

ORIGINAL ARTICLE

Open Access



Access to finance and intra-Africa trade efficiency

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Abstract

This paper examines the impact of access to finance on intra-Africa trade efficiency using a panel dataset comprising 44 African exporters. Between 2008 and 2021, a stochastic frontier version of the gravity model finds intra-Africa trade to have been lower than its full potential by \$1.1 billion on average. Exporters with better access to finance such as South Africa, Morocco and Mauritius operated closer to their full potential. The effect of access to finance on intra-Africa trade is found to have been stronger between distant trading partners. This suggests that access to finance largely promotes intra-Africa trade through financing transportation and logistics. In view of these results, the analysis recommends policy efforts to improve access to finance in order to maximize trade between African countries.

Keywords: Access to finance, Intra-Africa trade, Africa's trade potential, Trade inefficiency

Introduction

Sound financial systems are key drivers of economic development. Yet about 80 percent of people in Africa lack access to formal financial services while about 83 percent of enterprises have unmet financing needs (Adegboye and Iweriebor 2018). These statistics have led many to speculate that Africa's limited access to finance could be derailing its development. Of particular interest to trade economists is the extent to which this predicament is affecting intra-Africa trade. The share of intra-Africa imports and intra-Africa exports is reported to have averaged only 13 percent and 20 percent, respectively between 2013 and 2019 (Larguet and Bouakkaz 2023).

In theory, better access to finance can spur intra-Africa trade by financing trade-related costs associated with international shipping, learning export markets, regulatory compliance, product customization and the maintenance of foreign distribution networks (Feenstra et al. 2014). In addition, Africa has poor infrastructure that is characterized by deteriorated and often unpaved roads, limited network connectivity in transit, high cost of data, cross border delays and inefficient ports. These infrastructural bottlenecks increase transactional and logistical costs which, in the absence of accessible financial services, may erode competitive advantage, and discourage trade within the region. The Infrastructure Consortium of Africa (ICA) particularly demonstrates that

poor infrastructure increases the costs of trading goods among African countries by 30–40 percent.

When analyzing the impact of access to finance on intra-Africa trade efficiency, it is necessary to first define trade efficiency. Trade efficiency measures the distance between actual trade volumes and the potential trade volumes (Kumbhakar and Horncastle 2015). The potential trade frontier is an unobservable which is estimated and determined by the best performing country. A country whose trade volumes are lower than the trade frontier is deemed to be inefficient. This trade inefficiency can also be referred to as trade shortfalls to the extent that it captures the volume of trade that the country would have realized if it were efficient.

With the above background, it becomes necessary to empirically pose the question, could an improvement in access to finance override Africa's liquidity challenges and push intra-Africa trade towards its full potential? Empirical literature is divided on this question. On the one hand, Yakubu et al. (2018) from a system generalized method of moments and a panel data sample comprising 42 African countries observed between 1980 and 2015 find domestic credit affecting trade positively in Africa. On the other hand, Sare et al. (2019) using a pool mean group approach and a panel dataset comprising 46 African countries observed between 1980 and 2016 find the relationship insignificant.

This paper departs from the above literature (Yakubu et al. 2018; Sare et al. 2019) in three ways. Firstly, unlike Yakubu et al. (2018) who examine the impact of access to finance on Africa's average exports to the rest of the world, this analysis focuses exclusively on intra-Africa trade. Secondly, it explicitly addresses the concept of trade potential in the context of African economies. Thirdly, it pays attention to the endogeneity of access to finance and the exporting country's productive capacity.

The results of this analysis confirm that intra-Africa trade is, as reported in previous accounts, significantly lower than its potential. On average, intra-Africa exports are found to be only around 5 percent of their potential. From an average of USD54 million worth of exports within Africa between 2008 and 2021, average exports were short of their potential by an estimated USD1.1 billion. This trade inefficiency indicates a large scope for raising bilateral exports among African countries at current income levels.

