

Effect of women entrepreneurship and ICT on bilateral trade in Africa: Evidence from a panel study using the extended gravity model

KOKO A BIDIAS RIGOBERTE CARINE

PhD Student Economics

University of Yaounde 2, Cameroon

Email : kokokarine98@gmail.com

MOUGNOL A EKOULA HERVE WILLIAM

Lecturer

University of Yaounde 2, Cameroon

Email: wmougnol@yahoo.com

MVELE SIGISMOND HERVEY

Associate professor

University of Yaounde 2, Cameroon

Email : sigismondh@yahoo.fr

Abstract

Women entrepreneurs and ICT bring new perspectives, skills and innovative ideas that can boost trade between African countries. This paper examines the effect of female entrepreneurship and ICT on bilateral trade, using a sample of 32 African countries over the period 2005-2019. Adopting the Poisson estimator of Pseudo maximum likelihood with high-dimensional fixed effects (PPMLHDFE). Two results emerge: first, female entrepreneurship (paid in minimum, entrepreneurship (self-employment) have a positive and significant impact on the evolution of bilateral trade in Africa. Secondly, adoption of ICT has a positive effect on bilateral trade flows of goods through the reduction of transaction costs. In terms of economic policy implications, it is therefore essential to support and encourage female entrepreneurship in Africa. This can be done by providing equitable access to finance, building women's entrepreneurial capacity, promoting gender equality in economic policies and fostering the creation of business networks for women entrepreneurs. We also recommend that government and private sector should enhance digital infrastructure thereby expanding network coverage especially in rural areas and making it accessible to every user. This will encourage public-private partnership. Also, integrate digital literacy and entrepreneurial skills in the educational sector and provide training for existing entrepreneurs. In addition, the government should

develop e-government platforms and access to government services, this can help female entrepreneurs to reach wider markets.

Key word: Africa, Bilateral trade, Women entrepreneurship, ICT, Gravity model, PPMLHDFE.
JEL codes : F02, F14, F41, J21

1. Introduction

Information and Communication Technologies (ICTs), essentially driven by the forces of international evolution, play a crucial role in the growth and economic development (Ogunsola, 2005; Xing, 2017; Ozcan, 2017; Nath eand Liu, 2017; Ali et al., 2020; Tay, 2020). In this line, Baldwin (2016) argues that ICTs and increasing trade flows are becoming the two fundamental drivers of the new globalization around the world. However, the evolution of international trade shows strong disparities between regions whit Africa as the region with the lowest level of intra-regional trade. According to the UNCTAD's Report (2019) on African Development, the average total value of exports from Africa to others countries around the world represents an amount of 760 billion of US dollars in current prices between 2015 and 2017, compared to 481 billion for Oceania, 4109 billion for Europe, 5140 billion for the United States and 6801 billion for Asia. In 2017, intra-African exports accounted for only 16.6% of total exports, compared to 68.1% for intra-European exports, 59.4% for intra-Asian exports, 55.0% for intra-American exports and 7.0% for intra-Oceanic exports. Intra-African trade, which is the average of intra-African exports and imports, amounted to about 15.2% of Africa's total exports during 2015-2017, while America, Asia, Europe and Oceania had intra-continental trade of 47%, 61%, 67% and 7% of total trade, respectively. This low level of intra-African trade represents a significant loss of earnings for these economies, which are still struggling to sustain their economic development process (Song and al. 2022).

In 2019, intra-African trade will account for around 17% of the continent's total trade (United Nations, 2021). However, this share remains relatively low compared with other regions of the world. Key bilateral trade sectors in Africa include agriculture, natural resources (oil, gas, minerals, etc.), manufacturing and services. Initiatives such as the African Continental Free Trade Area (AfCFTA) aim to facilitate intra-African trade by eliminating tariff and non-tariff barriers. Contemporary literature identifies several factors that explain trade in the world and in Africa in particular, such as distance, official development assistance, digital facilitation,

CO2 emissions, information and communication technologies (ICTs) and economic complexity. (Egger, 2008; Pettersson, and Johansson, 2013; Ismail, 2021; Ünal et al., 2023; Billon et al., 2023; Abdi et al., 2023), to which should be added female entrepreneurship, which is a significant determinant of intra-regional trade in Africa.

Trade generates competitive pressure and increases the odds of discrimination against women in general and entrepreneurship in particular, in an integrated world. Countries that do not allow women to participate fully in the economy are less competitive internationally, particularly those whose export industries employ a high proportion of women (World Bank, 2011). Companies involved in international trade employ more women. In developing countries, women account for 33.2% of the workforce, compared with just 24.3% in non-exporting companies and 28.1% in non-importing companies.

Trade boosts women's wages and economic equality. Women earn a smaller share of wages worldwide. In Africa, trade liberalisation could help close the wage gap, particularly for skilled women workers. Women entrepreneurs contribute to economic growth and development by setting up businesses and actively participating in international trade. Female entrepreneurship encourages the diversification of economic sectors and stimulates innovation. Women's entrepreneurship takes place in various fields such as agriculture, crafts, services, technology and retail. Women's commercial activities contribute to the expansion of bilateral trade by offering new business opportunities and expanding markets.

Entrepreneurs have different motivations, which can be grouped into two categories (Orhan and Scott, 2001; Blanchard and Warnecke, 2010). Firstly, there are those who are driven by necessity because they have no other work options. They are pushed into self-employment, mainly in the informal economy and in low-growth, low-profit sectors of the service sector (Rehman and Roomi, 2012). Access to these sectors is made easy by the absence of fixed costs on entry and the negligible amount of sunk costs on exit. Then there are those who are motivated by the opportunities on offer and who aspire to greater independence and higher incomes.

Therefore, ICTs¹ have proliferated over the last decades, emerging in African countries as a great opportunity for marginalized groups, to reduce gender inequalities as laid out in the fifth United Nation's sustainable development goal (International Telecommunication Union, 2019).

¹ Information and Communication Technologies (ICTs) is a broader term for Information Technology (IT), which refers to all communication technologies enabling users to access, retrieve, store, transmit, and manipulate information in a digital form.

Indeed, not only do ICTs have an increasingly important role in countries and financial inclusion, they also increase the transparency of labor market information (Roztock et al., 2019).

According to this argument, Freund and Weinhold (2000) performed cross-countries regressions based on the gravity model and find that internet positively and significantly impacts bilateral trade. The use of mobile phone and internet also offer the possibility of sailing and buying on line, with low physical movement of persons but with an important gain of time and efficiency. ICTs can also improve trade through electronic payment. In this line, internet online selling and mobile money, mobile banking and payment offer opportunities to accelerate trade and finally attract more foreign investors (Avom and Melingui, 2020).

