | 17.13 |
| Angola | 18.15 | Equatorial Guinea | 17.04 |
| Namibia | 17.92 | Benin | 16.31 |
| Nigeria | 16.54 | Gabon | 16.03 |
| Niger | 15.67 | Tanzania | 15.43 |
| Tanzania | 15.47 | Zimbabwe | 14.67 |
| Djibouti | 15.14 | Rwanda | 13.27 |

Source: UN *Comtrade*.

Table 2: Summary of variables

| Variables | Obs. | Units | Means | Std. Dev. | Min | Max | Annual average growth rate (%) |
|---|------|--------------|-------|-----------|-------|--------|--------------------------------|
| China's real bilateral exports to African countries | 588 | Million US\$ | 3800 | 8410 | 0.33 | 70900 | 29.7 |
| China's real imports from African countries | 588 | Million US\$ | 2700 | 9570 | 0.001 | 111000 | 34.4 |
| Real bilateral exchange rates between African countries and China | 588 | 2000=100 | 114 | 31 | 36.3 | 262 | 3.89 |
| Nominal exchange rate \$/€ | 588 | 2000=100 | 84.71 | 14.89 | 68.27 | 111.75 | |
| Real GDP of African countries | 586 | Billion US\$ | 14.5 | 31.5 | 0.002 | 193 | 4.8 |
| Real GDP of China | 588 | Billion US\$ | 2180 | 760 | 1200 | 3550 | 10.6 |
| Ratio of GDP per capita of African countries relative to China in log | 586 | 2000=100 | -1.01 | -3.18 | 2.08 | 6.68 | |
| China's economic cooperation in African countries | 588 | Million US\$ | 179 | 472 | 0 | 4290 | 35.9 |
| ODA of all international donors to African countries | 539 | Million US\$ | 457 | 621 | 0 | 8550 | 11.7 |
| Chinese FDI in African countries | 406 | Million US\$ | 86.3 | 233 | 0.008 | 2490 | 56 |
| Terms of trade of African countries | 600 | 2000=100 | 112 | 37 | 21 | 251 | |
| African landlocked countries | 588 | | 0.28 | 0.45 | 0 | 1 | |
| Distance between China and African countries | 588 | Kilometers | 10742 | 1551 | 7796 | 12958 | |
| Governance of African countries | 588 | | -0.57 | 0.58 | -1.78 | 1.25 | |
| Currencies pegged to US\$ or South-African rand | 588 | | 0.22 | 0.41 | 0 | 1 | |
| Currencies pegged to the euro | 588 | | 0.29 | 0.45 | 0 | 1 | |
| Dummy variable of Euro appreciation relative to the dollar | 588 | | 0.25 | 0.43 | 0 | 1 | |
| High inflation dummy variable | 588 | | 0.006 | 0.08 | 0 | 1 | |
| Chinese SEZ in African countries | 588 | | 0 | 0.24 | 0 | 1 | |
| Oil dummy variable | 588 | | 0.14 | 0.35 | 0 | 1 | |

Source: see appendix 1.

Table 3. Determinants of the bilateral real trade between China and 49 African countries
2000-2011

| ln(China's real bilateral exports to African countries) | Fixed effects | | Random effects | | Hausman-Taylor | |
|---|-----------------------|--------------------|----------------------|--------------------|----------------------|--------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| ln(Real bilateral exchange rates between African countries and China) | 0.37** (2.67) | 0.28* (1.82) | 0.36** (2.67) | 0.27* (1.83) | 0.38** (2.77) | 0.29* (1.93) |
| ln(Real GDP of African countries) | 1.07*** (4.73) | 1.07*** (4.71) | 0.86*** (6.76) | 0.86*** (6.70) | 0.86*** (6.82) | 0.86*** (6.73) |
| ln(Real GDP of China) | 1.24*** (10.75) | | 1.33*** (15.10) | | 1.33*** (15.09) | |
| Landlocked countries | | | -0.75* (-1.63) | -0.74* (-1.60) | -0.74* (-1.63) | -0.75* (-1.63) |
| ln(Distance between China and African countries) | | | -0.83 (-0.58) | -0.82 (-0.56) | -0.73 (-0.51) | -0.83 (-0.85) |
| Governance of African countries | 0.22** (2.32) | 0.21** (2.19) | 0.23** (2.55) | 0.23** (2.43) | 0.23* (2.57) | 0.23** (2.45) |
| Chinese SEZ in African countries | -0.25** (-2.20) | -0.26** (-2.32) | -0.24** (-2.13) | -0.25** (-2.25) | -0.24* (-2.19) | -0.26** (-2.30) |
| ln(China's economic cooperation in African countries) | 0.23*** (9.56) | 0.23*** (9.71) | 0.23*** (10.00) | 0.24*** (10.17) | 0.23*** (9.96) | 0.24*** (10.16) |
| Constant | -44.04*** (-14.27) | -8.10* (-1.63) | -33.99*** (-2.49) | 4.43 (0.32) | -34.93*** (-2.60) | 3.27 (0.24) |
| Time-fixed effects | No | Yes | No | Yes | No | Yes |
| Country-fixed effects | Yes | Yes | No | No | No | No |
| Number of observations | 580 | 580 | 580 | 580 | 580 | 580 |
| Number of countries | 49 | 49 | 49 | 49 | 49 | 49 |
| R ² | 0.77 | 0.77 | 0.52 | 0.52 | | |