The rest of the paper is organized as follows. Sect. "Literature review" provides an overview of trade in Africa and a conceptual framework. This is followed by a review of related literature in Sect. "Model specification". Sect. "Results and discussion" specifies the empirical model and describes the dataset, Sect. "Conclusion" presents and interprets the empirical findings, while Sect. 6 provides a summary of the study, conclusion, and policy implications.

Literature review

In theory, the relationship between access to finance and international trade is heavily founded on the work of Melitz (2003) and Chaney (2016). These models theoretically include liquidity constraints as a determinant of exporting at firm-level. Chaney (2016) specifically assumed that firms ought to pay entry cost when tapping into foreign markets. Borrowing from the same reasoning, Manova (2013) shows that financial frictions impede firm-level exports, as well as firm entry into foreign markets,

export product scope and trade partner intensity. More recently, Goksel (2012) develops a model of international trade based on new trade theory with financial constraints and non-homothetic preferences. Predicted in the model is that (i) financial constraints act as trade barriers, (ii) the largest amount of trade is between countries that have healthier financial systems in terms of access to loans and (iii) financial constraints can cause one way or zero trade.

From an empirical standpoint, studies have, in the main, focused on the impact of financial development and access to finance on trade flows. Muûls (2015) for instance conducts a firm level analysis in the context of Belgium and finds firms with lower creditworthiness less likely to export. In Berman and Héricourt (2010), access to external finance is found to have a positive effect on the firm's probability to export. Egger and Kesina (2013) and Jarreau and Poncet (2010) reach a similar conclusion. Using a sample of Chinese firms, they document a dampening effect of credit constraints on exports as did Minetti and Zhu (2011) and Forlani (2021) in the context of Italian firms. Forlani (2021) particularly finds the probability of exporting rising by 17 percent in response to a 10 percent increase in the cash stock of constrained firms.

Country level studies have largely produced mixed results. Yakubu et al. (2018), for instance, examine the impact of financial development on trade flows in the context of 46 African countries observed between 1980 and 2015. Their results find a negative impact of private credit on trade and a positive effect of domestic credit on trade. For South Africa, Kohler and Saville (2011) find a one percentage point increase in the interbank lending rate of South Africa's trade partner reducing exports by approximately ten per cent suggesting that limited access to finance has a dampening effect on South Africa's trade flows.

Bista and Khan (2023) find that countries exporting the least benefit the most from high financial development. In fact, the positive effect of financial development on trade is found to be driven primarily by country-pairs than trade at the median or lower end of the export distribution. Interestingly, the positive association of the relationship disappears for countries that trade at the highest end of the export distribution. Their results reinforce the argument that financial development alleviates fixed costs to exports, but more importantly so, for country-pairs that trade the least.

Olney (2022) show that the limited intra-African exports cannot be simply modelled by conventional gravity equations. The author probes into possible explanations and identifies factors that enhance intra-Africa trade. Intra-African exports are particularly found to increase with road infrastructure, the establishment of trade agreements in Africa, and declining trade costs.

Within the body of knowledge, very few studies have sought to link access to finance with the ability of countries to realise full potential. The closest analysis is Foroutan and Pritchett (1993) who use a traditional gravity model to compare the actual trade with what a gravity model would predict. Their analysis finds that the gravity model predicts very well the low level of intra-SSA trade. For the nineteen SSA countries in their sample, the actual share of SSA share of imports plus exports was an average (median) of 8.1 per cent (4.5 per cent) while the gravity model predicted a slightly lower, not higher, mean (median) of 7.5 per cent (4.5 per cent). Foroutan and Pritchett

(1993) did not however proceed to explain the deviation between actual trade shares and the predicted trade shares.