Based on the above, three contributions emerge from this work. Firstly, the consideration of female entrepreneurship and ICT as a relevant factor in explaining bilateral trade in Africa. This is an important contribution that goes beyond demonstrating the role of entrepreneurship associated with ICT in the economy. Thus, we use women's entrepreneurship as a better illustration of women's participation in the bilateral trade process of co-trading countries and ICT as a means of reducing transaction costs. These two contributions are complemented by improved methodological elements using the Pseudo Maximum Likelihood with Large Fixed Effect (PPMLHDFE) Poisson estimator that provide robust validations of the effect of female entrepreneurship on bilateral trade in Africa.

Following this introduction, the rest of the article is organised into three sections. The second presents stylised facts about women's entrepreneurship, ICT and two-way trade in Africa. The third identifies a selective review of the state of the art and the positioning of the theory. The fourth briefly outlines the different stages of the empirical strategy adopted. The results are then discussed. The article ends with a conclusion and policy recommendations.

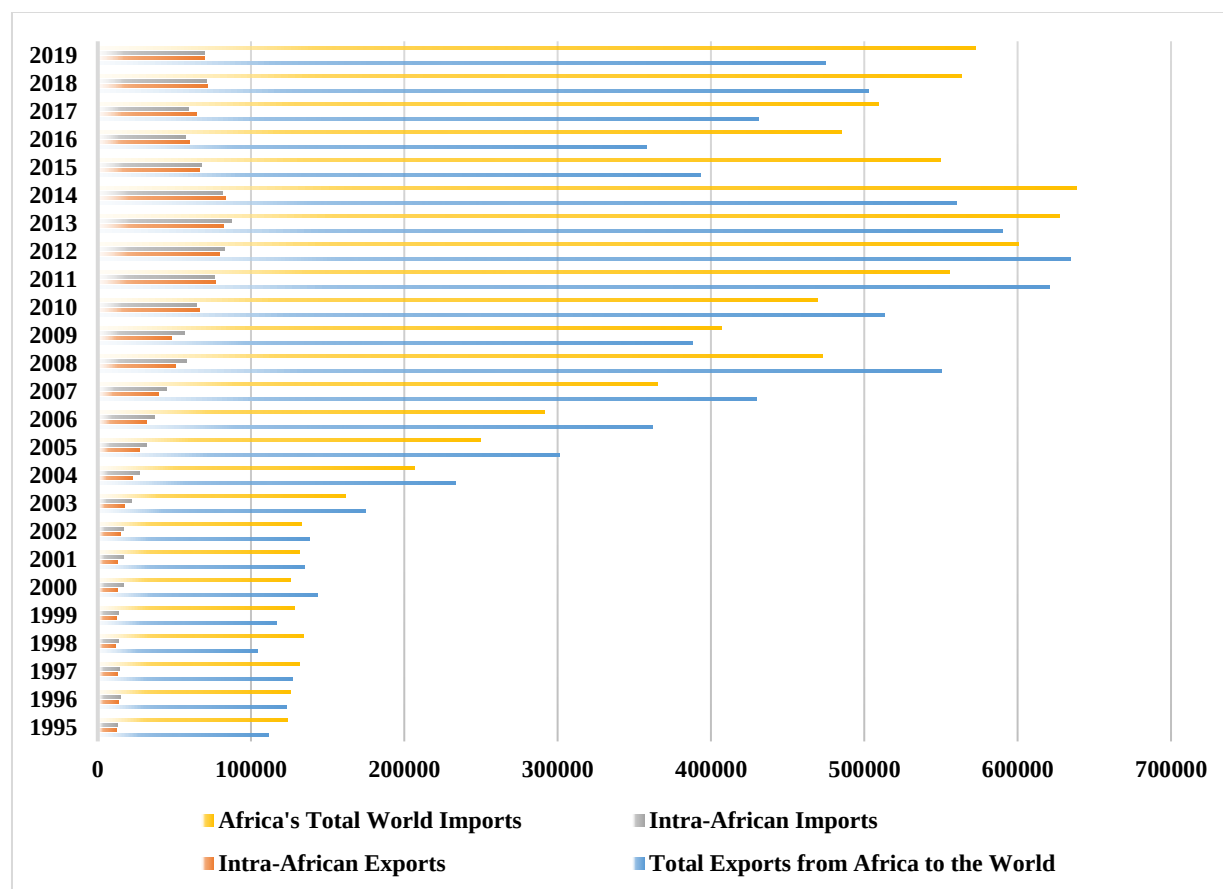
2. A few stylised facts: Entrepreneurship, ICT and bilateral trade

2.1. Africa's bilateral trade remains weak and focused on the rest of the world

Figure 1 shows the evolution of intra-African trade and African international trade. Trade between African countries and the rest of the world has grown steadily since 1995, rising from 111,157 to 474,580 million USD in 2019 for exports and from 123,933 in 1995 to 57,2580 million USD in 2019 for imports. The amount of international trade has quadrupled over time since 1995. This upward trend has been the same for intra-African trade. In 2019, intra-African exports stood at 69,584, compared with imports of USD 69,476 million. This means that intra-

African trade accounts for only 15% of imports to the rest of the world and 12% of exports to other continents.

Figure 1: Evolution of trade in Africa (in millions of US Dollars at current prices)

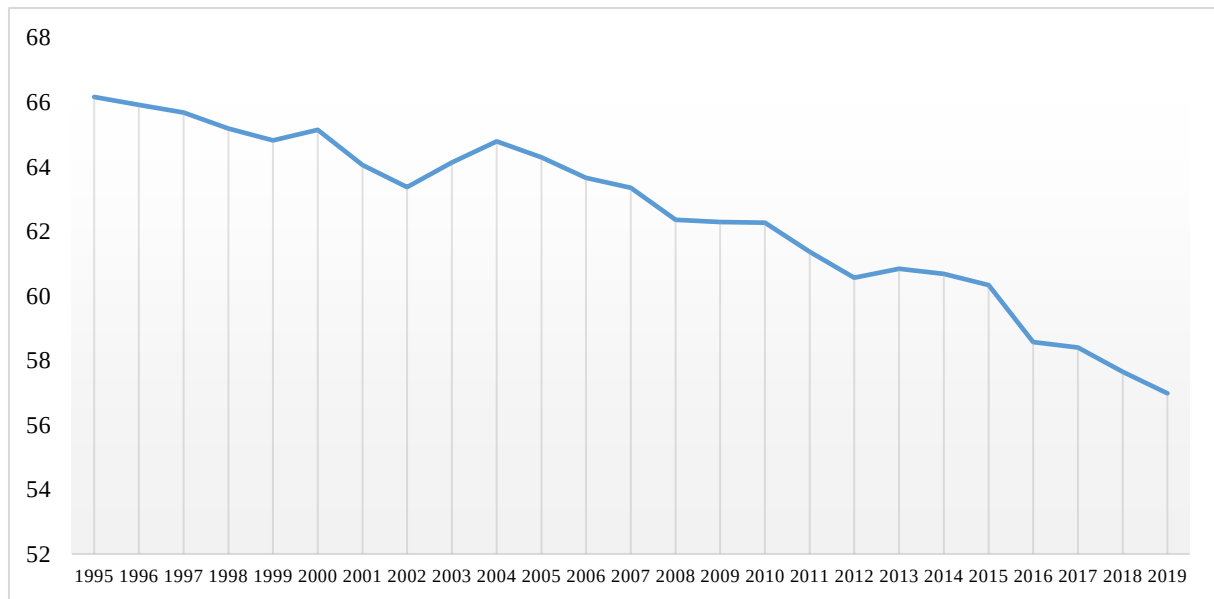


Source: Authors' using data from WDI (2020).

