Growth-enhancing effect of openness to trade and migrations: What is the effective transmission channel for Africa?*

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Abstract

This paper investigates the growth-enhancing effect of openness to trade and to migration by focusing on African countries. Relying on robust estimation techniques dealing with both endogeneity and omitted variables issues, our results put forward the importance of accounting for the type of the partner country. We find evidence that while trade between Africa and industrialized countries has a clear and robust positive impact on Africa's standards of living, trade with developing countries fails to be growth-enhancing. Moreover, our findings show that migration has no significant effect on per capita income in Africa regardless of the partner. Finally, exploring the trade openness transmission channel, we establish that the growth-enhancing effect of Africa's trade with industrialized countries mainly occurs through an improvement in total factor productivity.

Keywords: Trade, International migration, Income per person, Africa.
JEL classification: F22, F4, O4, O55.

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1 Introduction

While a vast literature exists on the link between income and openness to trade,[1] Frankel and Romer (1999) were the first to offer a convincing causality analysis regarding the income-enhancing effect of trade openness. The authors use the geographic characteristics as an instrument in a gravity-type model to demonstrate a positive effect of trade on per capita income; the main argument being that these factors are plausibly uncorrelated with other determinants of income per person. These findings were confirmed by several subsequent works (see among others Frankel and Rose, 2002; Dollar and Kraay, 2003; Noguer and Siscart, 2005; Freund and Bolaky, 2008), including across different time periods (see for example Irwin and Terviö, 2002).

However, consensus is far from clear on this issue. Rodriguez and Rodrik (2000) highlight the non-robust nature of these results once controlled for omitted variables such as distance from the equator or institutions. More recently, Ortega and Peri (2014) go a step further, and argue that the geographical factors used by Frankel and Romer (1999) can also impact income through migration. Geographic characteristics may raise income through the interactions between countries (exchange of ideas, technological diffusion, innovation, investment) and these interactions would be reflected in the mobility of goods (trade) and of people (migration). Thus, trade is not the sole vehicle of globalization through which interactions between countries promote economic growth. Acknowledging that openness to trade and openness to migration may be both considered as determinants of income,[2] Ortega and Peri (2014) find evidence of a strong positive effect of openness to migration on long-run per capita income but fail to do so for trade openness.

Despite the abundance of the literature, the debate is still open regarding the relationship between income and openness. Indeed, previous studies indiscriminately examine the growth-enhancing effect of openness without accounting for the heterogeneity of countries regarding the benefits or costs of openness. This paper fills this gap and focuses on the specific case of Africa. We aim at studying the overall effect of openness on long-term growth in Africa by paying particular attention to the type—African, over developing, developed—of partner countries. To this end, we retain the general trade-growth identification setting of Frankel and Romer (1999)[3] and follow Ortega and Peri (2014) in considering that intensity of openness between

[1] For a survey, see Edwards (1995) and Rodrik (1995) among others.

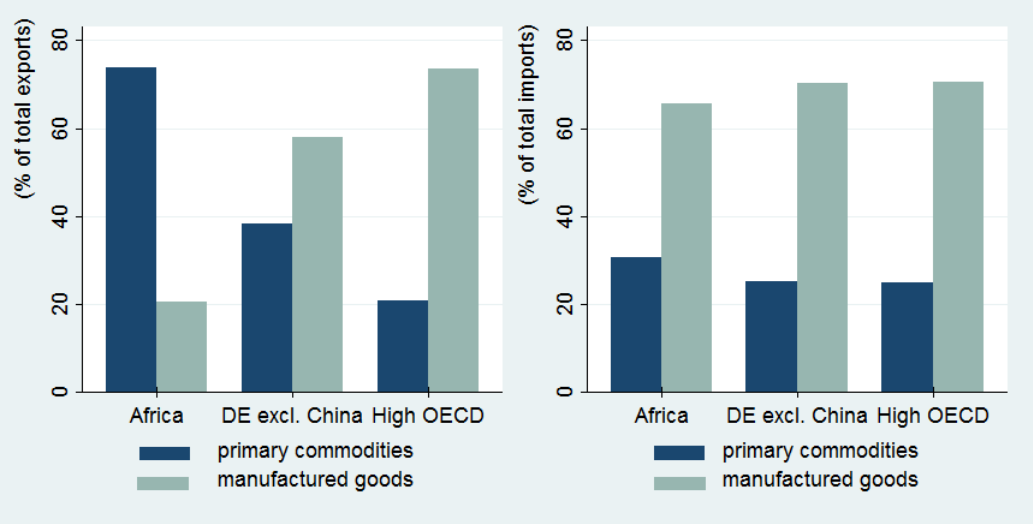
[2] More precisely, openness to trade and openness to migration are jointly introduced in the income equation, being instrumented by the same geographical factors.

[3] Recall that this framework is based on the gravity model of trade in which countries' geographic characteristics are used to obtain instrumental variables estimates of trade effect on income.

two countries should be captured by both bilateral trade and bilateral migration. Such a framework is even more relevant in the case of Africa, where openness to global finance is still in its infancy.

The choice of Africa and its singularity deserve some comments. Firstly, by scrutinizing the architecture of international trade, the case of Africa stands out as unique. As shown in Figure 1, unlike the rest of the world exports of African countries largely focus on commodities, while their imports are dominated by manufactured goods with a similar overall structure to that of developing and industrialized economies. Furthermore, as illustrated by the right side of Figure 2, Africa's trade (imports and exports) is mainly realized with developed countries. Although this trade orientation could be beneficial for long-term growth in Africa—particularly through improvement in total factor productivity[4]—this growth is subject to the ups and downs of the terms of trade due to the high concentration of exports on commodities.

Figure 1: Comparative structure of international trade

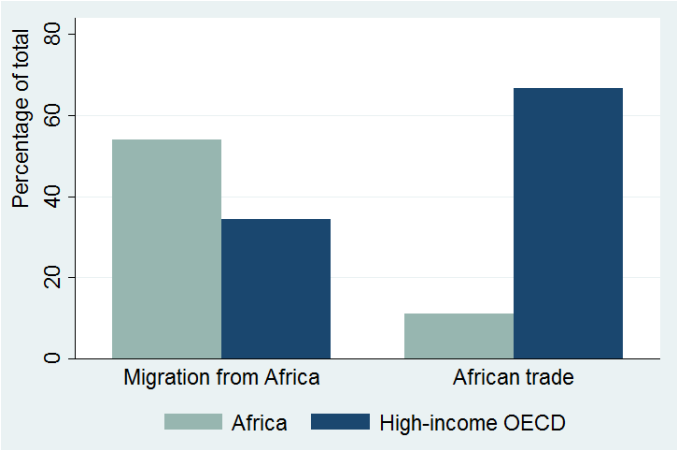


Notes: The left-hand side (resp. right-hand side) figure reports the percentage of primary commodities and manufactured goods in the total exports (resp. imports) for each region. DE = Developing Economies. Data source: UNCTAD (mean values over the 1995-2014 period).

Secondly, statistics on international migration underline that Africa is characterized by (i) strong intra-continental migration, and (ii) emigration to industrialized OECD countries. As shown in Figure 2, Africa's openness to migration in 2000 was more than half intra-African, while one-third was directed towards the industrialized OECD countries. This migration structure of Africa can be seen somewhat dichoto-

[4]See among others Edwards (1998) and Miller and Upadhyay (2000). See also our analysis in Section 5.

Figure 2: Openness of Africa (in 2000)



Notes: Trade is measured by the sum of imports and exports. Migration from Africa is measured by the stock of African nationals living abroad. Data sources: UNCTAD (trade data) and World Bank (migration data).

mous. On the one hand, it may be viewed as detrimental because "brain drain" (emigration of relatively highly educated individuals) could hamper economic development in Africa. On the other hand, it may be considered as an enhancer factor of development in the sense that African nationals living in industrialized countries are vectors of transmission of human and technological capital (education and experience), but also vectors of transmission of financial capital (migrants' remittances) and better institutions.

Finally, despite the strong dominance of developed countries in Africa's trade, some developing economies such as China are gaining more and more market share in Africa since the beginning of the 2000s. If the growth-enhancing effect of openness between Africa and its new developing partners is debatable (see, among others, Lyons and Brown, 2010; He, 2013; Kaplinsky, 2013), this dynamics brings back the old question about the impact of South-South and North-South openness on growth and productivity in the southern countries. Addressing this hot-debated issue is thus worthy of investigation due to the continuously increasing role played by China in African trade.

Falling into the strand of the literature initiated by Frankel and Romer (1999) and Ortega and Peri (2014), our contribution is threefold. First, while the previous literature is mainly done at a global level, we pay particular attention to countries' specificities and heterogeneity in the face of openness by focusing on a panel of African economies. Second, we go further than previous studies by highlighting the

importance of the trading partner. We investigate whether the effect of openness to trade and to migration on growth is sensitive to the type (African, other developing, industrialized) of the partner country. In doing so, we also contribute to the very topical debate concerning China-Africa trade links. Third, in addition to the detailed study of the openness-income nexus, we identify the transmission channel through which trade affects growth.

Our main results can be summarized as follows. First, we establish a mitigated overall impact of openness on income in Africa. While trade seems to exert a positive effect on income, this impact is not robust to the inclusion of control variables. The influence of immigration is also fragile and depends on the method used to predict the geographic component of openness. Second, we put forward the importance of accounting for the type of the trading partner. Indeed, we find evidence of a clear and robust partner-varying impact of openness for Africa: only trade with industrialized countries has a strong and robust positive impact on income. Compared to Ortega and Peri (2014)'s contribution—which is the closest paper to ours and which insists on the dominant role of migration—we thus rehabilitate the growth-enhancing effect of trade, provided that Africa's trade partner country is an advanced one. Third, the positive impact of migration from African economies to industrialized countries (emigration for Africa) is not robust. This probably reflects the confrontation between the "brain drain" negative effect and the "productivity transfer" positive impact of emigration for Africa. Moreover, we find that Africa's openness (both to trade and to migration) with developing and emerging countries—including China—fails to improve per capita income.[5] Finally, exploring the openness transmission channel thanks to the income decomposition of Hall and Jones (1999), we establish that the growth-enhancing effect of African trade with industrialized countries mainly occurs through an improvement in total factor productivity. Various sensitivity analyses are provided to assess the robustness of all our findings.

The rest of the paper is organized as follows. Section 2 describes our empirical strategy. Section 3 is devoted to the presentation of data. In Section 4, we present and discuss our main results, and provide some robustness checks. Section 5 is dedicated to examining the transmission channel through which openness impacts income. Finally, Section 6 concludes the paper.