The reason behind the lack of studies linking access to finance with intra-Africa trade efficiency is the assumption held in previous accounts that finance is a technology variable that shifts the trade frontier rather than a variable that influences the movement of countries towards their full trade potential. Treatment of access to finance as a technology variable stems from the argument that improved access to finance spurs innovation that ultimately shifts the trade frontier given a direct relationship between a country's production function and its volumes of exports. The latter argument entails motivating a case in which access to finance increases trade volumes with a given productive capacity. A plausible explanation could be that improved access to finance spurs credit growth and motivates firms to reallocate some of the goods and services initially intended to service domestic markets into exports. These reallocation effects imply that trade inefficiency may arise from the deliberate actions of liquidity-constrained firms. This theoretical explanation is strongly supported by the work of Melitz (2003) and Chaney (2016). Melitz (2003) show that liquidity-constrained firms deliberately shift towards the home market. Firms that are not liquidity-constrained are more likely to participate in export markets. In line with this theoretical prediction, it can be argued that better access to finance may encourage a reallocation of firm output from domestic markets to export markets.

By linking access to finance with the ability of African countries to improve trade efficiency, this paper follows the empirical frameworks applied in Anderson and Yotov (2016), Kelkar and Kalirajan (2021), Kaushal (2022), Abdullahi et al. (2022), and more recently Masunda and Mhonyera (2024). In the main, these studies apply a stochastic frontier framework in linking free trade areas with intra-trade potential. The current study differs from this literature in two respects. Firstly, it pays careful attention to the potential endogeneity of productive capacities and access to credit. Secondly, for the first time in empirical literature, it links access to finance with the gap between observed intra-trade volumes among African economies and their maximum potential.

Model specification

To ascertain the impact of access to credit on the trade efficiency, a modified version of the gravity model extended to capture the effect of access to credit on trade efficiency is applied borrowing from the stochastic frontier model of production. The standard gravity model does not capture trade inefficiencies since all trade discrepancies (after controlling for trade determinants) are attributed to random shocks. The extended gravity stochastic frontier model has the advantage of accommodating discrepancies that systematically arise from trade inefficiencies. The alternative approach is the Data Envelopment Analysis (DEA) which is mostly deterministic. The primary advantage of the stochastic frontier gravity model over the DEA approach is its ability to separate trade inefficiencies from stochastic disturbances, measurement error and noise in data (Ruggiero 2007). Bilateral trade flows are generally measured with error due to differences in classification concepts and detail, time of recording, valuation, and coverage as well as processing errors. The general specification of the stochastic frontier gravity model takes the following form.

$$y_{ijt} = x'_{ijt} \beta + e_{it} \tag{1}$$

$$e_{it} = v_{it} - u_{it}$$

$$u_{it} = \delta m_{ijt} + w_{it} \tag{2}$$

where y_{ijt} are export flows from country i to country j , x is a vector of factors affecting bilateral trade flows, β is the corresponding vector of unknown coefficients to be estimated and e is the error term. Borrowing from the gravity literature, x contains GDP of the exporting, and importing country. Intuitively, Eq. 1 is the frontier specification which posits that deviation of bilateral exports from their full potential arises from stochastic factors v_{it} and inefficiencies u_{it} . Variable m captures access to finance while w is an error term. The study hypothesizes that access to credit affects the achievement of full potential by influencing trade inefficiency, u . In other words, the slope coefficient δ determines the relationship between access to finance (m) and trade inefficiency (u). A negative δ would imply that trade inefficiency is lower for exporting countries with better access to finance.

The problem with Eqs. 1 and 2, however, is that GDP is partly an outcome of trade, and growth in trade volumes can influence the demand for credit. Do and Levchenko (2007) for instance show that financial development is endogenous to the extent that it is determined by the demand for external finance in individual countries. Under these circumstances, standard estimators will produce biased estimates of β and δ (Karakaplan and Kutlu 2017). To handle this form of endogeneity, I apply the instrumental variable approach proposed in Karakaplan and Kutlu (2017). The model takes the following form.