2.2. Female entrepreneurship is declining in Africa

Figure 2 shows a decline in female entrepreneurship as a proportion of total female employment. The decline ranges from 66.15% in 1995 to 56.97% in 2019. Although there was a slight improvement between 2004 and 2005, the slope of this curve continues to fall. There are a number of reasons for this, including an increase in the proportion of employed women, while the number of women entrepreneurs has remained constant over the period.

Figure 2: Trends in women's self-employment (% of women employed)

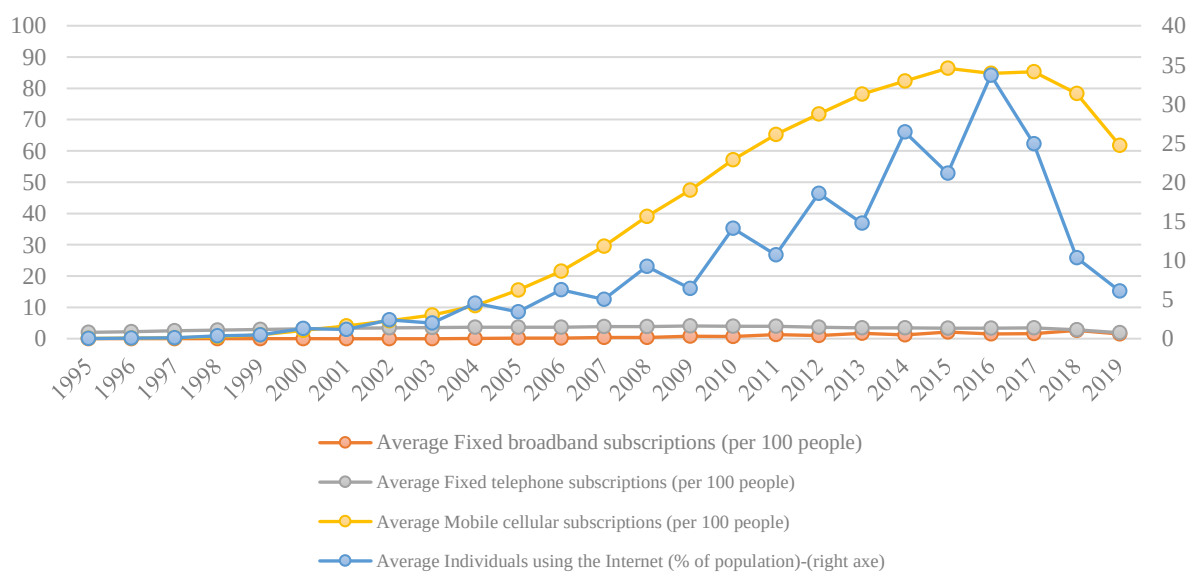


Source: Authors' using data from WDI (2020).

Figure 3 present evolution on ICT indicators

Four different ICTs indicators are considered in this article because they have different impacts derived from their diffusion trajectories. Figure 1 shows the evolution of internet, mobile phone, fixed phone and broadband diffusion in Africa over the studied period. Average mobile phone, fixed phone and broadband subscriptions per 100 people jumped from 0.144; 2.000 and 0.090 in 1995 to 61.76; 1.894 and 6.063 in 2019 respectively. In the same period, average internet penetration increased from 1.16 to 26.86%.

Figure 3: Evolution of ICT variables in Africa



Source: Authors' construction using data from WDI (2020).

2.3. Empirical synthesis

Empirical analysis of the effect of women's entrepreneurship on bilateral trade highlights several lessons. In the age of globalisation, no economy in the world can achieve economic development without interacting (trading) with other economies. Lock and Lawton (2016) draw on primary research conducted through face-to-face surveys with women entrepreneurs in Kenya across a wide range of sectors, all of whom have their own micro-enterprises. The study shows that women entrepreneurs in Kenya face far fewer barriers to setting up micro-enterprises today than in the past, and that this model is proving highly effective in helping them and their families to lift themselves out of poverty. Entrepreneurial ventures contribute to economic growth, but the potentially gendered nature of this contribution needs to be explored as the outcomes of male and female-owned businesses differ (Crane, 2022).

However, there are a number of barriers to growth in the micro-enterprise sector. Based on these barriers, Lock and Lawton (2016) argue that for women's entrepreneurship to have a greater impact on economic growth in Kenya, the country needs to introduce more effective policies, regulation of the informal sector and additional support for women entrepreneurs, for example through business training, mentoring and financial support. In non-parametric analyses, female-led companies in developed countries perform similarly to male-led companies, while in developing countries, male-led companies perform significantly better than female-led companies. Crane (2022) also finds strong evidence that the gender of the Schumpeterian entrepreneur does not matter in contributing to economic growth. Lock and Lawton (2016) indicate that women face ongoing cultural barriers in innovation-related fields and that gender norms persist in entrepreneurship. Therefore, removing cultural barriers and continuing to support Schumpeterian entrepreneurship will benefit women and contribute to a country's economic growth.

Sajjad et al. (2020) explain the significant impact of women's entrepreneurship on the world's economies. It has been observed that women's participation in entrepreneurial activities not only contributes to the income of their families, but also plays an important role in the economic development and social well-being of society. Nwakanma (2021) explores how entrepreneurship and women's empowerment intersect in theory and practice to drive economic development in Africa. Drawing on the ideas of the intersection of women, entrepreneurship and economic development, it describes the various ways in which these intersections are ultimately synergistic and influence change on the continent.

Many studies argue that the informal sector is well suited to the needs of women entrepreneurs because it offers greater flexibility in terms of working hours, pace of work and proximity of

employment to the home (Bahramitash and Salehi Esfahani, 2011; Manning, 1998; Poncela and Steiger, 1996). Indeed, studies in developing countries highlight the enormous presence of women in the informal sector, particularly in commercial activities and as self-employed workers in family businesses.