[5]It would be interesting to reevaluate this effect in a few years (especially for China), when more—recent—observations will be available to better capture a potential medium to long-term growth-enhancing impact.

2 Empirical strategy

Our empirical framework is inspired from Ortega and Peri (2014) which, in turn, extends the specification proposed by Frankel and Romer (1999). To overcome the well-known endogeneity issue in the trade-income relationship, Frankel and Romer (1999) rely on the instrumental variable technique based on a gravity model. They estimate the causal effects of trade on income using cross-country variation in trade flows due to bilateral geography. According to Ortega and Peri (2014), Frankel and Romer (1999)'s specification suffers from a potential omitted-variables problem because trade and migration openness are both influenced by geography. Thus, country's geographic characteristics can affect income not only through trade but also through migration. Indeed, geographical proximity and accessibility raise income through the interactions between countries (exchange of ideas, technological diffusion, innovation, investment) which would be reflected in the mobility of goods and of people (Ortega and Peri, 2014). In other words, trade is not the sole channel through which interactions between countries increase income. Therefore, to fully identify the impact of trade openness, these two vehicles of globalization should be jointly considered.

2.1 Baseline specification

Our empirical model is given by:

$$lnY_i = \alpha_0 + \alpha_T T_i + \alpha_M M_i + \alpha_P lnPop_i + \alpha_A lnArea_i + \beta' \mathbf{X}_i + u_i \qquad (1)$$

where Y_i denotes per capita income in country i, T_i and M_i represent openness to trade and openness to migration, respectively, Pop_i and $Area_i$ stand for population and area which capture the impact of country size, $\mathbf{X}_i$ collects control variables, and u_i is the error term.

The rationale behind this empirical model is as follows. Classical international trade theory has highlighted that openness to trade increases output through specialization based on comparative advantages. New trade theory has documented the growth-enhancing role of trade by focusing on the exploitation of increasing returns to scale and network effects (Grossman and Helpman, 1991a,b; Helpman and Krugman, 1985).

The joint impact of trade and migration on income is explained by Ortega and Peri (2014) in a simple multi-country model that features trade and migration flows both

across country borders and across regions within the same country. In this model—which extends Alesina et al. (2000)—aggregate production is a function of varieties for intermediate goods and human capital; and each region is endowed with a differentiated good and a differentiated type of labor. Intermediate goods and labor being mobile across regions of different countries but subject to iceberg-type costs, this model derives income per worker as a function of theoretical measures of trade and migration openness which are, respectively, inverse measures of trade and migration costs. Their empirical counterparts are respectively trade flows (exports+imports) as share of GDP, and immigration rate (foreign-born) as share of total population.

The income-enhancing impact of openness to migration in the theoretical model of Ortega and Peri (2014) operates through an increase in total factor productivity reflecting growing diversity in productive skills caused by immigration. At a first sight, this channel is not very relevant for African economies which are net labor-sending countries: brain drain might negatively affect income per capita by depriving African economies of valuable talents. However, there are many channels through which emigration can promote economic performance in home countries. Foremost, remittances for emigrants can compensate for the loss of workers by enabling households and entrepreneurs to overcome credit constraints and providing an alternative way to finance investment in human and physical capital (Giuliano and Ruiz-Arranz, 2009). Besides, home countries can benefit from human capital of returning migrants (Stark et al., 1997; Beine et al., 2008) and the transfer of knowledge through the diaspora (Ortega and Peri, 2014). Furthermore, since there is strong evidence of the role of institutions in economic development,[6] emigration can be profitable to economic growth in the home country by improving the quality of institutions. Indeed, many recent studies in international migration literature highlight the role of emigration in improving institutions (Spilimbergo, 2009; Docquier et al., 2016). Using an international dataset, Spilimbergo (2009) shows that foreign-educated individuals play an important role in fostering democracy in the home country, but only if foreign education is acquired in democratic countries. Based on cross-section and panel analyses for a large sample of developing countries, Docquier et al. (2016) also find that general emigration has a positive effect on the quality of institutions in the home country.

Acknowledging the econometric concerns discussed above, Ortega and Peri (2014) propose to instrument both trade openness and openness to migration by their gravity-based predictors. This geography-based prediction of bilateral trade or bi-

[6]See the influential papers of Hall and Jones (1999), Acemoglu et al. (2001) and Rodrik et al. (2004).

lateral migration stock is obtained by estimating the following pseudo-gravity model:

$$\begin{aligned} lnW_{ij} =& \gamma_0 + \gamma_1 lnDist_{ij} + \gamma_2 lnPop_i + \gamma_3 lnPop_j + \gamma_4 lnArea_i \\ &+ \gamma_5 lnArea_j + \gamma_6 (Landlocked_i + Landlocked_j) + \gamma_7 Border_{ij} \\ &+ \gamma_8 Colony_{ij} + \gamma_9 ComLang_{ij} + \gamma_{10} Comcur_{ij} \\ &+ \gamma_{11} Time_{ij} + \gamma_{12} lnDist_{ij} \times Border_{ij} \\ &+ \gamma_{13} lnPop_i \times Border_{ij} + \gamma_{14} lnPop_j \times Border_{ij} \\ &+ \gamma_{15} lnArea_i \times Border_{ij} + \gamma_{16} lnArea_j \times Border_{ij} \\ &+ \gamma_{17} (Landlocked_i + Landlocked_j) \times Border_{ij} + e_{ij} \end{aligned} \tag{2}$$

where W_{ij} is either bilateral trade—i.e., the value of trade (exports + imports) between countries i and j divided by the GDP of origin country i—or bilateral migration (emigration)—i.e., the stock of migrants born in country j (i) and living in country i (j) as share of country i's population, $Dist_{ij}$ is the distance between country i and country j, Pop and $Area$ are the same variables defined in (1) and they are included to account for country size, $Landlocked$ is a dummy variable for landlocked countries, $Border$ is a dummy variable to indicate whether countries i and j share a common border, $Colony$ is a dummy for colonial relationship, and $ComLang$ is a dummy for sharing a common official language. Our specification includes an additional variable ($Comcur$) compared to Ortega and Peri (2014). This variable aims at capturing the sharing of a common currency and might play an important role since the impact of currency unions on bilateral trade was frequently relayed in related studies (Rose, 2000, 2001; Frankel and Rose, 2002). As argued by the literature on the endogeneity of optimum currency area criteria, sharing a single currency may set motion forces that promote economic integration and then facilitate migration. Following Ortega and Peri (2014), we include time zone differences denoted by $Time_{ij}$. As mentioned by Head et al. (2009), the impact of time zone differences between the exporting country and its trading partners is ambiguous since two contradictory effects that differ across service subcategories are at play, namely the continuity effect (the ability to operate around the clock) and the synchronization effect (the need to coordinate during business hours). Since a large part of trade is with immediate neighbors, we finally include interaction terms of border dummy with the distance, population, area, and landlocked dummies (see e.g. Frankel and Romer, 1999).

Once the gravity regressions described by (2) are estimated, we sum up them over partner countries j to obtain the predicted trade and migration openness for each origin country i. More specifically, let Z_{ij} be the vector of explanatory variables included in Equation (2), Γ_T the vector of coefficients in the bilateral trade regression, and Γ_M the corresponding vector for the bilateral migration regression. The

gravity-based predictor of trade openness for origin country i, $\hat{T}_i$, is then obtained by summing up bilateral trade over partner countries j:

$$\hat{T}_i = \sum_{j \neq i} exp(\Gamma_T Z_{ij}) \tag{3}$$

Similarly, the gravity-based predictor of migration openness for origin country i, $\hat{M}_i$, is given by:

$$\hat{M}_i = \sum_{j \neq i} exp(\Gamma_M Z_{ij}) \tag{4}$$

2.2 Identifying partner-varying impact of openness

The income-enhancing impact of openness described in Equation (1) is based on the idea that interactions among countries affect income (through trade and migration) in the same way whatever the partner country. However, it is very reasonable to think that the income-enhancing impact of openness (to trade and to migration) depends on the partner country, especially for African economies. First, with regards to openness to trade, new trade theory suggests that a country can obtain advanced technology from its trading partners through trade. If this channel is dominant, countries may benefit more from trading with advanced economies which are more technologically innovative (Yanikkaya, 2003). As a consequence, trade with industrialized countries may be more income-enhancing for Africa than trade with other countries like China and African neighbors.

Second, turning to migration openness, its impact should also depend on the partner country. Openness to migration in African countries is mainly characterized by an important intra-continental mobility and emigration to developed countries (Europe, North America). Therefore, because of the aforementioned ambiguous relationship between growth and emigration, it is reasonable to think that the impact of African migration with developed countries (which is mainly emigration from Africa to developed countries) may be different to the effect of intra-African migration.

To evaluate this partner-varying impact of the two vehicles of globalization, we consider the following disaggregated model:

$$lnY_i = \alpha_0 + \alpha_T^S T_i^S + \alpha_M^S M_i^S + \alpha_P lnPop_i + \alpha_A lnArea_i + \beta' \mathbf{X}_i + u_i \tag{5}$$

where T_i^S and M_i^S respectively represent trade and migration openness of an African country i with a particular partner country $j \in S$, S being either the subset of

African parterns, the subset of partners among developing countries, or the subset of partners among industrialized countries.