$$y_{ijt} = x'_{yijt} \beta + v_{it} - u_{it} \tag{3}$$

$$x_{it} = Z_{it} \delta + \varepsilon_{it} \tag{4}$$

$$\begin{bmatrix} \tilde{\varepsilon}_{it} \\ v_{it} \end{bmatrix} \equiv \begin{bmatrix} \Omega^{\frac{1}{2}} \varepsilon_{it} \\ v_{it} \end{bmatrix} \sim N \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} I_p & \sigma_v \rho \\ \sigma_v \rho' & \sigma_v^2 \end{bmatrix} \right)$$

$$u_{it} = h(x'_{uit} \varphi_{it}) u_i^*$$

where y_{it} is the logarithm of bilateral exports from country i to country j at time t , x'_{yijt} is a vector of exogenous and endogenous variables; x_{it} is a $p \times 1$ vector of all endogenous variables (excluding bilateral exports y_{it}), $Z_{it} = I_p \otimes z'_{it}$ where z_{it} is a $q \times 1$ vector of all exogenous variables, v_{it} and ε_{it} are two-sided error terms, $v_{it} \geq 0$ is a one sided error term capturing the distance between observed exports and potential exports, $h(x'_{uit} \varphi_{it}) > 0$, x_{uit} is a vector of exogenous and endogenous variables, and u_i^* is a country-specific random component independent from v_{it} and ε_{it} . Parameter Ω is the variance–covariance matrix of ε_{it} , σ_v^2 is the variance of v_{it} , and ρ is the vector representing correlation between $\tilde{\varepsilon}_{it}$ and v_{it} . It is further assumed that:

$$u_i^* \sim N^+(\mu, \sigma_u^2)$$

$$h_{it}^2 = \exp(x'_{uit}\varphi_u)$$

where the last expression links the trade inefficiency with a set of variables including access to finance through the variance. Because u_{it} measures the extent to which bilateral trade is below its full potential as alluded to earlier, it follows that a negative φ_u would imply that improved access to finance reduces the trade inefficiency. GDP of the exporting partner and access to finance are treated as endogenous instrumented by their lagged terms. Estimation is through the one-step maximum likelihood estimator. The one-step approach is preferred due to its ability to address the bias that characterizes the two-step approach (Battese and Coelli 1995; Wang 2002). The alternative was the Pseudo-maximum likelihood estimator whose justification has mainly lied in its ability to produce consistent and robust estimates when estimating gravity models of international trade. Despite these attractive features of the Pseudo maximum likelihood estimator, Andor and Parmeter (2017) find its performance almost identical to the maximum likelihood estimator when estimating stochastic frontier models.

The estimation begins with a parsimonious specification which only includes access to credit. Additional regressions are then considered for robustness purposes with control variables. Doing so allows the analysis to determine whether the effect of access to credit on intra-Africa trade is sensitive to the inclusion of macroeconomic control variables. Selection of the control variables is guided by prior literature and economic intuition. For instance, the analysis considers the real exchange rate since it is likely to intuitively affect both trade and the financial sector. Weaker exchange rates are likely to spur exports but tighter monetary policies that normally follow a currency fall are likely to stifle access to credit. By measurement, the real effective exchange rate from the World Development Indicators (WDI) is used as a proxy variable for the real exchange rate. Secondly, the analysis adds inflation to control for monetary policy developments. Inflation can affect money demand (through eroding currency value) and intra-trade through spurring macroeconomic volatility. Thirdly, the analysis considers an information and communications technology (ICT) index from UNCTAD. The justification is that ICTs are likely to jointly affect both access to credit and intra-Africa trade through remote banking, marketing, and improved access to markets. Lastly, foreign direct investment as a percentage of GDP is included. Foreign direct investment which, in the main, implies the financing of domestic investment through foreign savings, is likely to jointly affect trade through foreign networks and financial sector stability.

As a robustness exercise, the true fixed effects stochastic gravity frontier model by Greene (2005a, b) estimated via the Wang and Ho (2010) approach is considered. This model separates unobserved heterogeneity from intra-Africa trade shortfalls. The model takes the following form:

$$y_{ijt} = \alpha_i + x'_{it}\beta + \varepsilon_{it}, \quad (5)$$

$$\varepsilon_{it} = v_{it} - u_{it},$$

$$v_{it} \sim N(0, \sigma_v^2),$$

$$\begin{aligned}
 u_{it} &= h_{it}u_i^*, \\
 h_{it} &= f(z'_{it}, \delta), \\
 \sigma_i^2 &= f(z'_{it}, \theta) \\
 u_i^* &\sim N^+(u, \sigma_u^2), i = 1, \dots, N, t = 1, \dots, T
 \end{aligned} \tag{6}$$