By empowering women, they can contribute to increased production and hence welfare and increased exports of goods (Krumbiegel, 2020; Van and Maertens, 2017). The results show that women's employment has a statistically significant and positive effect on total household income, women's income share, women's income and asset ownership and a negative effect on women's reproductive workload in Ghana (Krumbiegel, 2020). Subsequently, Maertens and Swinnen (2012) report that 94% of women workers in export-oriented horticulture enterprises in Senegal report that their decision-making power within the household has increased, 67% that they enjoy more respect within their community, and 78% that they benefit from meeting and exchanging with other women in the enterprises.

Most research on entrepreneurship has focused on men. Others have examined the reasons why women become entrepreneurs (Sarri and Trihopoulou, 2005) or the barriers they face in setting up a business (Menzies et al., 2003; Brindley, 2005). According to Hisrich and Öztürk (1999), most of the research on women's entrepreneurship has been conducted mainly in developed countries, economies and marginally in developing countries. However, several studies have shown that giving women the opportunity to start a business would have a positive impact on society in general and on the family in particular (Tayeb, 2005). Djodjo et al. (2017) argue that by acquiring income, women will not only be able to participate in household expenses, but also provide for their own needs, in exchange for which men sacrifice part of their decision-making Power.

Three lessons can be drawn from the above developments. First, most of the work identifies the effects of entrepreneurship on the economy and, to some extent, on different sectors. This limits the understanding of the effects of entrepreneurship on international trade. Second, because of its complexity, any analysis of the impact of entrepreneurship must explicitly take into account the informal sector and ICTs. Third, the surprising paucity of empirical studies on the effect of women's entrepreneurship may warrant further investigation in the context of regional integration in Africa as advocated by the African Continental Free Trade Area.

3. Specification of the gravity model

The gravity model has been widely used in the empirical literature on international trade since the pioneering work of Tinbergen (1962). By introducing the concept of the multilateral resistance term (Anderson and Van Wincoop, 2003), the gravity model of bilateral trade between importing country i and exporting country j can be expressed as follows:

$$X_{ij} = \frac{E_i}{P_i^{-\beta}} \frac{Y_j}{\pi_j^{-\beta}} \theta_{ij}^{-\beta} \quad (1)$$

Where Y_j is the total output of the origin country, E_i is the total expenditure in the destination country θ_{ij} is the vector of variables that can affect trade costs between any pair of countries, such as country, distance, common languages, barriers to trade, infrastructure and customs unions, among others.

In addition, the elasticity of trade flows with respect to trade costs and the incoming and outgoing multilateral resistance indices (Anderson and Van Wincoop, 2003), which capture the general equilibrium effects on trade. This is the specification that allows infrastructure to be introduced into the gravity model. The basic gravity model is approximated by the distance between trading partners.

We follow Carrère (2006) in adopting the following formulation of θ_{ij} .

$$\theta_{ij} = \beta_i [(Dist_{ij}) (Area_i) (Area_j)] \times [exp(\beta_4 \text{female entrepreneurship}_{i(j)t} + \beta_5 \text{Kaufindexit} + \beta_6 \text{fin Dev}_{i(j)t} + \beta_7 \text{ICT}_{i(j)t} + \beta_8 \text{Landij} + \beta_9 \text{ComBordtij} + \beta_{10} \text{Langij} + \beta_{11} \text{Comcolij})] \quad (2)$$

Where $Area_{i(j)}$ is the area of country $i(j)$; in square kilometres; $Dist_{ij}$ is the distance between country i and country j ; $ComBordtij = 1$ if i and j share the same border, otherwise 0; $Comcol = 1$ for common settler, otherwise 0; $Landij = 1$ if countries i and j are members of the community, otherwise 0; $Lang = 1$ if countries i and j share the same language, otherwise 0; $Comcur = 1$ if countries have the same currency, otherwise 0.

To introduce multilateral resistance terms, country fixed effect dummy variables $\alpha_{i(j)}$ are used. After applying log to linearise equation (1), the following equation is estimated:

$$\log X_{ij} = \beta_0 + \beta_1 \log Y_{it} + \beta_2 \log Y_{jt} + \beta_3 (Dist_{ij}) + \beta_4 \log(Area_i) + \beta_5 \log(Area_j) + \beta_6 \text{female entrepreneurship}_{i(j)t} + \beta_7 \text{Kaufindexit} +$$

$$\beta_8 finDev_{i(j)t} + \beta_9 ICT_{i(j)t} + \beta_{10} ComBordtij + \beta_{11} Langij + \beta_{12} Comcolij + \beta_{13} Land_{ij} + \alpha_i + \alpha_j + \varepsilon_{i,t} \quad (3)$$

Finally, one of the most recognised problems in estimating gravity models is the presence of non-negative trade flows. To deal with zero trade flows, the PPML estimator, using a log-linear function instead of a log-one approach, is adopted (Silva and Tenreyro, 2006). For robustness checking, the Heckman sample selection estimator is also applied (Helpman et al., 2008). Since the work of Anderson and Van Wincoop (2003), a multilateral resistance term has been included in the estimation of gravity models. The multilateral resistance term captures variations in the cost of trade on a bilateral route that may affect trade flows on all other routes due to relative price effects. Thus, exports from country *i* to country *j* depend on trade costs in all possible export markets, and imports into country *i* from country *j* depend on trade costs from all possible suppliers. To deal with these multilateral resistance terms, we use the PPML estimator with HDFE, which in turn allows for multiple sources of heterogeneity and multiple fixed effects (Abowd et al., 1999; Correia et al., 2020).

4. Study data and variables

Data on macroeconomic variables come from the World Bank's World Development Indicators (2022) and Doing Business (2022). Data on distance, borders, language and colonisation come from the database of the "Center for Prospective Studies and International Information." (CEPSII). The sample includes 32 African countries (Table A2 in appendix). The African region was chosen because of the low level of intra-regional trade, the lack of infrastructure and the very high cost of transport. The choice of the period from 2005 to 2019 is justified by the availability of data on our two variables of interest for the beginning of the period and by the start of the Covid-19 crisis for the end of the period, which led African economies to close their borders.

4.1. The dependent variable

Bilateral trade: measures bilateral intra-African exports between country *i* and country *j* in period *t* (Mignamissi, 2018).

4.1.1. The variables of interest

Female entrepreneurship in Africa:

In this study, we use the World Bank's new measure of business density (the paid in minimum variable), taken from its Doing Business report, which measures the business environment in a

country. This indicator focuses on the creation of new businesses and activities to promote creative destruction (Djankov et al., 2010). However, this indicator shows just how limited it is to assess only new businesses operating in the formal sector. It does not take into account entrepreneurship in the informal sector, which is an important part of entrepreneurship in African economies.

Fin Dev: financial development, which is "the accumulation of financial assets at a faster rate than the accumulation of non-financial assets" (Shaw, 1973).