In this case, to better characterize openness with the subset of partners S, openness to trade and to migration are instrumented by estimating the pseudo-gravity model on only the subset of partners S:

$$\begin{aligned} lnW_{ij}^{S} =& \gamma_0^S + \gamma_1^S lnDist_{ij} + \gamma_2^S lnPop_i + \gamma_3^S lnPop_j + \gamma_4^S lnArea_i \\ &+ \gamma_5^S lnArea_j + \gamma_6^S (Landlocked_i + Landlocked_j) + \gamma_7^S Border_{ij} \\ &+ \gamma_8^S Colony_{ij} + \gamma_9^S ComLang_{ij} + \gamma_{10}^S Comcur_{ij} \\ &+ \gamma_{11}^S Time_{ij} + \gamma_{12}^S lnDist_{ij} \times Border_{ij} \\ &+ \gamma_{13}^S lnPop_i \times Border_{ij} + \gamma_{14}^S lnPop_j \times Border_{ij} \\ &+ \gamma_{15}^S lnArea_i \times Border_{ij} + \gamma_{16}^S lnArea_j \times Border_{ij} \\ &+ \gamma_{17}^S (Landlocked_i + Landlocked_j) \times Border_{ij} + e_{ij}^S \end{aligned} \tag{6}$$

Based on the estimation of the disaggregated pseudo-gravity model in Equation (6), the gravity-based predictors of trade openness ($\hat{T}_i^S$) and migration openness ($\hat{M}_i^S$) for country i are respectively obtained by summing up bilateral trade and migration over partner countries j among the subset S:

$$\hat{T}_i^S = \sum_{j \in S} exp(\Gamma_T Z_{ij}) \tag{7}$$

$$\hat{M}_i^S = \sum_{j \in S} exp(\Gamma_M Z_{ij}) \tag{8}$$

2.3 Control variables and identification

The validity of geographically-constructed instrumental variables is weakened by the fact that geographical features may influence directly income per capita or indirectly through other channels than openness (Rodriguez and Rodrik, 2000): impacts of location and of climate on transport costs, disease burdens, agricultural productivity and natural resources endowment (Gallup et al., 1999), on colonial history and institutional quality (Hall and Jones, 1999; Acemoglu et al., 2001). To tackle this econometric issue, we include a set of control variables allowing us to account for all the main potential channels through which geographical features can influence income per capita. More precisely, we consider distance to the equator, the key

geographic variable found to increase the odds of European settlements in the country and, therefore, to determine the history of institutions' quality (Hall and Jones, 1999; Rodriguez and Rodrik, 2000).[7] We also consider other controls: a landlocked dummy and distance to the coast to control for transport costs, the percent of land area in geographical tropics to account for agricultural productivity, disease environment (incidence of malaria and yellow fever) that may influence human history, and legal origin from colonial history that matters for economic outcomes (La Porta et al., 1999, 2008).

3 Data

Our data are taken from various sources. Data on bilateral trade are collected from the IMF Direction of Trade Statistics (DOTS). The DOTS database contains data on the value of merchandise exports and imports between each country and all its trading partners. The period for which data are available depends on the considered country but for most of them data extend from the 1980s to the present. As in Ortega and Peri (2014), bilateral migration data are taken from Docquier et al. (2010)—a database of bilateral stocks of immigrants (and emigrants) covering the 1990s-2000s for 194 countries. Data on geographic variables are from the CEPII's Gravity database described in Head et al. (2010) and from Gallup et al. (1999). We also use the Gravity database for ethnic, linguistic and colonial ties. The real income per person (real PPP-adjusted GDP per person) is collected from the Penn World Tables (version 7.1). Data on nominal GDP and population are taken from the World Bank World Development Indicators (WDI) database. As in Ortega and Peri (2014), we use the database from Acemoglu et al. (2001) for legal origins, oil endowment and disease environment. Paying particular attention to Africa, we consider, in addition to our whole, world sample, a subsample of 52 African countries.[8]

Table 1 reports some basic descriptive statistics for the main variables considered in

[7] The distance from the equator may be viewed as reflecting the effect of climate or as a proxy for omitted country's specificities that are correlated with latitude. The underlying idea is that countries which are nearer the equator have generally worse health conditions and institutions (see e.g. Sachs and Warner, 1997; Hall and Jones, 1999; Easterly and Levine, 2001).

[8] The 52 countries are: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo Dem. Rep., Congo Rep., Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe.

Table 1: Descriptive statistics

	Mean	Std. Dev.	Min.	Max.	N
Whole sample					
Real GDP per person in 2000 (PPP, 2005 USD)	10732	13067	180	65125	187
Trade (in % of GDP)	0.54	0.42	0	2.68	200
Immigration rate	0.05	0.08	0	0.53	200
Population (in thousands)	30739	119883	942	1262645	200
Area (in sq. kms)	691427	1894387	25	17075400	200
Distance to equator (in degrees)	25.79	16.97	0.2	64.18	200
Euro. descent in 1900 (in %)	29.57	41.69	0	100	157
Africa sample					
Real GDP per person in 2000 (PPP, 2005 USD)	2790	4502	180	25993	52
Trade (in % of GDP)					
Total	0.43	0.31	0	1.33	52
Intra-African	0.07	0.08	0	0.31	52
With no highly ind.	0.17	0.15	0	0.83	52
With highly ind.	0.25	0.22	0	1	52
Migration rate					
Total	0.03	0.06	0	0.32	52
Intra-African	0.03	0.06	0	0.31	52
From no highly ind. (including Africa)	0.03	0.06	0	0.31	52
To highly ind.	0.01	0.03	0	0.16	52
Population (in thousands)	15428	21909	81.13	122877	52
Area (in sq. kms)	581749	643900	455	2505813	52
Distance to equator (in degrees)	13.47	10.05	0.2	36.83	52
Euro. descent in 1900 (in %)	3.64	14.33	0	100	51

Notes: Statistics are reported for the year 2000. N denotes the number of countries.

the paper. The mean of real GDP per person in the world is $10,732 with a standard deviation of 13,067, while in Africa the mean is only 2,790 with a standard deviation of 4,502. The minimum real GDP per person in the world is in Africa. Average trade share is 54% in the world and 43% in Africa.[9] In line with Figure 2, African trade is dominated by trade with industrialized countries, while intra-African trade is very small. Concerning migration (foreign-born) share (per 1,000 population), its mean is 0.05 in the world and 0.03 in Africa, with a standard deviation of 0.08 and 0.06, respectively. Openness to migration in African countries is characterized by an important intra-continental mobility and emigration to industrialized countries. Table 1 also reports descriptive statistics on some of our main control variables (population, area, percent of European descent in 1900).

[9]Trade share for each country is calculated as the sum of its observed bilateral trade divided by GDP. Compared to the use of aggregate data, doing so allows us to specifically identity the partner country and, consequently, to account for potential different effects of openness depending on the type of the partner.

4 Empirical results

4.1 Gravity estimates for trade and migration

Columns (1) to (4) of Table 2 contain the gravity model estimation results for global openness (trade and migration) as in Ortega and Peri (2014), while columns (5)-(8) concern openness of Africa to the world. The odd columns display the OLS results, while the even columns are related to the Poisson Pseudo Maximum Likelihood (PPML) non-linear approach. As argued by Silva and Tenreyro (2006), contrary to the log-linearized model estimation by OLS, PPML estimation has two main advantages: it allows to deal with (i) observations of the dependent variable with zero value, and (ii) heteroskedasticity-related issues. We follow the procedure of Silva and Tenreyro (2010) in order to address the identification problem of the (pseudo) maximum likelihood estimates of the Poisson regression models with non-negative values of the dependent variable (bilateral trade or bilateral migration) and a large number of zeros on some regressors.

As shown in Table 2, except for some quantitative differences, the two estimators produce broadly similar results about the nature of the relationship between exogenous factors and the endogenous variable. Focusing on the sample as a whole, we find that countries which trade more with each other are those that are geographically closer, speak the same language, have colonial ties and share a common currency. We also note that the intensity of trade between two countries increases with the size of the destination country and time zone differences, but decreases with the size of the country of origin, the surface area of the destination country and landlockedness. The same links are qualitatively observed between the regressors and the intensity of migration across countries. On the whole, our results are in line with those of Ortega and Peri (2014), the main differences being the introduction among regressors of a dummy to capture the sharing of a common currency, the use of the IMF trade database (instead of the NBER-UN dataset) and the sample of countries which is larger in our study. Although these results are qualitatively consistent with expectations, their quantitative interpretation should be done with caution, especially because of the interaction terms that should be considered. For instance, the negative sign associated with the variable reflecting sharing a common border cannot be interpreted as a negative impact of the border because of its interactions with other variables.[10]

Let us now focus on the specific and interesting case of Africa. Africa being char-

[10] Frankel and Romer (1999) also emphasize the problem of accuracy in the estimation of this coefficient.

Table 2: Gravity regression, African openness with the World

	All countries				African countries			
	Trade		Immigration		Trade		Immigration	
	OLS	PPML	OLS	PPML	OLS	PPML	OLS	PPML
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln distance	-1.85***	-1.04***	-1.35***	-1.40***	-0.77***	-0.66***	-1.52***	-1.45***
	(0.04)	(0.06)	(0.04)	(0.08)	(0.08)	(0.11)	(0.08)	(0.15)
Ln pop. origin	0.04***	-0.08**	-0.41***	-0.35***	0.05*	-0.16***	-0.50***	-0.47***
	(0.02)	(0.04)	(0.02)	(0.07)	(0.03)	(0.05)	(0.04)	(0.12)
Ln pop. dest.	1.06***	0.74***	0.65***	0.80***	1.20***	0.97***	0.57***	0.52***
	(0.01)	(0.03)	(0.02)	(0.08)	(0.03)	(0.05)	(0.04)	(0.11)
Ln area origin	-0.06***	0.04	0.19***	0.14***	-0.00	0.12***	0.24***	0.14*
	(0.01)	(0.03)	(0.02)	(0.03)	(0.02)	(0.04)	(0.03)	(0.08)
Ln area dest.	-0.23***	-0.08**	-0.08***	-0.07	-0.33***	-0.25***	-0.13***	-0.01
	(0.01)	(0.04)	(0.02)	(0.05)	(0.02)	(0.06)	(0.03)	(0.10)
Sum landlocked	-0.85***	-0.55***	-0.28***	-0.64***	-0.96***	-0.96***	-0.44***	-0.79***
	(0.04)	(0.07)	(0.05)	(0.13)	(0.06)	(0.12)	(0.08)	(0.23)
Border	-4.60***	-1.71	-0.17	-5.17***	6.21***	0.61	0.63	-0.90
	(0.87)	(1.07)	(0.99)	(1.69)	(1.80)	(2.28)	(1.68)	(2.87)
Border*Ln dist.	0.92***	0.27	0.07	1.12***	-0.48	0.40	0.28	0.50
	(0.19)	(0.29)	(0.22)	(0.36)	(0.42)	(0.64)	(0.33)	(0.60)
Border*Ln pop. origin	-0.33***	0.17	-0.13	0.31**	-0.18	0.12	0.05	0.31
	(0.09)	(0.10)	(0.09)	(0.14)	(0.17)	(0.23)	(0.14)	(0.25)
Border*Ln pop. dest.	-0.18**	-0.10	-0.25***	-0.64***	-0.52***	-0.69***	-0.10	-0.20
	(0.08)	(0.09)	(0.09)	(0.13)	(0.16)	(0.22)	(0.16)	(0.22)
Border*Ln area origin	0.01	-0.16	-0.16	-0.46***	-0.23	-0.44**	-0.40***	-0.27
	(0.08)	(0.10)	(0.10)	(0.06)	(0.17)	(0.22)	(0.14)	(0.21)
Border*Ln area dest.	-0.04	0.08	0.34***	0.31*	0.22	0.20	0.11	-0.05
	(0.09)	(0.16)	(0.09)	(0.17)	(0.17)	(0.17)	(0.14)	(0.25)
Border*landlocked	0.72***	0.65***	0.32**	0.43**	0.86***	0.85***	0.24	0.47
	(0.12)	(0.15)	(0.12)	(0.21)	(0.20)	(0.31)	(0.19)	(0.34)
Common language	0.67***	0.74***	0.91***	0.93***	0.36***	0.27	0.65***	1.29***
	(0.09)	(0.13)	(0.10)	(0.20)	(0.12)	(0.21)	(0.14)	(0.36)
Common off. lang.	-0.05	-0.03	0.45***	0.16	0.47***	0.30	0.88***	0.11
	(0.09)	(0.14)	(0.10)	(0.22)	(0.12)	(0.22)	(0.14)	(0.37)
Colonial ties	3.16***	1.67***	1.33***	0.95***	4.11***	2.51***	1.24***	0.84*
	(0.14)	(0.14)	(0.17)	(0.22)	(0.18)	(0.19)	(0.27)	(0.44)
Origin hegemon	-2.29***	-2.06***	0.97***	0.46	-3.35***	-3.07***	1.09***	0.72
	(0.19)	(0.21)	(0.22)	(0.33)	(0.29)	(0.29)	(0.34)	(0.62)
Time zone diff.	0.13***	0.05***	0.09***	-0.03	-0.12***	-0.00	-0.01	-0.30***
	(0.01)	(0.02)	(0.01)	(0.04)	(0.02)	(0.04)	(0.02)	(0.07)
Common currency	0.79***	0.58***	0.99***	0.55**	0.55***	-0.19	0.75***	0.90**
	(0.12)	(0.14)	(0.13)	(0.25)	(0.21)	(0.36)	(0.21)	(0.43)
Constant	5.60***	0.96**	-0.79**	0.73	-3.72***	-2.53***	0.98	1.49
	(0.29)	(0.43)	(0.33)	(0.55)	(0.66)	(0.92)	(0.70)	(1.16)
Observations	20,980	37,044	8,219	38,612	8,311	16,761	2,426	17,462
R-squared	0.41	0.20	0.44	0.40	0.34	0.19	0.55	0.19