Table 3 continued

| ln(China's real imports from African countries) | Fixed effects | | Random effects | | Hausman-Taylor | |
|---|-------------------|-------------------|---------------------|---------------------|--------------------|--------------------|
| | 7 | 8 | 9 | 10 | 11 | 12 |
| ln(Real bilateral exchange rates between African countries and China) | -0.46 (0.76) | -0.64 (-1.00) | -0.45 (-0.84) | -0.51 (-0.974) | -0.64 (-1.10) | -0.86 (-1.42) |
| ln(Real GDP of African countries) | 1.22** (2.22) | 1.46* (2.48) | 1.43*** (6.26) | 1.42*** (6.85) | 1.35*** (4.28) | 1.26*** (3.77) |
| ln(Real GDP of China) | 1.51** (2.57) | | 0.70* (1.84) | | 0.78** (1.98) | |
| Landlocked countries | | | -0.47 (-0.62) | -0.47 (-0.71) | -0.58 (-0.53) | -0.58 (-0.49) |
| ln(Distance between China and African countries) | | | -0.92 (-0.43) | -0.89 (-0.47) | -1.03 (-0.33) | -0.88 (-0.26) |
| Governance of African countries | -0.95* (-1.80) | -0.80* (-1.75) | -1.19*** (-3.07) | -1.15*** (-3.09) | -1.16** (-2.67) | -1.08** (-2.43) |
| Chinese SEZ in African countries | 0.58* (1.68) | 0.65* (1.89) | 0.38 (1.15) | 0.39 (1.13) | 0.58* (1.73) | 0.64** (1.92) |
| ln(China's FDI in African countries) | 0.18** (2.17) | 0.20** (2.32) | 0.19** (2.39) | 0.22** (2.64) | 0.17** (2.08) | 0.19** (2.32) |
| Constant | -20.66 (-1.43) | 27.49 (1.29) | -26.24 (-1.16) | -5.97 (-0.33) | -24.18 (-0.78) | -0.38 (-0.01) |
| Time-fixed effects | No | Yes | No | Yes | No | Yes |
| Country-fixed effects | Yes | yes | No | No | No | No |
| Number of observations | 399 | 399 | 399 | 399 | 399 | 399 |
| Number of countries | 47 | 47 | 47 | 47 | 47 | 47 |
| R ² | 0.35 | 0.35 | 0.54 | 0.54 | | |

Notes. - China's GDP is dropped when the time-fixed effect is added. In Hausman-Taylor estimations, landlocked countries, distance and governance are considered as exogenous, while the others are taken as endogenous.

- t-statistics corrected for heteroskedasticity by the while procedure are reported in parentheses.

- *, ** and *** indicate significance at the 10%, 5% and 1% levels of confidence, respectively.