ICT: This is a composite index calculated using the following elements: total number of telephone subscribers (per 100 inhabitants), fixed broadband internet subscribers (cable) per 100 inhabitants, international broadband connectivity (Mbps), and the number of internet users (per 100 inhabitants) (Song et al, 2022).

4.1.2. Control variables

Population can be used to represent the size of a country's consumer market as well as its labour market. It is difficult to predict the effect of population on trade; it can have a positive or negative effect. The larger the population, the greater the supply capacity, which means a greater volume of exports and a positive effect on the volume of bilateral trade. On the other hand, a larger population constitutes a larger supply, which reduces imports, resulting in a negative correlation with trade volume (Gao and Zhang, 2015).

The distance between country *i* and country *j* should have a negative sign. As noted by Loungani et al. (2002), distance includes not only transport costs, but also information and research costs. Geographical distance is therefore used as a proxy for transport costs, given the unavailability of reliable data on these costs (Fontagné et al., 2002). The other traditional variables of the gravity model such as: common border, common language, common settler are inspired by the work of Foroutan and Pritchett (1993); Avom and Gbetnkom (2005); Avom and Mignamissi (2017). The nominal GDP of country *i* and its trading partner *j* as an indicator of the economic size of the two countries. It is expected that a higher real GDP product will lead to a higher volume of trade between the two countries (Thai, 2006). Therefore, it is estimated that the product will have a positive effect on exports Gandjon (2017).

Area: Logarithm of the surface area of the exporting/importing country in square kilometers (Martinez-Zarzoso & Chelala, 2020).

Land: Is the dummy variable which takes 1 if the exporting/importing country is landlocked and 0 otherwise (Martinez-Zarzoso and Chelala, 2020).

5. Results and interpretation

5.1 Basic analysis

Equation (3) is then estimated using different techniques (columns 1 to 4 of Table 2). Column (1) applies the OLS while the simple PPML method is shown in column (2) and the PPML-HDFE is in column (3). To ensure the robustness of the results, the area of the country is replaced by the population density in column (4) using the PPML-HDFE estimation technique. To ensure the reliability and validity of the results, the area of the country is replaced by the population density in column (4) according to the PPML-HDFE estimation technique.

In the four columns, the coefficients for female entrepreneurship are significant overall. According to the PPML with HDFE estimation (columns 3 & 4), the main variable of interest which is "paid in minimum" has a positive and significant impact at 1% with low coefficients whether the country is an exporter or importer of intra-African trade. One result shows the place that female entrepreneurship occupies in economic activity in general and in the development of bilateral trade in particular. This result is in line with those found in the literature by Krumbiegel (2020); Van and Maertens, (2017) for whom, by empowering women, their level of participation contributes to increasing production and therefore welfare and increasing exports of goods.

As for our control variables, most are significant with expected signs. The coefficient estimated for geographical distance is negative and significant at the level of about 1, indicating that a 1% increase in distance reduces exports by about 3%. The dummy variables of sharing a common border, language and common settler facilitate trade. This is consistent with the literature and following the results of Head et al (2010), Rauch (1999), the colonial past stimulates bilateral trade between countries.

A variation of 1% in the GDP of the exporting country leads to a variation in intra-African exports of around 1.32% to 1.27%. Conversely, a variation of 1% in the GDP of the importing country leads to a variation in intra-African exports of between 0.59% and 0.59%. These results corroborate the assertion that a country trades with its partners in proportion to its income and the size of its population. These results are consistent with those found by Avom and Mignamissi (2017), Avom and Gandjon (2014) and Gbetnkom and Avom (2005) in the African context.

All ICT dimensions considered in exporting country *i* and importing country *j* explain the evolution of exports to Africa. While access to fibre optics, access to mobile telephones and access to fixed telephones in the exporting country have a significantly positive effect on bilateral intra-African trade. This result corroborates that found in the literature by Lin (2015) for whom internet adoption has a positive effect on bilateral trade flows of goods through the reduction of transaction costs.

For these countries, better access to broadband and secure servers improves business performance between trading partners and encourages individuals and businesses to seek out the best service providers or producers, regardless of physical distance. In addition, the cost of processing tacit knowledge is naturally lower and the use of ICTs constitutes a genuine comparative advantage that can stimulate bilateral trade flows, as shown by Choi (2010), Vemuri and Siddiqi (2009) and Freund and Weinhold (2004), who found that the spread of ICTs helps to improve trade flows in both developed and developing countries.

Table 5: Results of the gravity model with the variable paid in minimum for doing business

Dep. Var. Exportij	(1) REGHDFE	(2) PPML	(3) PPMLHDFE	(4) PPMLHDFE
Ind. Var.				
Logdistij	-107,456*** (7,723)	-3.077*** (0.0741)	-3.085*** (0.0701)	-3.092*** (0.0816)
logPibi	55,257*** 6,065	1.309*** (0.0700)	1.321*** (0.0663)	1.271*** (0.0687)
logPibj	15,875*** 3,868	0.483*** (0.0741)	0.509*** (0.0733)	0.596*** (0.188)
Lareai	780.9 (856.2)	0.136*** (0.0333)	0.114*** (0.0311)	-
Lareaj	6,289*** (1,62)	0.217*** (0.0355)	0.218*** (0.0384)	-
PaidMini	26.02*** (5.655)	9.48e-05 (0.000143)	0.000303*** (9.96e-05)	0.000313*** (0.000102)
PaidMinj	15.07*** (3.130)	8.24e-05 (0.000104)	0.000309*** (8.46e-05)	0.000299*** (8.06e-05)
Devfini	202,996*** 14,689	3.131*** (0.293)	3.410*** (0.267)	3.431*** (0.264)
Devfinj	367,909*** 37,409	5.291*** (0.214)	5.260*** (0.252)	5.290*** (0.273)
IndUsingInti	379.7*** (115.5)	0.000376 (0.00411)	0.000611 (0.00354)	0.000874 (0.00369)
IndUsingIntj	573.5***	0.00200	0.00240	0.00229