where y is as defined before, x is a vector containing GDP of the exporting and importing country and access to credit in the vector z . Note that by expressing both u and σ_u^2 as functions of access to credit, the analysis allows access to credit to affect intra-Africa trade inefficiencies through both the mean and the variance specification. The latter is interesting to the extent that it allows one to test whether improved access to finance across Africa countries leads to a convergence of intra-Africa trade efficiency. The inefficiency term is assumed to follow a truncated normal distribution. By doing so, the analysis imposes a nonzero mode following Stevenson (1980). A truncated normal distribution seems appropriate in the present case given the sluggish pace of trade liberalization in eliminating trade inefficiencies. On the contrary, the half-normal distribution would imply the presence of high intra-Africa trade efficiencies which seems implausible given the available trade data and previous empirical accounts.

Data

An unbalanced annual panel dataset comprising 44 African exporters is used covering the 2008 to 2021 period. Selection of the exporters and the sampling period is guided by data availability on total exports. Because the analysis is limited to intra-Africa trade, the trading partners are also African, and their number varies across the 44 exporters. The least number of trading partners is 38 for two exporting countries Guinea-Bissau and Lesotho. The highest number of trading partners is 38 observed in six exporting countries, Egypt, Kenya, Mozambique, South Africa, Tanzania, and Zambia. For the remaining 36 exporters, the number of trading partners ranges from 39 to 52. Data on total exports are from IMF directions on trade. GDP is in nominal terms, and it is sourced from the World Development Indicators (WDI). Access to finance is an index sourced from the United Nations Conference on Trade and Development (UNCTAD). Literature has mainly defined access to finance as the extent to which individuals and firms are prevented from mainstream financial services such as loans and insurance (Beck and de la Torre 2007; Beck et al. 2007). UNCTAD measures its index using the principal component analysis that uses common indicators of access to finance. The index is normalized using the Z-score standardization method, and the standardized values are normalized to fall between the range of 0–1. An increase in the index denotes an increase in access to finance.

Results and discussion

Table 1 presents summary statistics. The index of access to finance ranged from 0.1 to 0.9 with an average of 0.52. This descriptively supports the view that access to finance is not high in Africa on average. In terms of the range, access to finance is lowest

Table 1 Summary statistics

Variable	Mean	Std. Dev	Min	Max
Exports	54.60362	274.3752	0	5918.624
GDPi	5.36e + 10	9.82e + 10	1.88e + 08	5.74e + 11
GDPj	4.60e + 10	9.04e + 10	1.88e + 08	5.74e + 11
Credit access	0.524023	0.1485449	0.1	0.9
Common border	0.489133	0.162812	0	1

Table 2 Testing for trade Inefficiencies

	L(Ho)	L(Ha)	LR	Decision
No trade inefficiencies	-37,190,7	28,816,74	132,014,8	Rejection
5% critical value* = 2.706				

*Critical values are derived from Kodde and Palm (1986)

in Sierra-Leone and highest in South Africa. Intra-Africa exports on the other hand averaged only USD54.6 million with a minimum and maximum of 0 and USD5.9 billion, respectively. The latter reflects Egypt's exports to Eritrea.

As a starting point, it is necessary to test whether trade inefficiencies exist. The Likelihood ratio statistic derived from the restricted and unrestricted specifications is greater than the 5% critical value (Table 2) hence the null hypothesis of no trade inefficiencies is strongly rejected. The stochastic gravity model is therefore preferable over the standard gravity model with normal errors. This diagnostic test supports results in Foroutan and Pritchett (1993), Ngepah, and Udeagha (2018), and more recently Masunda and Mhonyera (2024) which confirm that intra-Africa trade is considerably lower than its full potential. Most importantly, it agrees with Olney's (2022) argument that the standard gravity model inadequately captures intra-Africa trade inefficiency.