Notes: The dependent variable "Trade" refers to trade openness measured by the sum of bilateral exports and imports divided by GDP. The dependent variable "Immigration" reflects migration openness measured by the number of foreign-born living in the country divided by the total population. Heteroskedasticity-robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively.

acterized by strong intra-continental migration and emigration in the industrialized world, we first look at migration from the perspective of the destination country (immigration) and consider indiscriminately—as Ortega and Peri (2014)—the partners of Africa. Then, we go a step further with the aim of identifying a possible

differentiated impact of openness depending on the partner. In this case, our variable of interest becomes immigration in the context of intra-continental openness and more generally for openness with developing countries. Regarding the relations with industrialized countries, our variable of interest is rather emigration from the perspective of Africa. As shown in Table 2 (columns (5)-(8)), we find as for the whole sample that geographical, cultural and historical factors largely explain the intensity of bilateral trade. Qualitatively, the results are very close to those obtained for the whole sample with the only difference that in the latter case, the impact of time zone differences is negative. This is not surprising given that the time zone effect depends on the countries and, especially, the type of services (Head et al., 2009).

Table 3 reports the results concerning openness between African countries themselves (columns (1)-(4)), and between Africa and developing countries (columns (5)-(8)). Overall, these results are consistent with our previous findings. They confirm that a country has more links (trade and migration) with those that are closer geographically and culturally, more populated, with a coastline or with those with which it shares the same currency. These results also corroborate the fact that trade and migration are both explained by the same factors, as pointed out by Ortega and Peri (2014). In most cases, the explanatory power of migration models is higher than that of trade models.

Finally, Table 4 provides the estimation results concerning openness between Africa and the industrialized countries. These results are also consistent with theoretical predictions. In particular, geographical, cultural and historical factors explain well bilateral emigration from African countries to industrialized economies. It should be noted that, as Africa has no common border with industrialized countries in our sample, the dummy variable for common border and its interactions with other variables do not appear in the results.

Table 3: Gravity regression, African openness with developing countries

	Intra-Africa				With no industrialized			
	Trade		Immigration		Trade		Immigration	
	OLS	PPML	OLS	PPML	OLS	PPML	OLS	PPML
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln distance	-1.30***	-1.25***	-1.50***	-1.30***	-1.17***	-1.19***	-1.71***	-1.50***
	(0.17)	(0.15)	(0.17)	(0.34)	(0.08)	(0.11)	(0.07)	(0.12)
Ln pop. origin	-0.01	0.22	-0.88***	-0.85***	0.15***	-0.07	-0.40***	-0.47***
	(0.09)	(0.15)	(0.08)	(0.25)	(0.03)	(0.06)	(0.04)	(0.11)
Ln pop. dest.	0.85***	0.90***	0.22**	0.15	1.09***	0.97***	0.59***	0.93***
	(0.08)	(0.09)	(0.10)	(0.15)	(0.03)	(0.08)	(0.04)	(0.12)
Ln area origin	-0.17**	-0.22	0.02	0.34**	-0.08***	0.06	0.03	0.17***
	(0.07)	(0.16)	(0.07)	(0.17)	(0.02)	(0.05)	(0.03)	(0.05)
Ln area dest.	-0.15**	0.12	0.02	0.04	-0.29***	-0.22***	-0.04	-0.03
	(0.07)	(0.16)	(0.07)	(0.17)	(0.02)	(0.08)	(0.03)	(0.08)
Sum landlocked	-0.94***	-0.50*	-0.07	-0.58**	-0.98***	-0.85***	-0.19***	-0.78***
	(0.13)	(0.28)	(0.13)	(0.28)	(0.06)	(0.20)	(0.07)	(0.20)
Border	0.19	-6.28***	-1.25	-1.02	2.94	-3.19	-3.63***	-3.80**
	(2.13)	(2.19)	(1.83)	(3.41)	(1.80)	(2.04)	(1.12)	(1.69)
Border*Ln dist.	0.41	1.54***	0.18	0.54	-0.08	0.91	0.51**	0.99***
	(0.46)	(0.53)	(0.36)	(0.69)	(0.43)	(0.56)	(0.24)	(0.37)
Border*Ln pop. origin	-0.04	-0.32	0.38**	0.77**	-0.26	-0.17	-0.16	0.23
	(0.20)	(0.22)	(0.15)	(0.35)	(0.17)	(0.18)	(0.10)	(0.16)
Border*Ln pop. dest.	-0.05	-0.21	0.27	0.22	-0.37**	-0.31	-0.21**	-0.68***
	(0.18)	(0.19)	(0.17)	(0.24)	(0.16)	(0.23)	(0.10)	(0.15)
Border*Ln area origin	-0.18	-0.12	-0.04	-0.47*	-0.14	-0.21	-0.00	-0.43***
	(0.20)	(0.26)	(0.15)	(0.28)	(0.17)	(0.19)	(0.11)	(0.06)
Border*Ln area dest.	-0.09	-0.30	-0.06	-0.11	0.17	0.03	0.30***	0.26
	(0.19)	(0.22)	(0.15)	(0.29)	(0.17)	(0.17)	(0.10)	(0.20)
Border*landlocked	0.74***	0.34	-0.17	0.20	0.86***	0.65*	0.28*	0.46*
	(0.24)	(0.34)	(0.21)	(0.35)	(0.21)	(0.34)	(0.14)	(0.27)
Common language	0.50***	0.65**	0.37**	1.07***	0.43***	0.03	0.94***	0.93***
	(0.19)	(0.27)	(0.16)	(0.39)	(0.12)	(0.27)	(0.14)	(0.25)
Common off. lang.	0.72***	0.33	0.01	-0.39	0.36***	0.51*	0.39***	0.03
	(0.19)	(0.23)	(0.17)	(0.40)	(0.12)	(0.30)	(0.14)	(0.25)
Colonial ties	0.62	-2.41**	-1.39	-0.69	1.92***	-0.76	0.92**	0.73*
	(0.44)	(0.99)	(1.06)	(0.67)	(0.51)	(0.71)	(0.45)	(0.41)
Origin hegemon	-1.41***	-0.45	2.19*	0.15	-0.81	0.61	0.71	-0.08
	(0.39)	(1.12)	(1.24)	(1.01)	(0.56)	(0.77)	(0.64)	(0.65)
Time zone diff.	-0.43***	-0.62***	0.02	-0.67***	-0.03**	0.09***	0.05**	-0.20***
	(0.09)	(0.20)	(0.09)	(0.21)	(0.02)	(0.03)	(0.02)	(0.07)
Common currency	0.37	-0.24	0.77***	1.08**	0.74***	-0.05	1.30***	0.90***
	(0.24)	(0.34)	(0.20)	(0.44)	(0.21)	(0.37)	(0.21)	(0.28)
Constant	0.94	0.79	3.61***	0.90	-0.65	0.94	2.25***	0.89
	(1.28)	(1.14)	(1.27)	(1.98)	(0.67)	(0.84)	(0.51)	(0.78)
Observations	1,331	2,450	525	2,550	7,366	15,634	3,760	30,102
R-squared	0.41	0.19	0.67	0.25	0.34	0.09	0.53	0.54

Notes: The dependent variable "Trade" refers to trade openness measured by the sum of bilateral exports and imports divided by GDP. The dependent variable "Immigration" reflects migration openness measured by the number of foreign-born living in the country divided by the total population. Heteroskedasticity-robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively.