Table 4. Determinants of the real bilateral exchange rates of the renminbi relative to the 49 African currencies, 2000-2011

| ln(real bilateral exchange rates) | Panel data for 49 African currencies for the period 2000-2011 | | | | | | Cross-country data |
|---|---|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|
| | Fixed effects | | Random effects | | Hausman Taylor | | OLS |
| Currencies pegged to the dollar or the rand | 0.08* (2.04) | 0.07* (1.84) | 0.09** (2.69) | 0.08** (2.46) | 0.09** (2.47) | 0.08** (2.38) | 0.19** (2.20) |
| Currencies pegged to the euro | | | 0.20*** (3.33) | 0.22*** (3.70) | 0.20*** (2.64) | 0.22*** (3.52) | 0.45*** (3.87) |
| Nominal exchange rate \$/€ | 0.40*** (5.20) | | 0.27*** (4.84) | | 0.28*** (4.80) | | |
| Dummy variable of Euro appreciation against the dollar | 0.14*** (6.17) | 0.11*** (4.75) | 0.16*** (7.39) | 0.11*** (4.69) | 0.16*** (7.35) | 0.11*** (4.73) | |
| High inflation dummy variable | 0.22** (2.75) | 0.23*** (2.91) | 0.18** (2.32) | 0.21*** (2.77) | 0.20** (2.53) | 0.23*** (2.91) | |
| ln(China's economic cooperation) | 0.02*** (2.56) | 0.02*** (3.12) | 0.02** (2.40) | 0.02** (3.13) | 0.02** (2.29) | 0.02* (2.98) | 0.06** (2.70) |
| ln(ODA of all international donors) | 0.04*** (2.88) | 0.04** (2.96) | 0.03** (2.68) | 0.03** (2.74) | 0.04*** (3.17) | 0.04*** (3.12) | 0.10* (1.84) |
| ln(International terms of trade of African countries) | 0.08** (2.13) | 0.11*** (3.00) | 0.08** (2.22) | 0.10** (2.78) | 0.08** (2.31) | 0.10** (2.83) | 0.25* (1.87) |
| Oil and metal dummy variable | | | 0.17** (2.29) | 0.18** (2.44) | 0.15* (1.64) | 0.18** (2.29) | -0.09 (-0.66) |
| ln (ratio of GDP per capita of African countries relative to China) | 0.13*** (3.04) | -0.03 (-0.49) | 0.03* (1.72) | -0.01 (-0.17) | 0.05* (1.73) | -0.01 (-0.23) | -0.09 (-0.45) |
| Constant | 0.91* (1.79) | 3.15*** (7.31) | 1.97*** (5.93) | | 1.69*** (4.67) | 3.00*** (10.78) | -0.21** (-2.39) |
| Time-fixed effect | No | Yes | No | Yes | No | Yes | |
| Country-fixed effect | Yes | Yes | No | No | No | No | |
| Number of observations | 574 | 574 | 574 | 574 | 574 | 574 | |
| Countries | 49 | 49 | 49 | 49 | 49 | 49 | 49 |
| R ² | 0.31 | 0.35 | 0.35 | 0.35 | | | 0.41 |

Notes.- Nominal exchange rate \$/€ is dropped when the time-fixed effect is added. In Hausman-Taylor estimations, currencies pegged to the dollar or the South-African rand, currencies pegged to the euro, nominal exchange rate \$/€, dummy of the Euro appreciation relative to the dollar, terms of trade, and the oil dummy variable are considered as exogenous. The others (China's economic cooperation, ODA of all international donors, and ratio of GDP per capita of African countries relative to China and high inflation dummy variable) are taken as endogenous.

- t-statistics corrected for heteroskedasticity by the while procedure are reported in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels of confidence, respectively.