Table 3 presents the regression results from a stochastic gravity model of intra-Africa trade. The first column presents results from an estimation which treats all variables as exogenous. The second column contains results from an estimation which treats GDP of the exporting partner and access to finance as endogenous. The coefficients of both GDPs are positive and significant as predicted by the gravity model of international trade. In the main model (which addresses endogeneity), a 10 percent increase in GDP of the exporting and importing country is estimated to raise export flows by 3 and 4 percent, respectively. The inelastic responses suggest that bilateral intra-African exports are less responsive to income dynamics within the continent. This could be attributed to the inherent structural bottlenecks which inhibit the supply side. Hartzenberg (2011) for instance argue that trade among African countries is more tedious, costly, and time-consuming than elsewhere in the world.

The main results are presented in the lower part of the table. The results of the study are consistent with empirical literature on the role of credit on export performance. The coefficient on access to credit is significantly negative demonstrating that improved access to credit reduces the gap between observed exports and potential

Table 3 Access to Credit and Intra-African Trade

Dep. var: logexportsij	Total Sample	
	Model EX	Model EN
Constant	− 10.235*** (0.569)	− 10.669*** (0.584)
loggdpi	0.296*** (0.016)	0.306*** (0.016)
loggdpi	0.392*** (0.015)	0.392*** (0.400)
Dep. var: ln (σ^2_u)		
Constant	3.358*** (0.038)	3.385*** (0.039)
Access to credit	− 0.210*** (0.030)	− 0.273*** (0.036)
Dep. var: ln (σ^2_v)		
Constant	− 1.123*** (0.011)	
Dep. var: ln (σ^2_w)		
Constant		− 1.123*** (0.011)
eta1(loggdpi)		− 0.070** (0.037)
eta2(access to credit)		− 0.266** (0.092)
eta Endogeneity test		X2 = 14.05 p = 0.003
Observations	18,056	18,056
Log Likelihood	− 20,478.01	28,816.74
Mean Tech Efficiency	0.0494	0.0496
Median Tech Efficiency	0.0055	0.0057

*, **, *** denotes $p < 0.1$, $p < 0.05$ & $p < 0.01$, respectively. Figures in parentheses are robust standard errors

exports. This result supports Yakubu et al.'s (2018) conclusion that domestic credit positively affects trade.

The average efficiency level demonstrates that intra-African exports are only 4.96 percent of their potential. This is corroborative of the view that intra-African trade is considerably low. Jordaan (2014), demonstrated empirically that Africa trades far less with itself than with its developed nation trading partners. In their work, the share of intra-African exports was found to range between 1 and 15 percent while African exports to the rest of the World was at least 75 percent.

The endogeneity test produces a significant probability value justifying the correction of endogeneity in the model. A comparison of the two models shows that the model that assumes exogeneity slightly understates the effect of access to accredit on the trade gap by 30 percent. In Table 4, macroeconomic controls are added into the specification in a bid to isolate the effect of access to finance from other macroeconomic variables. A look at Table 4 shows that access to credit retains its significantly negative sign after the inclusion of foreign direct investment, the real exchange rate, inflation, and an index capturing information and technology. The probability that the coefficient of access to finance on intra-Africa trade efficient reported in Table 3 was picking the effect of macroeconomic developments is therefore low based on results reported in Table 4.