Table 4: Gravity regression, African openness with industrialized countries

	Trade		Emigration	
	OLS	PPML	OLS	PPML
	(1)	(2)	(3)	(4)
Ln distance	-0.88***	-0.78***	-1.04***	-1.96***
	(0.13)	(0.13)	(0.15)	(0.22)
Ln pop. origin	-0.13**	-0.28***	-0.12**	-0.05
	(0.05)	(0.08)	(0.05)	(0.11)
Ln pop. dest.	1.50***	1.11***	0.77***	0.33***
	(0.05)	(0.07)	(0.05)	(0.12)
Ln area origin	0.01	0.11**	-0.22***	-0.46***
	(0.04)	(0.05)	(0.04)	(0.08)
Ln area dest.	-0.36***	-0.28***	-0.05	0.20
	(0.04)	(0.08)	(0.05)	(0.15)
Sum landlocked	-1.07***	-0.85***	-0.93***	-1.05***
	(0.11)	(0.13)	(0.11)	(0.23)
Common language	0.83***	0.51	0.45**	0.49*
	(0.26)	(0.31)	(0.20)	(0.27)
Common off. lang.	0.06	0.13	1.40***	0.77*
	(0.24)	(0.29)	(0.19)	(0.40)
Colonial ties	2.46***	1.41***	1.64***	1.40***
	(0.20)	(0.23)	(0.20)	(0.33)
Origin hegemon	-2.59***	-2.68***		
	(0.31)	(0.32)		
Time zone diff.	-0.10***	0.04*	0.04	0.10*
	(0.03)	(0.03)	(0.03)	(0.06)
Constant	-1.61	-0.56	-1.95	8.22***
	(1.13)	(1.39)	(1.36)	(1.95)
Observations	2,036	2,300	898	1,173
R-squared	0.49	0.35	0.59	0.46

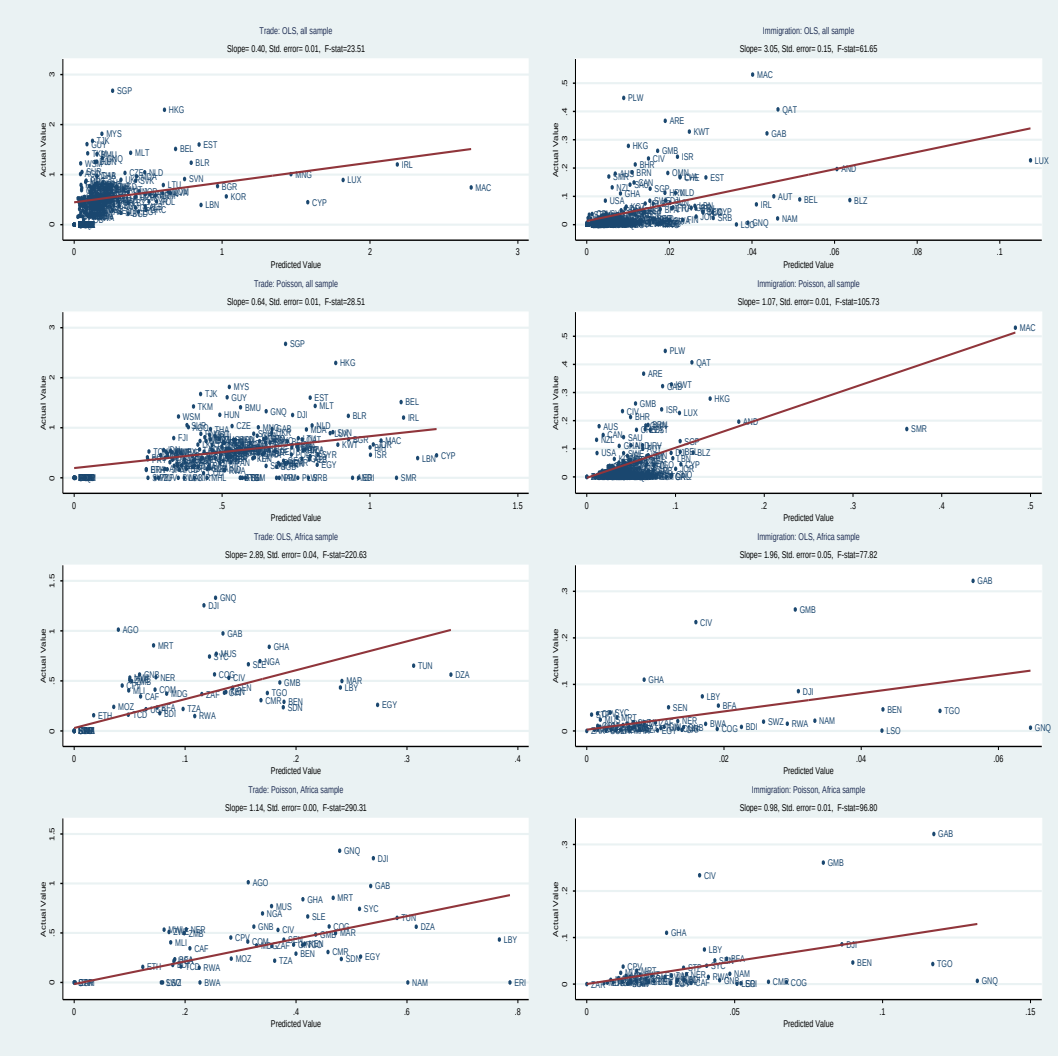
Notes: The dependent variable "Trade" refers to trade openness measured by the sum of bilateral exports and imports divided by GDP. The dependent variable "Emigration" reflects migration openness measured by the number of nationals living abroad divided by the total population. Heteroskedasticity-robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively.

For the sake of completeness and as a robustness check, we also investigate the relationship between actual and constructed openness. This link is displayed in the corresponding scatterplots reproduced in Figures 3 and 4. Figure 3 depicts overall openness against its gravity-predicted value for the world and for African openness with the world, based on both OLS and non-linear (Poisson) estimations. For both trade and migration, observed openness is highly correlated with its predicted measure, particularly for the African sample. Figure 4[11] displays the same relationship for the African sample depending on partners: intra-African trade, African trade with low-income countries and with advanced countries, intra-African migration, immigration in Africa from low-income countries including Africa, and emigration from Africa to advanced countries. For each type of disaggregated openness of

[11] To save space, Figure 4 considers only gravity-predicted openness based on non-linear (PPML) estimation.

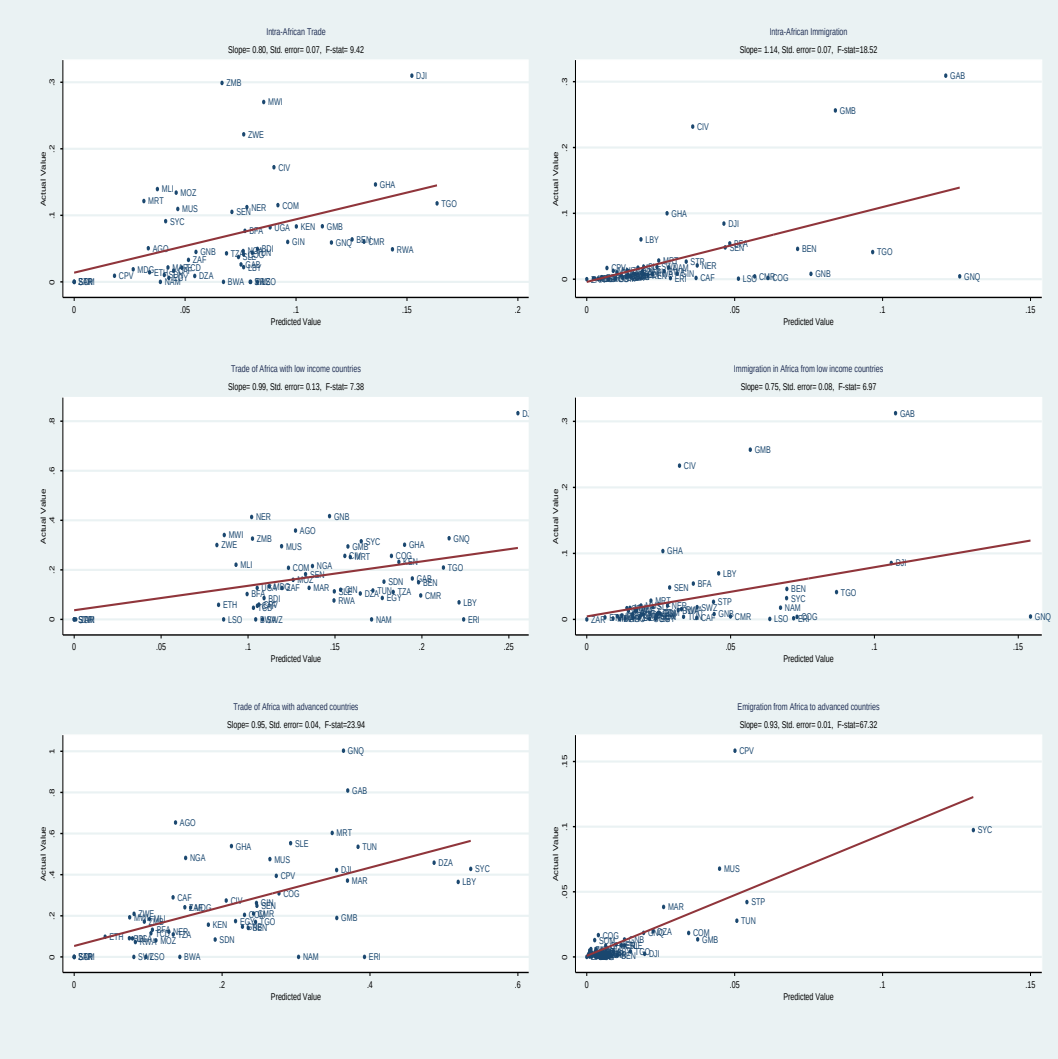
Africa, there is high correlation between observed openness and its predicted value. In other words, the figure shows that geographic, cultural and historical variables account for the major part of variation in Africa's openness. On the whole, our gravity-predicted values for openness thus appear to be reasonable proxies for observed values.

Figure 3: Observed openness and predicted openness



Notes: This figure reports the scatterplots of the relationship between actual and predicted values of trade (left side) and migration (right side).

Figure 4: Observed openness and predicted openness, depending on partners



Notes: This figure reports the scatterplots of the relationship between actual and predicted values of trade (left side) and migration (right side) for the subsample of African countries.