	(116.7)	(0.00370)	(0.00272)	(0.00265)
Mobceli	29.08	0.000815	0.00411***	0.00436***
	(34.18)	(0.00119)	(0.000954)	(0.00106)
Mobcelj	221.1***	0.00191***	0.00571***	0.00526***
	(24.78)	(0.000683)	(0.000668)	(0.00102)
FixedBBi	3,488***	0.0316*	0.0439**	0.0433**
	(694.6)	(0.0165)	(0.0171)	(0.0171)
FixedBBj	3,263***	0.0297*	0.0323***	0.0335***
	(841.7)	(0.0167)	(0.0116)	(0.0121)
Fixedteli	1,869***	0.00618	0.0451***	0.0480***
	(295.0)	(0.00628)	(0.00428)	(0.00506)
Fixedtelj	2,626***	0.0196***	0.0569***	0.0545***
	(455.6)	(0.00707)	(0.00860)	(0.00788)
Frontij	31,502***	0.218***	0.245***	0.241***
	3,939	(0.0418)	(0.0430)	(0.0479)
Langij	40,264***	0.539***	0.552***	0.549***
	3,727	(0.0430)	(0.0404)	(0.0415)
COMCOLij	18,426***	0.0390	-0.0342	-0.0234
	1,934	(0.0455)	(0.0385)	(0.0407)
Landi	32,491***	1.185***	0.981***	0.970***
	3,473	(0.0991)	(0.0925)	(0.101)
Landj	6,740***	0.148***	-0.0201	-0.0328
	1,956	(0.0522)	(0.0543)	(0.0672)
log(density_Pop)i				0.0707
				(0.0612)
log(density_Pop)j				-0.127
				(0.189)
Constant	-546,502***	-5.965***	-6.110***	-6.025***
	53,356	(0.494)	(0.307)	(0.301)
Time fixed effects	Yes	No	Yes	Yes
Reporter fixed effects	Yes	No	Yes	Yes
Partner fixed effects	No	No	No	No
Observations	12,64	12,64	12,64	12,64

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors'

5.2 Robustness analysis

The main variable of interest, paid in minimum, is replaced by self-employment. The positive and significant sign at 5% (column 3) and 1% (column 4) at export level is maintained. This positive effect can be explained by the International Labour Organisation (ILO), which considers entrepreneurship as one of the factors of production in addition to the three others (land, labour and capital). It is the set of skills and knowledge that employers need, as well as anyone who starts or owns a business.

There are several reasons for this, not least that female entrepreneurship encourages diversification of the products and services traded. This is because women entrepreneurs often bring innovative and creative ideas to the table, which boosts competitiveness and commercial dynamism. Secondly, women entrepreneurs help to create jobs and reduce unemployment in Africa. Sectors of the economy such as agriculture, retail, crafts and services, which are important drivers of the African economy, are predominantly driven by women. Finally, women entrepreneurs are agents of social change and community development. They often invest their income in education, health and the well-being of their families and communities, which has a positive impact on human development in Africa. Other variables of interest, such as ICTs, continue to show the same signs, as does financial development.

Table 6: Results of the gravity model with wdi self-employment

	(1)	(2)	(3)	(4)
Dep. Var. Exportij	REGHDFE	PPML	PPMLHDFE	PPMLHDFE
Ind. Var.				
Logdistij	-108,226*** (8,016)	-3.090*** (0.0766)	-3.105*** (0.0672)	-3.116*** (0.0803)
logPibi	57,215*** (6,246)	1.310*** (0.0705)	1.339*** (0.0683)	1.477*** (0.0797)
logPibj	15,192*** (3,247)	0.495*** (0.0743)	0.530*** (0.0683)	0.629*** (0.213)
Lareai	81.70 (970.4)	0.155*** (0.0329)	0.134*** (0.0301)	-
Lareaj	5,671*** (1,427)	0.209*** (0.0379)	0.206*** (0.0397)	-
Selfemployi	150.4** (66.95)	0.00303** (0.00121)	0.00365** (0.00154)	0.00611*** (0.00188)
Selfemployj	340.9*** (69.41)	0.00284** (0.00121)	0.00106 (0.00132)	0.000656 (0.00225)
Devfini	205,824*** (15,161)	3.244*** (0.264)	3.539*** (0.302)	3.610*** (0.320)
Devfinj	348,607*** (34,81)	5.014*** (0.268)	5.152*** (0.315)	5.300*** (0.418)
IndUsingInti	447.9*** (122.0)	0.00121 (0.00405)	0.00316 (0.00403)	0.00351 (0.00418)
IndUsingIntj	522.4*** (112.8)	0.000822 (0.00374)	0.00214 (0.00281)	0.00262 (0.00317)
Mobceli	71.97 (45.69)	0.00128 (0.00130)	0.00495*** (0.00150)	0.00464*** (0.00143)
Mobcelj	165.0*** (23.72)	0.00142* (0.000745)	0.00548*** (0.000764)	0.00537*** (0.000857)

FixedBBi	4,496*** (888.9)	-0.0129 (0.0200)	0.0719** (0.0283)	0.0825*** (0.0293)
FixedBBj	1,907** (777.7)	-0.0442** (0.0187)	0.0305** (0.0134)	0.0412* (0.0220)
Fixedteli	2,643*** (405.6)	0.0118* (0.00633)	0.0476*** (0.00453)	0.0468*** (0.00465)
Fixedtelj	2,355*** (504.3)	0.0148* (0.00850)	0.0529*** (0.00821)	0.0514*** (0.00760)
Frontij	31,166*** (3,845)	0.208*** (0.0404)	0.231*** (0.0412)	0.229*** (0.0454)
Langij	42,736*** (3,852)	0.556*** (0.0445)	0.588*** (0.0407)	0.597*** (0.0405)
COMCOLij	-21,489*** (2,037)	0.0301 (0.0442)	-0.0573 (0.0380)	-0.0491 (0.0446)
Landi	38,813*** (3,954)	1.244*** (0.0644)	1.125*** (0.0658)	1.136*** (0.0725)
Landj	9,834*** (2,292)	0.155*** (0.0523)	0.0657 (0.0592)	0.0458 (0.0665)
log(density_Pop)i				-0.191*** (0.0512)
log(density_Pop)j				-0.153 (0.245)
Constant	-535,272*** (51,109)	-6.283*** (0.567)	-7.094*** (0.470)	-7.816*** (0.642)
Time fixed effects	Yes	No	Yes	Yes
Reporter fixed effects	Yes	No	Yes	Yes
Partner fixed effects	No	No	No	No
Observations	12,649	12,649	12,649	12,649

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors'

6. Conclusion

Bilateral trade between African countries plays a crucial role in the continent's economic development and growth. Growth in intra-African trade is possible. Women's entrepreneurship and ICT are profitable effect on bilateral trade in Africa, as it promotes economic diversification, job creation and community development. This paper examines the effect of female entrepreneurship associate with ICT on bilateral trade in a sample of 32 African countries over the period 2005-2019 using the Poisson estimator of Pseudo maximum likelihood with high-dimensional fixed effects (PPMLHDFE). The main finding that helped refine our problem is that entrepreneurship is considered as another factor of production alongside the other three (land, capital and labour). The empirical results reveal that the first

entrepreneurship variable (paid in minimum) has a positive and significant impact at 1% on bilateral trade in Africa, whether the country is an exporter or importer. Subsequently in robustness, the second entrepreneurship variable (self employment) is also positive and significant at 5% and 10% for exporters. This supports our main result that female entrepreneurship can be a channel through which intra-African trade can increase in line with Krumbiegel (2020); Van and Maertens, (2017).