Table 4 Access to Credit and Intra-African Trade

Dep. var: logexportsij	Total sample	
	Model EX	Model EN
Constant	− 9.041*** (0.433)	− 9.006*** (0.561)
loggdpi	0.336*** (0.014)	0.228*** (0.013)
loggdpij	0.352*** (0.015)	0.355*** (0.027)
Dep. var: ln (σ ² _u)		
Constant	3.371*** (0.024)	3.063*** (0.029)
Access to credit	− 0.199*** (0.011)	− 0.201*** (0.026)
logRER	0.278*** (0.003)	0.267*** (0.021)
logICT	− 0.071*** (0.002)	− 0.055*** (0.002)
FDI (% of GDP)	0.810*** (0.732)	0.618 (0.733)
Inflation (%)	0.071 (0.082)	0.098 (0.075)
Dep. var: ln (σ ² _v)		
Constant	− 1.583*** (0.011)	
Dep. var: ln (σ ² _w)		
Constant		− 1.523*** (0.011)
eta1(loggdpi)		− 0.090*** (0.025)
eta2(access to credit)		− 0.481*** (0.0042)
eta Endogeneity test		X2 = 14.04 p = 0.003
Observations	18,056	18,056
Log Likelihood	− 20,478.01	28,816.74
Mean Tech Efficiency	0.052	0.055
Median Tech Efficiency	0.0085	0.0053

* , ** , *** denotes $p < 0.1$, $p < 0.05$ & $p < 0.01$, respectively. Figures in parentheses are robust standard errors

Although the interpretation of control variables is of secondary importance, it is interesting to observe how nearly all of them enter with the expected signs. The real exchange rate is for example positive and statistically significant corroborating Cleaver’s (1985) view that appreciated exchange rates are detrimental to Africa’s trade. Inflation, although positively signed as expected, enters insignificantly. The insignificance of inflation is not surprising since its effect on trade efficiency are more likely to operate through the exchange rate. The negative and significant sign on FDI supports the general result that FDI facilitates the transfer of knowledge which elevates trade levels. In addition, foreign direct investors usually come with established foreign networks which makes it easier to tap into foreign markets. Lastly, evidence supports the notion that technological advancement in information and technologies facilitates intra-Africa trade. The coefficient of ICT is negative and statistically significant

implying that the gap between actual and potential intra-Africa exports decreases with improvements in ICT.

To check the robustness of the results, the stochastic frontier gravity model of international trade is estimated via the true-fixed effects approach proposed by Greene (2005a, b). Unlike the baseline model, the true-fixed effects approach separates time-invariant heterogeneity from trade inefficiencies. Because the approach primarily deals with heterogeneity endogeneity, idiosyncratic endogeneity associated with access to trade is ameliorated through lagging access to credit. The results of this robustness exercise are confirmatory (Table 5). Both GDP variables in the trade enter positively and significantly in the frontier equation. Most importantly, access to credit enters negatively and significantly in the trade inefficiency specification corroborating the baseline results. In addition, the coefficient interestingly enters negatively and significantly in the variance specification suggesting that better access to finance facilitates a convergence in intra-Africa trade efficiency.

The results particularly reconfirm that improved access to credit in the current period pushes intra-Africa exports closer to their potential in the subsequent period. The analysis proceeds to test whether the effect of access to finance on intra-Africa trade depends on the distance between trading partners. In standard gravity models of international trade, distance is a proxy for transportation costs and logistics. Therefore, it may be plausible to assume that distant trading partners may require better access to finance more than trading partners that are closer to each other. To test this hypothesis, two regression variants are estimated, one with countries sharing the same border and the other with trading partners that do not have a common border.

Table 6 presents the results. The coefficient of access to finance variable is larger (-0.418 compared to -0.328) and highly statistically significant (i.e., significant at the one percent level) for countries that do not share a common border. For countries sharing the same border, the coefficient is smaller and marginally significant (i.e., significant at the ten percent level). This demonstrates that access to finance has a larger and more relevant effect in countries that do not share a common border. By extension of intuition and logic, the result may be taken to reflect the role of distance and transport costs as potential mechanisms through which intra-Africa trade increases with access to finance. Transporting copper from Zambia to Malawi, or coal from South Africa to Botswana comes with relatively lower costs compared to the transportation of cobalt from the

Table 5 Access to credit and intra-Africa exports

logexports _{ij}	Coefficient	Robust standard error	z	$p > z $
<i>Frontier</i>				
Loggd _{pj}	0.1400	0.0415	3.37	0.001
Loggd _{pi}	0.2416	0.0424	5.69	0.000
<i>Mu</i>				
L.Access to Credit	-0.2541	0.1040	-2.44	0.015
Cons	9.3799	0.3029	30.96	0.000
<i>Usigma</i>				
L.Access to Credit	-0.0084	0.0021	4.000	0.000
N	17,899			