Appendix 1: Definitions and sources of variables

| Name of variables | Calculation methods | Sources |
|---|--|---|
| China's real bilateral exports to African countries | China's exports to African countries divided by the import unit values of the last ones (2000=100) | UN <i>Comtrade</i> UN <i>UNCTAD stat</i> |
| China's real bilateral imports from African countries | China's imports from African countries divided by the export unit values of the last ones (2000=100) | UN <i>Comtrade</i> UN <i>UNCTAD stat</i> |
| real GDP of African countries | Nominal GDP of African countries deflated by their deflators (2000 US\$) | World Bank <i>World Development Indicators</i> |
| China's real GDP | China's nominal GDP deflated by its deflator (2000 US\$) | World Bank <i>World Development Indicators</i> |
| Real GDP per capita of African countries | real GDP per capita of African countries (2000 US\$) | World Bank <i>World Development Indicators</i> |
| Real bilateral exchange rates of African countries versus China | Nominal bilateral exchange rate of African countries against China deflated by relative consumer prices between African countries and China | IMF <i>International Financial Statistics</i> |
| Landlocked countries | Burkina Faso, Botswana, Central African Republic, Ethiopia, Lesotho, Mali, Malawi, Niger, Rwanda, Swaziland, Chad, Uganda Zambia Zimbabwe | CEPII, Mayer, T. & Zignago, S. (2011) |
| Distance | Kilometres between China and African countries, correspond to simple distance simple calculated by CEPII | CEPII, Mayer, T. & Zignago, S. (2011) |
| Governance of African countries | Political stability in African countries calculated by Kaufmann <i>et al.</i> (2010) | World Bank |
| ODA of all international donors to African countries | ODA of DAC countries, multinationals and non DAC countries to African countries deflated by the import unit values of the last ones (2000 US\$) | OECD Development Assistance Committee |
| China's economic cooperation in African countries | China's economic cooperation exists in almost all African countries. It is deflated by the import unit value of the last one(2000 US\$) | UN <i>UNCTAD stat</i> <i>China Statistical Yearbook</i> |
| China's outward foreign direct investments in African countries | China's OFDI in an African country deflated by the import unit value of the last one (2000US\$) | UN <i>UNCTAD stat</i> <i>Statistical bulletin of China's outward foreign direct investment</i> |
| Terms of trade of African countries | Ratio between export unit value and import unit value of African countries | UN UNCTAD stat |
| China's special economic zones in African countries | Dummy variable equal to 1 if China's SEZ exists in African countries (Mauritius, Niger and Zambia since 2006, Algeria, Egypt, Ethiopia and Nigeria since 2007) and zero if not | Bräutigam and Tang (2011) |
| Currencies pegged to the dollar or the South-African rand | Dummy variable equal to 1 if African currencies are pegged to US\$ or South-African rand, and zero if not | |
| Currencies pegged to the euro | Dummy variable equal to 1 if African currencies pegged to the euro, and zero if | IMF <i>Annual Report 2012</i> Ilzetzi <i>et al.</i> (2011) |

| | | |
|------------------------------|--|---|
| | not | |
| Oil and metal dummy variable | Dummy variable equal to one for the oil and metal producing African countries, such as Algeria, Angola, Botswana Congo Republic, Equatorial Guinea, Gabon, Libya, Mauritania, Nigeria, South Africa, Sudan and Zambia. | Cheung <i>et al.</i> (2012) and authors' identification |

Appendix 2: Classification of African countries' exchange rate regimes in 2011

| Floating and assimilated ^a | Pegged to the US dollar and to the South-African rand | Pegged to the euro |
|---|---|--|
| Angola, Algeria, Burundi, Botswana, Djibouti, Egypt, Ethiopia, Ghana, Guinea, The Gambia, Kenya, Liberia, Madagascar, Mozambique, Mauritania, Mauritius, Malawi, Nigeria, Rwanda, Sudan, Sierra Leone, Seychelles, Tanzania, Tunisia, Uganda, South Africa, Congo, Dem. Rep, Zambia | Eritrea Lesotho Namibia Swaziland Zimbabwe ^b Morocco | Benin, Burkina Faso, Central African Republic, Cote d'Ivoire, Cameroon, Congo Rep., Comoros, Cape Verde, Gabon, Guinea-Bissau, Equatorial Guinea, Mali, Niger, Senegal, Chad, Togo, Sao Tome and Principe ^c |

Notes: a. managed floating or crawling peg; b. floating until 2008. c. since 2009

Sources: IMF *Annual Report 2013*.

Appendix 3. Results of panel data unit root tests

| Variables | Levin-Lin-Chu unit-root test* | Im-Pesaran-Shin unit-root test* |
|---|-------------------------------|---------------------------------|
| China's real bilateral exports to African countries | 0.0000 | 0.0000 |
| China's real imports from African countries | 0.0000 | 0.0000 |
| Real bilateral exchange rates between African countries and China | 0.0000 | 0.0114 |
| Ratio of real GDP of African countries relative to China | 0.0000 | 0.0010 |
| China's economic cooperation in African countries | 0.0000 | 0.0000 |
| ODA of all international donors to African countries | 0.0000 | 0.0000 |
| Chinese FDI in African countries | 0.0000 | 0.0015 |
| Terms of trade of African countries | 0.0000 | 0.0000 |
| Governance of African countries | 0.0000 | 0.0000 |

Note. *P-value. The panel data unit root tests are applied with time trend and panel (fixed effects) means.