4.2 Income and openness

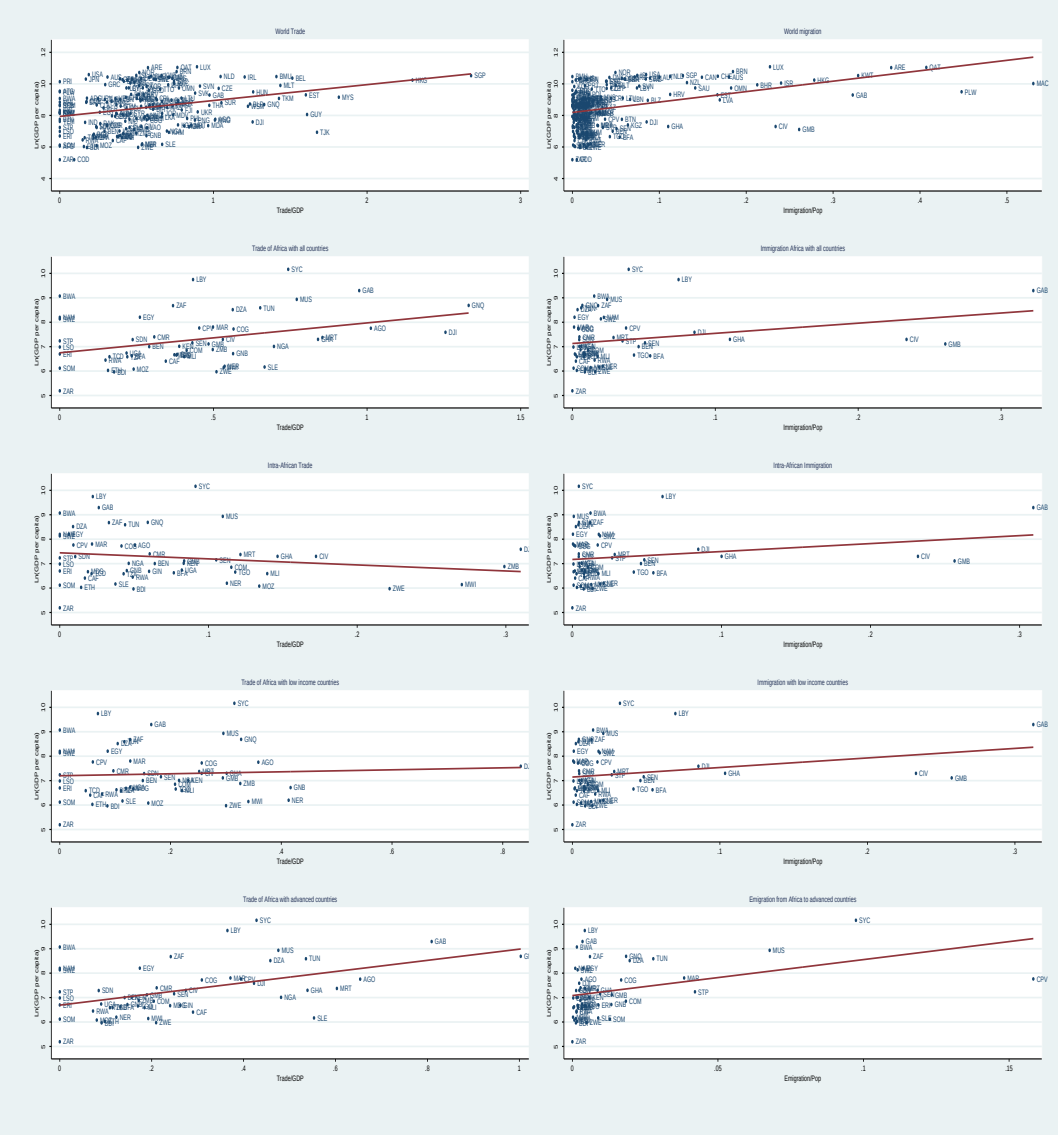
Scatterplots of income per capita against openness to trade and to migration reproduced in Figure 5 provide a first insight about the relationship between income per capita and openness. As shown, for the world sample, there is a positive correlation between income per capita and both trade and migration openness. This positive relationship is also present for Africa overall openness. However, at the disaggregated level, the link between income and openness is found to be related to the type of partners. Indeed, while the relationship between income per person and openness is not positive for intra-African trade and is slightly positive for trade with low-income countries (including Africa), income per capita is positively correlated with trade with advanced countries, intra-African migration, migration from low-income countries and emigration to advanced economies. The next steps give econometric estimations of this openness-growth nexus.

4.2.1 Baseline results

Tables 5 and 6 report the two-stage least-squares (2SLS) joint estimates of the impact of openness to trade and to migration on income per person, using their gravity-predicted measures as instruments. Table 5 displays the results using overall measures of openness for the world and African samples. To clearly highlight our contribution, we start by replicating the results of Ortega and Peri (2014) in columns (1)-(4). In columns (1) and (2) ((3) and (4)), the estimations are based on linear (non-linear, PPML) gravity-predicted openness. Estimations reported in columns (1) and (3) consider as control variables country size (area and population) and distance to equator—which is the key geographic control identified in the literature (Rodriguez and Rodrik, 2000). In column (1) based on linear predicted openness, the coefficient of openness to migration is significantly positive while the coefficient of openness to trade is not significant. In column (2), using also linear predicted openness and controlling for other geographic/climate and colonial factors, the impact of migration increases in level and in significance, while the coefficient of trade remains non significant. Using non-linear predicted openness in columns (3) and (4) as instruments, the impact of migration remains significantly positive when we consider a comprehensive set of control variables. To sum up, results in columns (1)-(4) of Table 5 highlight a robust, positive effect of openness to immigration on long-run income per capita at the world level, while there is no evidence of growth-enhancing impact of openness to trade. This finding confirms the results obtained by Ortega and Peri (2014).

At this stage, it is important to check the relevance of gravity-based instruments

Figure 5: Income and openness



Notes: This figure reports the scatterplots of income per capita against openness to trade (left side) and to migration (right side).

since the lack of significance of trade openness may come from a problem of weak instruments. To this end, we implement (i) the Kleibergen and Paap (2006) rk Wald F-stat test (KP test) which tests for the null hypothesis of jointly weak instruments, and (ii) the Sanderson and Windmeijer (2015) F-stat test (SW test) of weak identification for each endogenous regressor separately.[12] Doing so allows us to

[12]Note that this test constitutes a modification and improvement of the procedure described by

evaluate whether each individual endogenous regressor is well identified separately, by partialling-out the influence of the other endogenous regressors. For the world sample (columns (1)-(4) of Table 5), the null of (jointly and individual) weak identifications is rejected at conventional level of significance, except for column (1). Particularly, for the most relevant specification based on non-linear gravity-based instruments and using all control variables, the KP test statistic for jointly weak identification is 5.96, which is above the Stock and Yogo (2005)'s critical value at 25% max IV size (3.63). For this specification, for each endogenous regressor, we reject the null of individual weak identification. The SW test statistic for individual weak identification is 14.60 for openness to trade and 8.63 for openness to migration; both values being above all Stock and Yogo's critical values. On the whole, these results indicate that the weak instrument issue is not a severe concern in our estimations.

Let us now focus on the African sample. Columns (5)-(8) in Table 5 report the impact of African openness with the world. These results differ from those obtained for the world sample, and highlight the relevance of isolating this subgroup of countries. Based on both linear and non-linear predicted openness (columns (5) and (7)), the coefficient of trade is significantly positive when we control for country size and distance to equator. However, when we consider all the other controls, there is no evidence of positive and significant impact of trade, and migration has a positive significant effect only in the linear case. For all specifications but the one reported in column (6), we are not able to reject the null of weak instruments.

4.2.2 Identifying partner-varying impact of openness

The fact that results for Africa differ from those obtained at a world level using overall openness justifies the need to deepen the analysis of the potential growth-enhancing impact of openness in Africa. Indeed, it is reasonable to think that the difficulty to find strong evidence of the influence of openness at the aggregate level in Africa comes from the characteristics of African openness. As aforementioned, trade with advanced economies may have more income-enhancing impact in Africa than trade with other countries like China and African neighbors. With regards to migration, the impact of Africa's openness to migration with developed countries (net emigration) may differ from that of intra-African migration. To test these conjectures, we estimate the impact of openness on income in Africa depending on the type of partners; the gravity-predicted openness being derived from the estimation of Equation (6). The corresponding estimation results are reported in Table 6.

Angrist and Pischke (2009).

Table 5: Income and openness, baseline specification

	World openness				African openness			
	LP	LP	NLP	NLP	LP	LP	NLP	NLP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade	-1.80	0.31	1.50*	0.52	2.80**	0.45	3.89*	2.82
	(2.18)	(0.61)	(0.79)	(0.71)	(1.37)	(0.73)	(2.00)	(4.48)
Immig.	7.72**	11.94***	1.18	6.47**	1.13	9.16***	-4.14	18.62
	(3.65)	(2.59)	(1.06)	(3.04)	(7.72)	(2.87)	(11.61)	(16.83)
Ln pop.	0.03	-0.02	-0.04	-0.07	-0.24	-0.23**	-0.26	-0.15
	(0.12)	(0.06)	(0.07)	(0.05)	(0.18)	(0.11)	(0.22)	(0.22)
Ln area	-0.21*	0.24**	-0.10	0.20**	0.05	0.27**	0.06	0.44
	(0.11)	(0.10)	(0.06)	(0.08)	(0.11)	(0.12)	(0.14)	(0.45)
Dist. equator	0.05***	0.00	0.04***	-0.00	0.05***	-0.01	0.05***	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)
Constant	8.84***	7.17***	7.16***	7.66***	5.53***	7.57***	5.27***	6.37***
	(1.21)	(0.77)	(0.50)	(0.69)	(0.49)	(0.60)	(0.81)	(1.91)
Observations	187	131	187	131	52	44	52	44
Colonial controls	No	Yes	No	Yes	No	Yes	No	Yes
Geo/climate controls	No	Yes	No	Yes	No	Yes	No	Yes
K-P F-stat	0.89	5.79	5.30	5.96	0.81	4.30	0.77	0.13
SW F-stat for Trade	2.062	12.86	10.97	14.60	8.58	11.92	3.28	0.34
SW F-stat for Mig.	5.64	16.57	55.29	8.63	3.18	4.47	2.41	0.35
SY 10% max IV size	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03
SY 25% max IV size	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63

Notes: The dependent variable is the log of income per capita. LP (NLP) stands for linear predicted trade and migration based on the OLS (non-linear Poisson, PPML) gravity estimates. Geographic, climate and disease controls are regional dummies for Africa, a landlocked dummy, the percentage of land in the tropics, average distance to the coast, and a measure for oil reserves. Colonial history controls are dummy variables for former French colony, former English colony and the share of population of European descent in 1900. Heteroskedasticity-robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively. K-P F-stat is the Kleibergen and Paap (2006) rk Wald F-stat test of jointly weak identification. SW F-stat is the Sanderson and Windmeijer (2015) F-stat test of weak identification for each endogenous regressor separately. In the case of a single endogenous regressor, the SW F-stat is identical to the K-P F-stat. SY 10% max IV size and SY 10% max IV size are the Stock and Yogo (2005) critical values under the i.i.d. assumption.

The results in columns (1)-(4) show that there is no evidence of a growth-enhancing impact of intra-African openness. Neither intra-continental trade nor migration significantly influence growth, based on both linear and non-linear gravity-based instruments. In the non-linear case, the hypothesis of (jointly and individual) weak identification of endogenous regressors cannot be retained.

The results reported in columns (5)-(8) also indicate that there is no strong evidence of income-enhancing impact of openness with low-income countries (including African economies). When we only control for country size (population and area) and for distance to equator (columns (5) and (7)), neither trade nor migration has a significant impact and we cannot reject the weak identification of endogenous regressors. Including other controls in columns (6) and (8), there is a significant positive impact of trade in the linear case (column (6)) and a significant positive effect of migration in the non-linear case (column (8)); in both cases, only trade is not weakly identified.