Estimation is through the maximum likelihood estimator

Table 6 Access to finance, Distance, and Intra-Africa Trade

Dep. var: logexports _{ij}	Common border = 1		Common border = 0	
	Model EX	Model EN	Model EX	Model EN
Constant	-16.384*** (1.614)	-16.356*** (1.635)	-14.496*** (0.529)	-14.893*** (0.526)
loggdpi	0.440*** (0.045)	0.439*** (0.046)	0.393*** (0.015)	0.407*** (0.016)
loggdpi	0.530*** (0.035)	0.529*** (0.035)	0.424*** (0.017)	0.427*** (0.017)
Dep. var: ln(σ^2_u)				
Constant	2.712*** (0.135)	2.718*** (0.141)	2.968*** (0.044)	3.011*** (0.045)
Access to credit	-0.316* (0.140)	-0.328* (0.161)	-0.325*** (0.039)	-0.418*** (0.045)
Dep. var: ln(σ^2_v)				
Constant	-0.870*** (0.033)		-1.143*** (0.161)	
Dep. var: ln(σ^2_w)				
Constant		-0.870*** (0.033)		
eta1(loggdpi)		0.017 (0.111)		-0.156*** (0.038)
eta2(access to credit)		-0.058 (0.298)		-0.313* (0.097)
eta Endogeneity test		X ² = 0.06 p = 0.970		p = 0.000
Observations	2031	2031	16,038	16,038
Log Likelihood	-2381.35	1737.06	-17,742.07	16,169.33
Mean Tech Efficiency	0.1544	0.1543	0.0669	0.0676
Median Tech Efficiency	0.0569	0.0569	0.0168	0.171

*, **, *** denotes $p < 0.1$, $p < 0.05$ & $p < 0.01$, respectively. Figures in parentheses are robust standard errors

Democratic Republic of Congo to South Africa or cotton from Zimbabwe to Nigeria. In the former case, the sharing of a common border implies a shorter distance which consequently entails low fuel and administrative costs. In the latter case, the distance is longer hence one pays more in fuel and logistics.

The average efficiency score is higher for closer trading partners 15 percent to compared to the 6.7 percent score of distant trading partners. The endogeneity test retains a probability value of 0.0000 in the last variant again demonstrating the importance of exogenizing access to finance. Overall, the evidence suggests that access to finance is an important precondition for raising the levels of intra-Africa trade. This supports the widespread settings, institutional forums and conferences emphasizing financial inclusion in Africa as a catalyst for economic development. The result also agrees with Yakubu et al. (2018) who find domestic credit positively affecting trade in Africa.

Conclusion

The aim of this study was to determine whether Africa's limited access to finance is an obstacle inhibiting African countries from trading with each other at full potential. Using a stochastic gravity model of international trade, the study reaches three conclusions. The first is conclusion is a confirmation that intra-Africa trade is considerably

lower than its full potential. The second conclusion is that access to finance increases trade efficiency of African economies. The third conclusion is that the effect of access to finance increases with distance between trading partners. In view of these findings, responsible authorities are advised to embark on policies geared towards increasing access to finance and promoting financial inclusion in Africa as part of efforts to ensure that African countries trade with each other at full potential. Future studies may benefit from separating technical change effects from efficiency effects of access to finance.

Abbreviations

FDI	Foreign direct investment
GDP	Gross domestic product
ICT	Information and communication technology
RER	Real exchange rate
SSA	Sub-Saharan Africa
UNCTAD	United nations conference of trade and development
WDI	World development indicators

Acknowledgements

The author is grateful to Sol Plaatje University for financial support.

Author contributions

This is a single authored paper. The author is responsible for all the sections.

Funding

Funding for Article Processing Charges is from Sol Plaatje University.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests

The authors declare that they have no competing interests.

Received: 5 April 2024 Revised: 4 June 2024 Accepted: 26 June 2024

Published online: 03 July 2024

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