In terms of economic policy implications, it is therefore essential to support and encourage female entrepreneurship in Africa. This can be done by providing equitable access to finance, building women's entrepreneurial capacity, promoting gender equality in economic policies and fostering the creation of business networks for women entrepreneurs, since female entrepreneurship meets the requirements of justice and equity by enabling women to benefit from the same opportunities as men to create and develop their businesses.

References

- Abdi, A. H., Zaidi, M. A. S., and Karim, Z. A. (2023). Economic complexity and bilateral trade flows in selected COMESA and East Asia countries. *Technological and Economic Development of Economy*, 29(3), 846-873.
- Avom, D., Gbetnkom, D. (2005). Intégration par le marché : le cas de L'UEMOA. *Revue Région et Développement* n° 22.
- Avom, D., Mignamissi, D. (2013). Évaluation et analyse du potentiel commercial dans la Communauté économique et monétaire de l'Afrique centrale (CEMAC). *L'Actualité économique*, 89 (2), 115–145
- Avom, D., Mignamissi, D. (2017). Pourquoi le commerce intra-CEEAC est-il si faible? *Revue française d'économie* 2017/3 (Vol. XXXII), pages 136 à 170
- Baccini, A. (2010). Statistique Descriptive Multidimensionnelle (pour les nuls). Institut de Mathématiques de Toulouse-UMR CNRS, 5219.
- Balassa, B. (1961) The Theory of Economic Integration. Richard D. Irwin, Inc., Homewood. <https://doi.org/10.1111/j.1467-6435.1961.tb02365.x>
- Bahramitash, R., Salehi Esfahani, H. (2011). Veiled employment: Islamism and the political economy of women's employment in Iran. Syracuse: Syracuse University Press
- Batliwala, S. (1994). The meaning of women's empowerment: New concepts from action. *Population policies reconsidered: Health, empowerment and rights*, 17.
- Becker, G. E. (1965). A theory of the allocation of time. *Economic Journal*, 71, 493-517.
- Billon, M., Rodríguez-Andrés, A., and Rodríguez-Crespo, E. (2023). Broadband use and trade facilitation: Impacts on bilateral trade of sub-Saharan countries. *African Development Review*, 35(2), 113-125.
- Boserup, E. (1970). Women's role in economic development. New York: St. Martin's Press.
- Brindley, C. (2005). Barriers to women achieving their entrepreneurial potential : Women and risk, *Int J of Entrep Behavior and Research*, 11 (2) :144-161

- Carrère, C. (2006). Revisiting the Effects of Regional Trading Agreements on Trade Flows with Proper Specification of the Gravity Model. *Euro Econ Rev*, 50:223-247
- Crane, S. R. (2022). Entrepreneurship and economic growth: does gender matter ? *International Journal of Gender and Entrepreneurship*, 14(1), 3-25.
- Djodjo, G.E., El Oualidi M.N., Diaw, A. (2017). Mesure de l'empowerment des femmes : un essai théorique basé sur la typologie entrepreneuriale », *Revue Rep et Persp Eco*
- Egger, P. (2008). On the role of distance for bilateral trade. *World Economy*, 31(5), 653-662.
- Foroutan, J., Pritchett, L. (1993). Intra Sub-Saharan African Trade: Is It Too Little?, *Journal of African Economies*, vol. 2, 74-105.
- Freund, C., Weinhold, D. (2004). The effect of the Internet on International Trade, *JIE*, 62 :171-189.
- Gandjon, G. (2017). La prolifération des communautés économiques régionales constitue-t-elle une barrière aux échanges pour les pays d'Afrique Centrale ? *Région et développement*, n° 45-2017, 20 pages
- Gao, Z., Zhang, Y. (2015). A Study of Bilateral Trade Potential and Efficiency in the Construction of China-Pakistan Economic Corridor—Based on Stochastic Frontier Gravity Model. *Finance & Economics*, 11, 101-110.
- Grossman, G. M. (1984). International competition and the unionized sector. *Canadian Journal of Economics*, 541-556.
- Head, K., Mayer, T., Ries, J. (2010). The erosion of colonial trade linkages after independence. *JIE*, 81(1): 1-14.
- Hisrich RD, Öztürk SA (1999) Women entrepreneurs in a developing economy. *J of Manag Dev*, 18(2) : 114–125.
- Ismail, N. W. (2021). Digital trade facilitation and bilateral trade in selected Asian countries. *Studies in Economics and Finance*, 38(2), 257-271.
- Kenney, S. J. (1996). New Research on Gendered Political Institutions. *Political Research Quarterly*, 49(2), 445-466.
- Krugman, P. R. (1979). [Increasing returns, monopolistic competition, and international trade](#), *JIE*, Elsevier, 9(4) : 469-479.
- Krumbiegel, K., Maertens, M., Wollni, M. (2020). Can employment empower women? Female workers in the pineapple sector in Ghana, *Journal of Rural Studies*, Volume 80, 2020
- Lin, F. (2015). Estimating the effect of the internet on international trade. *The Journal of International Trade & Economic Development: An International and Comparative Review* doi:10.1080/09638199.2014.881906
- Linnemann, H. (1966). An Econometric Study of International Trade Flows, *Holland Publishing, Amsterdam*.
- Lock, R., Lawton, H. S. (2016). The impact of female entrepreneurship on economic growth in Kenya. *International Journal of Gender and Entrepreneurship*, 8(1), 90-96.
- Loungani, P., Mody, A., Razin, A. (2002). The global disconnect: the role of transactional distance and scale economies in gravity equations. *Scottish Journal of Political Economy*, 49(5), 526-543.*
- Lucas, R.E. (1988). On the Mechanics of Economic Development, *Journal of Mon Eco*, 22 : 3-42.