Turning to openness with advanced economies (trade with industrialized countries and emigration to industrialized economies), the results are reported in columns (9)-(12) of Table 6. They show overwhelming evidence of a growth-enhancing impact of trade with industrialized countries. When we only control for country size and distance to equator, we find a positive significant role of both trade and emigration on income per capita in the linear case (column (9)) and a positive significant effect of only trade in the non-linear case (column (10)); in both cases, trade and emigration are not weakly identified. In columns (10) and (12), when we include other control variables, there is only a positive significant impact of trade openness with advanced countries, and both endogenous regressors are not weakly identified, except for emigration in column (10).

To sum up, in analyzing the impact of openness in Africa depending on partners, we find strong evidence that trade with industrialized economies promotes economic development in African countries, while we do not establish a strong impact of openness to migration contrary to Ortega and Peri (2014). In addition to emphasizing the interest of accounting for the type of partner countries, these findings corroborate the theoretical intuition that African countries may benefit more from trading with advanced economies which are more technologically innovative (Yanikkaya, 2003). The underlying idea is that if growth is driven by technological progress, trade allows African countries to benefit from the advances in R&D activities of their trading partners. Besides, our findings also reflect the aforementioned ambiguous relationship between growth and emigration. In other words, we find a compensation between the adverse impact of emigration (through brain drain) and its positive effect (through remittances, human capital of returning migrants, knowledge transfer, improving institutions). Furthermore, the absence of significant impact of intra-African migration may reflect some lack of complementarity in African labor force.

Table 6: Income and openness, identifying partners' impact

	Intra-African				Africa with no ind.				Africa with ind.			
	LP	LP	NLP	NLP	LP	LP	NLP	NLP	LP	LP	NLP	NLP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Trade	8.28	13.97	0.86	4.86	4.44	3.50	5.15	6.68**	2.08**	3.42**	3.05***	4.51***
	(10.26)	(13.00)	(2.85)	(3.90)	(2.87)	(3.40)	(4.60)	(2.92)	(0.89)	(1.38)	(0.93)	(1.43)
Immig.	0.10	3.40	4.94	6.14	5.36	12.33**	6.80	6.21				
	(4.69)	(4.56)	(5.20)	(4.03)	(6.00)	(5.22)	(16.22)	(10.34)				
Emig.									34.52**	-2.21	16.16	-9.01
									(16.45)	(18.41)	(11.04)	(6.72)
Ln pop.	-0.45**	-0.39*	-0.34**	-0.27**	-0.30*	-0.15	-0.27	-0.24	-0.26*	-0.30**	-0.25*	-0.30**
	(0.21)	(0.22)	(0.14)	(0.13)	(0.16)	(0.14)	(0.22)	(0.19)	(0.15)	(0.12)	(0.15)	(0.14)
Ln area	0.15	0.27	0.07	0.17	0.09	0.16	0.09	0.21*	0.29	0.12	0.15	0.08
	(0.16)	(0.19)	(0.10)	(0.11)	(0.11)	(0.10)	(0.14)	(0.12)	(0.19)	(0.13)	(0.11)	(0.10)
Dist. equator	0.05***	0.06***	0.05***	0.06***	0.06***	0.07***	0.06***	0.07***	0.03*	0.04***	0.04***	0.05***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Constant	6.08***	5.14***	6.65***	5.73***	5.63***	4.93***	5.39***	4.55***	4.86***	5.79***	5.46***	5.85***
	(1.24)	(1.25)	(0.64)	(0.62)	(0.71)	(0.95)	(0.81)	(1.06)	(1.10)	(0.84)	(0.52)	(0.45)
Observations	52	50	52	50	52	50	52	50	52	50	52	50
Colonial/geo controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
K-P F-stat	0.953	0.847	6.171	4.468	1.814	2.123	0.225	3.337	3.738	1.695	9.923	4.850
SW F-stat for Trade	1.905	1.751	9.866	8.120	7.467	7.938	1.088	13.35	19.40	11.32	24.52	10.92
SW F-stat for Mig.	8.659	15.56	5.727	7.168	2.139	3.164	0.604	2.382	9.958	3.580	20.74	7.414
SY 10% max IV size	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03	7.03
SY 25% max IV size	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63

Notes: The dependent variable is the log of income per capita. LP (NLP) stands for linear predicted trade and migration based on the OLS (non-linear Poisson, PPML) gravity estimates. Colonial controls are dummy variables for former French colony, former English colony and the share of population of European descent in 1900, and geographic control is a landlocked dummy. Heteroskedasticity-robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively. K-P F-stat is the Kleibergen and Paap (2006) rk Wald F-stat test of jointly weak identification. SW F-stat is the Sanderson and Windmeijer (2015) F-stat test of weak identification for each endogenous regressor separately. In the case of a single endogenous regressor, the SW F-stat is identical to the K-P F-stat. SY 10% max IV size and SY 10% max IV size are the Stock and Yogo (2005) critical values under the i.i.d. assumption.

4.3 Sensitivity analyses

For the sake of completeness and as robustness checks, we now provide some sensitivity analyses. First, we investigate the robustness of our results to the African countries included in our sample. To this end, we focus on Sub-Saharan Africa (SSA) by excluding North African countries from the sample because of their geographical proximity to Europe.[13] As a second robustness check, we test the sensitivity of our results to the choice of the considered year in line with Irwin and Terviö (2002). In addition to our baseline year 2000, two over years are considered, namely 2005 and 2010. Third, we go further than a usual sensitivity analysis and address a hot-debated topic, namely the trade links between China and Africa. This relationship is of particular interest since trade between China and Africa is growing since the early 2000s while it was insignificant in the 1980s and 1990s. China has become the largest trading partner of many African economies including countries where trade was formerly largely oriented toward Europe or America because of colonial or historical ties, such as Angola, Benin, Ethiopia, Gambia, Ghana, Mauritania, Sudan, Togo and Tanzania. Specifically, China that accounted for only 3% of total African trade in 2000 rose to 12% in 2010 and continues to increase its market share on the continent, while the share of trade with traditional partners of Africa as France and the United States is declining. It is thus worthy of interest to investigate whether trade with this "new partner" is growth-enhancing for Africa. It should be mentioned that we focus on the trade side, since emigration of Africans to China is almost zero. Thus, in terms of openness between China and Africa, only the trade channel is relevant to consider.

The results of the sensitivity analyses are displayed in Table 7.[14] They confirm the evidence of income-enhancing impact of trade with advanced countries. Indeed, in line with our previous findings, Table 7 shows a significant positive impact of trade with industrialized countries for the subsample of SSA economies and whatever the period (year) of analysis. Besides and interestingly, there is no evidence of a strong positive impact of trade with China.

[13] The six following countries are excluded from the African sample: Algeria, Djibouti, Egypt, Libya, Morocco and Tunisia.

[14] To save space, we do not report the corresponding gravity estimates but they are available upon request to the authors.

Table 7: Sensitivity analysis

	2000, SSA only			2000	2005				2010			
	African	No ind.	ind.	China	African	No ind.	ind.	China	African	No ind.	ind.	China
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Trade	6.29	8.38*	3.74***	42.51	1.61	2.40	3.85***	19.38	1.92	2.70	4.46***	15.75*
	(7.03)	(4.77)	(1.44)	(30.21)	(2.59)	(1.55)	(1.23)	(12.11)	(2.58)	(1.72)	(1.63)	(8.12)
Immig.	5.15	15.55*			4.51	1.52			4.40	-8.73		
	(4.13)	(9.24)			(4.94)	(10.88)			(5.53)	(22.66)		
Emig.			-5.43				-4.00				-4.64	
			(5.59)				(7.05)				(7.93)	
Ln pop.	-0.42	-0.36	-0.31**	-0.04	-0.25**	-0.26*	-0.26*	-0.07	-0.25**	-0.29	-0.22	0.09
	(0.26)	(0.26)	(0.15)	(0.26)	(0.12)	(0.15)	(0.14)	(0.20)	(0.12)	(0.20)	(0.14)	(0.21)
Ln area	0.19	0.24	0.08	-0.02	0.16	0.21*	0.10	0.02	0.15	0.21	0.10	-0.03
	(0.17)	(0.18)	(0.10)	(0.16)	(0.11)	(0.11)	(0.10)	(0.13)	(0.10)	(0.14)	(0.11)	(0.15)
Dist. equator	0.03	0.06	0.04**	0.07***	0.05***	0.06***	0.04***	0.08***	0.05***	0.04*	0.03**	0.06***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
Constant	6.12***	4.32***	5.99***	5.30***	6.07***	5.47***	5.90***	5.56***	6.35***	5.97***	6.13***	5.59***
	(0.78)	(1.56)	(0.56)	(1.04)	(0.61)	(0.79)	(0.45)	(0.90)	(0.60)	(0.96)	(0.47)	(0.89)
Observations	44	44	44	50	50	50	50	50	51	51	51	51
Colonial/geo controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
K-P F-stat	2.897	1.063	1.856	1.061	6.071	0.872	7.396	2.354	6.540	0.741	5.982	5.444
SW F-stat for Trade	5.730	3.189	4.209	1.061	6.976	4.358	17.35	2.354	7.769	2.870	12.14	5.444
SW F-stat for Mig.	5.885	1.918	11.27		5.089	1.759	8.124		6.016	1.744	10.59	
SY 10% max IV size	7.030	7.030	7.030	16.38	7.030	7.030	7.030	16.38	7.030	7.030	7.030	16.38
SY 25% max IV size	3.630	3.630	3.630	5.53	3.630	3.630	3.630	5.53	3.630	3.630	3.630	5.53

Notes: The dependent variable is the log of income per capita. Predicted trade and migration are obtained from non-linear Poisson gravity estimates. Colonial controls are dummy variables for former French colony, former English colony and the share of population of European descent in 1900, and geographic control is a landlocked dummy. Heteroskedasticity-robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively. K-P F-stat is the Kleibergen and Paap (2006) rk Wald F-stat test of jointly weak identification. SW F-stat is the Sanderson and Windmeijer (2015) F-stat test of weak identification for each endogenous regressor separately. In the case of a single endogenous regressor, the SW F-stat is identical to the K-P F-stat. SY 10% max IV size and SY 10% max IV size are the Stock and Yogo (2005) critical values under the i.i.d. assumption.

5 The channel through which trade with developed countries affects income in Africa

While our previous results show that only trade with developed countries positively affects income in Africa, they do not provide information on the channel through which this positive effect operates. To shed light on this issue, we propose a decomposition of income based on a simple Cobb-Douglas production function in the same spirit as Hall and Jones (1999), Frankel and Romer (1999) and Ortega and Peri (2014). Specifically, we consider the following function:

$$Y_i = K_i^{\alpha}(H_i A_i)^{1-\alpha} \tag{9}$$

where Y_i stands for output in country i, K_i is the stock of physical capital, H_i denotes the human capital, A_i is a productivity term, and α represents the labor share in income. Rewriting this production function in terms of output per worker and using the logarithmic transformation, we get:

$$lny_i = \frac{\alpha}{(1-\alpha)} ln(\frac{K_i}{Y_i}) + lnh_i + ln(A_i) \tag{10}$$

where $y_i = Y_i/L_i$ denotes output per worker, and $h_i = H_i/L_i$ is human capital per worker. Data on stock of physical capital, workers and output are taken from the Penn World Tables. Regarding the level of productivity, it is calculated from the production function assuming that $\alpha = 1/3$ in line with standard neoclassical approach.[15] Moreover, following Hall and Jones (1999), we consider human capital as a function of returns to schooling ($H_i = e^{\phi(S_i)}L_i$) as estimated in a Mincerian wage regression. $\phi(S)$ is a function reflecting the efficiency of a unit of labor with S years of schooling. Data on the number of years of schooling are from Barro and Lee (2013) and the UNESCO Institute databases. Each of the components on the right-hand side of Equation (10) contributes to the improvement of income per worker.

The results of the 2SLS estimation of Equation (10) considering successively each term (respectively the log of income per worker, the log of the capital-output ratio, the log of human capital per worker, and the log of productivity) as the dependent variable are reported in Table 8. In the first four columns, our results are not controlled by geographical and historical (or colonial) variables, while it is the case in the last four columns. In line with our previous findings, an increase in trade between

[15] The empirical value of this parameter we get for African countries is 0.314, which is very close to the reference value.

Africa and the developed economies contributes significantly to improve income per worker in Africa regardless of the specification. Considering the model without geographical and colonial controls, we find that trade between Africa and the industrialized economies positively affects income per worker in Africa mainly through an improvement in human capital per worker and higher productivity. Specifically, our estimates indicate that a rise of one percentage point (pp) in trade increases the contribution of the intensity of physical capital to income of 3/4 pp whereas it increases the contribution of productivity to income about two pp. These elasticities are close to those of Frankel and Romer (1999) with a more heterogeneous sample.

When the complete specification is estimated (columns (5) to (8)), only productivity appears as the main transmission channel of the positive effect of trade on the standards of living, with an elasticity twice as high as before. Indeed, controlling for geographic and colonial regressors, we find that a one pp increase in trade between Africa and industrialized countries leads to an increase of the contribution of productivity to income per worker of four pp. This relatively high elasticity reflects to some extent the low initial level of productivity in African countries. Furthermore, in all configurations in which trade has a significant influence on income per worker or its components, the distance from equator significantly explains the differences in levels of income per worker between African countries. Moreover, our findings show that trade has not significantly helped to improve the contribution of capital intensity per worker to income.

To sum up, if international trade with developed countries increases income in Africa, productivity is clearly the main transmission channel. Figure A-1 in the Appendix shows the contents of Africa's imports in skills and technology intensity. Imports from the developed OECD countries are clearly more equipped in skills and technology intensive, contributing to the improvement of productivity in Africa. Indeed, if the content in low skill of Africa's imports is proportionally the same regardless of the partner, imports from the developed OECD countries are approximately twice as equipped with middle-skill and high-skill than those from Africa or other developing countries. These facts clearly support our empirical results. The latter also find several anchorage points in the literature even if the specific case of Africa has not been studied before. Indeed, the decisive role of trade openness in improving total factor productivity has been empirically emphasized by Edwards (1998). Miller and Upadhyay (2000) confirmed this result by showing that over and above the positive impact of trade openness on total factor productivity, outward-oriented countries also experience an improvement in total factor productivity.

Table 8: Trade with developed countries and components of income in Africa

	lnY/L	$((\alpha/(1-\alpha))lnK/Y$	lnH/L	lnA	lnY/L	$(\alpha/(1-\alpha))lnK/Y$	H/L	lnA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade	2.28***	0.01	0.78**	2.04***	3.54**	-0.37	0.58	4.00***
	(0.73)	(0.30)	(0.36)	(0.72)	(1.52)	(0.48)	(0.63)	(1.54)
Ln pop.	-0.22*	-0.05	-0.00	-0.16	-0.26**	-0.08*	-0.05	-0.16
	(0.12)	(0.04)	(0.06)	(0.12)	(0.13)	(0.05)	(0.04)	(0.15)
Ln area	0.03	-0.01	-0.03	0.04	0.07	-0.00	0.02	0.07
	(0.08)	(0.03)	(0.05)	(0.08)	(0.09)	(0.03)	(0.03)	(0.11)
Dist. equator	0.05***	-0.00	0.01**	0.05***	0.05***	-0.00	0.00	0.05***
	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Constant	-3.92***	-0.02	-0.90***	-3.43***	-4.60***	0.26	-0.99***	-4.42***
	(0.35)	(0.11)	(0.12)	(0.37)	(0.47)	(0.17)	(0.18)	(0.49)
Observations	46	46	49	45	45	45	47	44
Colonial/geo controls	No	No	No	No	Yes	Yes	Yes	Yes
K-P F-stat	33.62	33.62	36.76	33.37	9.373	9.373	15.35	9.246
SW F-stat	33.62	33.62	36.76	33.37	9.373	9.373	15.35	9.246
SY 10% max IV size	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38
SY 25% max IV size	5.530	5.530	5.530	5.530	5.530	5.530	5.530	5.530

Notes: The explained variables are normalized by the value of the US. The predicted trade values are those based on the non-linear estimation. Colonial controls are dummy variables for former French colony, former English colony and the share of population of European descent in 1900, and geographic control is a landlocked dummy. Heteroskedasticity-robust standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively. K-P F-stat is the Kleibergen and Paap (2006) rk Wald F-stat test of jointly weak identification. SW F-stat is the Sanderson and Windmeijer (2015) F-stat test of weak identification for each endogenous regressor separately. In the case of a single endogenous regressor, the SW F-stat is identical to the K-P F-stat. SY 10% max IV size and SY 10% max IV size are the Stock and Yogo (2005) critical values under the i.i.d. assumption.

6 Conclusion

This paper contributes to the debate on the growth-enhancing impact of openness by focusing on Africa. Examining the nature of the relationship both in a South-South and North-South perspective, we jointly consider openness to trade and to migration as vehicles of globalization; both types of openness being instrumented by gravity-based predictors.

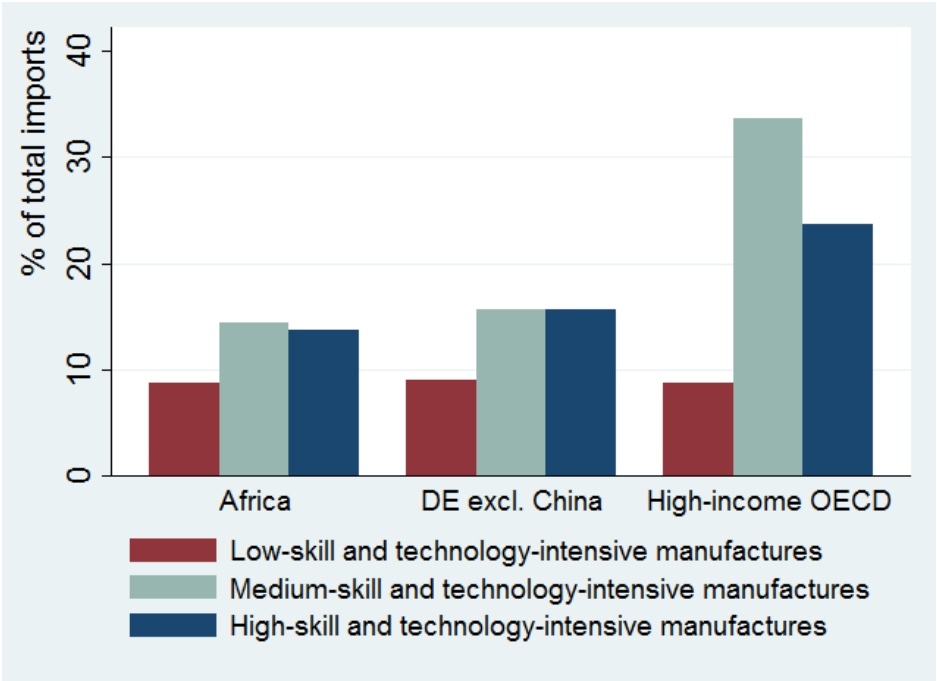
Without distinguishing between partners, we show that international openness (both to trade and to migration) has a mitigated impact on per capita income in Africa; the positive effect of trade and migration being sensitive to the inclusion of control variables and the method used (linear or non-linear) to predict the geographic component of openness. In contrast, discriminating according to the partner allows us to obtain interesting and robust findings. Specifically, we establish that trade between Africa and the industrialized countries has a clear and significant positive impact on the standards of living in Africa, and show that such fostering effect operates through an improvement in total factor productivity. This growth-enhancing effect is consistent with the new trade theory suggesting that countries benefit from the advances in technological progress of their trading partners. Conversely, South-South openness fails to improve income in Africa regardless of the configuration (intra-African openness or openness between Africa and other developing countries). Turning to openness to migration, we do not find evidence of any growth-enhancing effect in Africa, whatever the partner country.

South-South trade fails to improve the standards of living in Africa, probably because of the similarity of traded products and production techniques, which leave little room for learning between countries and technology transfer. Similarly, homogeneity of skills and institutions is likely to explain the failure of intra-African immigration to improve per capita income. Moreover, the lack of evidence of clear-cut positive effect of emigration from Africa to developed countries may result from two opposing effects at play in the African context: the negative effect of the "brain drain" and the positive impact of the transfer of knowledge.

On the whole, while our findings do not attribute a key role to openness to migration, they show that trade increases income in Africa, provided that the trade partner is an advanced country. In other words, our results underline that the characteristics of the trading partner—i.e., whether it is a developed or developing country—strongly matters in the trade-growth relationship. These findings highlight the importance of trade flows and trade-promoting policies between Africa and industrialized economies to foster African growth in a North-South perspective.

Appendix

Figure A-1: Composition of Africa's imports



Notes: Data are extracted from UNCTAD and correspond to mean values over the 1995-2014 period.

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