- Maertens, M., Swinnen, J. (2012). Gender and modern supply chains in developing countries. *Journal of Dev Stud.* 48 (10) :1412–1430
- Manning, C. (1998). Indonesian labour in transition: An East Asian success story? *Cambridge: Cambridge University Press.*
- Manova, K. (2008). Credit Constraints, Equity Market Liberalizations and International Trade, *JIE*, 76 : 33-47
- Martínez-Zarzoso. i., Chelala, S. (2020). [The impact of single windows on trade](#), *The World Economy*, 43, (10), 2549-2573
- Melitz, M.J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, *Econometrica, Econometric Society*, vol. 71(6), pages 1695-1725, November.
- Menzies, T.V., Brenner, G. A., Fillion, L.J. (2003). Social capital, networks and ethnic minority entrepreneurs: transnational entrepreneurship and bootstrap capitalism», dans H. Etemad et R.W. Wright (dir.), *globalization and Entrepreneurship: Policy and strategy Perspectives*, Northampton, mass., Edward Elgar Publishing, 125-151.
- Mincer, J. (1962). Labour force participation of married women: A study of labour supply. Aspects of labour economics. In A conference of the universities: National bureau committee for economic research. NJ USA: Princeton University Press, 1962.
- Niroomand, F., Hajilee, Nasser, A. L. (2014). Financial market development and trade openness: evidence from emerging economies. *Applied Eco.* 46 (10)
- Nwakanma, A. P. (2021). Women, entrepreneurship, and economic development in Africa. In *The Palgrave Handbook of African Women's Studies* (pp. 1583-1599). Cham: Springer International Publishing.
- Özmutaf, N.M., Aktekin, E., Ergani, B., Çıta, K. (2015). The Effects of Innovative Features of Women Managers on their Business Performance: The Food Exporter Companies in Aegean Region Sample, *Procedia - Social and Behavioral Sciences*, Volume 195 : 220-229
- Pettersson, J., Johansson, L. (2013). Aid, aid for trade, and bilateral trade: An empirical study. *The Journal of International Trade and Economic Development*, 22(6), 866-894.
- Poncela, A. M., Steiger, B. (1996). The disruptions of adjustment: Women in Nicaragua. *Latin American Perspectives*, 23 : 49-66.
- Rauch, J.E. (1999). Networks versus Markets in International Trade, *JIE*, 48(1): 7-35.
- Romer, P. (1986). Increasing Returns and Long Run Growth, *JPE*, 94 :1002-1037.
- Sajjad, M., Kaleem, N., Chani, M. I., Ahmed, M. (2020). Worldwide role of women entrepreneurs in economic development. *Asia Pacific Journal of Innovation and Entrepreneurship*, 14(2), 151-160.
- Santos Silva, J.M.C., Tenreyro, S. (2006). The Log of Gravity. *Rev of Eco and Statistics*, 88: 641-658.
- Sarri, K., Trihopoulou, A. (2005). Female Entrepreneurs' Personal Characteristics and Motivation: A Review of The Greek Situation. *Women in Manag Rev*, 20(1):24-36.
- Sen, A. (1985). Well-being, agency and freedom: The Dewey Lectures 1984. *Journal of Philosophy*, 4(82), 169-221.
- Sinha, J. N. (1967). Dynamics of female participation in economic activity in a developing economy. In United Nations department of economic and social affairs. Proceedings of

- the world population conference, Belgrade 1965 (Vol. IV, pp. 336-337). New York: UN Publications.
- Song J.S; Mognol A Ekoula H. W and Melingui bate Adalbert A. G (2022), « Does ICTs diffusion increase bilateral trade in Africa? Empirical evidence using the extended gravity model», *Economic bulletin*
- Song, J.S., Ngnouwal Eloundou, G., Bitoto Ewolo, F., Ondoua Beyene, B. (2023). « Does Social Media Contribute to Economic Growth? » [*Journal of the Knowledge Economy*](#)
- Tayeb, M. H. (2005). International Human Resource Management. A Multinational Company Perspective. Oxford: Oxford University Press.
- Thai, T. D. (2006). A gravity model for trade between Vietnam and twenty-three European countries.
- Tinbergen, J. (1962). Shaping the world economy: suggestions for an international economic policy, Twentieth Century Fund, NY.
- Ünal, E., Lin, B., and Managi, S. (2023). CO2 emissions embodied in bilateral trade in China: An input-output analysis. *Environmental Impact Assessment Review*, 103, 107218.
- United Nations. (2021). *Reaping the potential benefits of the African continental free trade area for inclusive growth*. Economic development in Africa report. United Nations Conference on Trade and Development. UNCTAD.
- Vemuri, V. K., Siddiqi, S. (2009). Impact of commercialization of the internet on international trade: A panel study using the extended gravity model, *The Int Trade J*, 23: 458-484.

Appendix

Table A1: Variables description

Variables	Description	Source
$Ln(EXP)_{ij,t}$	Value of bilateral exports from <i>i</i> to <i>j</i> at time <i>t</i>	WDI (2020)
$Ln(GDP)_{it,jt}$	Logarithm of nominal GDP per capita of country <i>i</i> at <i>t</i> and country <i>j</i> at <i>t</i>	WDI 2020
$Female\ Entrep_{it,jt}$	Female entrepreneurship of country <i>i</i> at <i>t</i> and country <i>j</i> at <i>t</i>	Doing Business 2020
$Financial\ dev_{it,jt}$	Financial development of country <i>i</i> at time <i>t</i> and country <i>j</i> at <i>t</i>	WDI 2020
$Internet_{it,jt}$	Internet users (per 100 people) of country <i>i</i> at time <i>t</i> and country <i>j</i> at <i>t</i>	WDI 2020
$Mobile\ phone_{it,jt}$	Mobile cellular subscriptions (per 100 people) of country <i>i</i> at time <i>t</i> and country <i>j</i> at <i>t</i>	WDI 2020
$Fixed\ phone_{it,jt}$	Fixed telephone subscriptions (per 100 people) of country <i>i</i> at time <i>t</i> and country <i>j</i> at <i>t</i>	WDI 2020
$Broadband_{it,jt}$	fixed broadband subscriptions (per 100 people) of country <i>i</i> at time <i>t</i> and country <i>j</i> at <i>t</i>	WDI 2020
$Ln(Distance)_{ij}$	Logarithm of physical distance between the capital cities of country <i>i</i> and country <i>j</i> (in kilometers)	CEPII
$Language_{ij}$	Dummy variable that takes 1 if the country <i>i</i> and country <i>j</i> shares at least one common language and 0 otherwise	CEPII
$Colonial\ Origin_{ij}$	Dummy variable that takes 1 if the country <i>i</i> and country <i>j</i> have a former colonial link	CEPII
$Common\ border_{ij}$	Countries trading share the same border (1=yes and 0=otherwise) of country <i>i</i>	CEPII
$Area_{ij}$	Logarithme de la superficie du pays exportateur et importateur en kilomètres carrés.	Banque Mondiale 2020
$Landlocked_{i,j}$	Est la variable muette qui prend 1 si le pays exportateur et importateur est enclavé et 0 sinon.	Martinez-Zarzoso_Chelala (2020) et les auteurs
$Ln(Population)_{ij,t}$	Logarithm of Population of exporting of country <i>i</i> at time <i>t</i> and country <i>j</i> at <i>t</i>	WDI 2020

Notes: WDI: World Development Indicators; CEPII: Center for Prospective Studies and International Information, EWNM: External Wealth of Nations Mark.

Source: Authors.

Table A5: List of countries

Algeria, Angola, Benin, Burkina-Faso, Cameroon, Capo Verde, Chad, Congo, Ivory Coast, Equatorial Guinea, Guinea Bissau, Ethiopia, Egypt, Gabon, Gambia, Ghana, Kenya, Liberia, Libya, Madagascar, Mali, Mauritania, Morocco, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Togo, Tunisia

Source: Authors.