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Article

The Impact of Port Performance on Trade: The Case of Selected African States

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Abstract: Maritime transport remains the main gateway to the global marketplace. Ocean ports are a central and necessary component in facilitating trade. Ports are essentially a channel of integration into the global economic system. Resourceful and well-connected container ports empowered by regular and consistent shipping services are key to reducing trade costs, including transport costs, connecting supply chains and supporting global trade. Consequently, port performance is an important factor that can influence countries' trade competitiveness. However, for Africa, the ports are dilapidated, lack essential infrastructure, are congested and perform poorly. Africa's shipping and ports do not always match global trends and standards. In light of this, this study seeks to assess Africa's current port performance and test the relationship between Africa's port performance and trade performance. Very few studies have attempted to investigate the impact of port performance on trade. Hence, it was worthwhile to study the impact of port performance on Africa's trade. The study used panel data that covering the period 2005–2018. An ARDL panel technique was used for estimation purposes. Results showed that port performance positively affects trade. This study argues that African ports require expensive infrastructure to be able to compete successfully. Africa needs to pursue an intensive course of infrastructure development so as to maintain economic growth and improve port efficiency and trade competitiveness. At the moment, African ports are inefficient, and there is congestion partly because the ports cannot accommodate further expansion without serious investments.



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Keywords: maritime transport; ports; international trade; global economic system; infrastructure; port performance; trade competitiveness

1. Introduction

Ocean ports are a central and necessary component in facilitating trade. According to Ndlendle (2018), trade competitiveness requires governments and key stakeholders to see ports as facilitators of trade and integrators in the logistics supply chain. Over 90% of international trade moves via the sea, making ports and their hinterlands vital for global trade (Sok 2016; Fugazza and Hofman 2017; International Maritime Organization 2018; Jha 2019; Chelin and Reva 2020; SAIMI 2020; Heiland and Ulltveit-Moe 2020). Shipping is the lifeblood of the global economy, and without shipping, efficient intercontinental trade would simply not be possible (International Chamber of Shipping 2020; United Nations Conference on Trade and Development cited in Marley (2020)). This shows that Maritime transport is at the core of international trade, and in order for maritime transport to be efficient, there should be, among other things, well-functioning ports. Munim and Schramm (2018) argue that ports are the hub and node of networks for all kinds of waterborne transport and link countries with the rest of the world; accordingly, they promote transportation and distribution in an economical way. Ports are a primary conduit of international trade and are central to the growth of the global economy. Seaports are also an important locational determinant of exporters' location (Nazarczuk et al. 2020). Greater strides should be made to ensure that ports are efficient and their operations are frictionless in order to spur trade.

Efficient ports set the ground for trade, and ports can also enhance a country's growth prospects. It can thus be said that port efficiency is important to improving trade facilitation. Thien (2019) and Sebastian (2019) state that every hour of port time saved by ships translates into savings in port infrastructure expenditure for ports, ship capital costs for carriers and inventory holding outlays for shippers. Resourceful and well-connected container ports empowered by regular and consistent shipping services are key to reducing trade costs, including transport costs, connecting supply chains and supporting global trade (Benamara et al. 2019). Heiland and Ulltveit-Moe (2020) concur and state that networks are the facilitators for production linkages that permit the more effective allocation of resources through the utilization of comparative advantage and economies of scale. Consequently, port efficiency is a fundamental aspect that can determine the trade performance of any country.

Ports are an important part of the logistics network in Africa, with many ports having an extensive hinterland often covering a number of countries, which makes them a natural focus for regional development (PwC 2019). Maritime transport is the lifeblood of Africa, with over 90% of the continent's trade merchandise transported by sea (African Union 2019; Manduku 2019). Furthermore, Africa is located on one of the busiest global sea routes, vital to global maritime logistics, and its geographical position offers an enormous chance for investing in a diversified global market. Despite the significance of ports to international trade, the development and integration of ports in Africa's wider logistics chains and performance remains poor (Shaw 2018; Tralac 2018; Chimbelu 2019; Chelin and Reva 2020; Gicheru 2020; Kahyarara 2020). Africa still makes up just a small percentage of global trade, with problems persisting at its ports from performance concerns to ineffective handling time, poor security and, in some places, corruption (Kingsland 2020).

Africa needs to make use of the economic potential of its ports and maritime sector if it is to achieve its growth ambitions. An analysis by the PwC in 2018 revealed that upgrades in port efficiency might increase growth, demonstrating the close relationship between port effectiveness and trade competitiveness (Booth 2018; Niselow 2018). However, with increasing congestion in several African ports¹, Africa faces the risk of foregoing further development through poor or little investment in port infrastructure. Access to effective ports, interconnecting infrastructure and effective operations to deal with current demand and future growth could lead to reduced costs and improved overall freight logistics efficiency and reliability, all of which are essential to the region's future success (UNCTAD 2019). It is against this background that this study engages in an investigation of the impact of port performance on trade. The study seeks to answer the following question: does port performance affect trade? Considering the current state of ports in Africa, it is important to embark on a study on how port performance affects trade. The impacts of port performance on Africa's trade and economy have been largely overlooked in the existing literature. Very few studies (African Development Bank 2009; UNCTAD 2018a; Humphreys et al. 2019; PwC 2019; UNCTAD 2020) have attempted to investigate the impact of port performance on trade. Hence, it is worthwhile to study the impact of port performance on Africa's trade. There are no records of similar studies having been conducted in Africa. This study makes an original contribution towards the scope of maritime transport and trade.

The paper is divided into six sections: following the introduction in the first section, section two provides a review of the current state of ports in Africa, section three presents a review of literature, section four presents the methodology which was utilized to carry out the study, whilst section five and six discuss the findings and conclusions of the study, respectively.

2. The Current State of Ports in Africa

The section makes an attempt to build a glimpse of port performance in Africa. The key aim is to show the current performance of ports. This is important because it might give an insight into whether African ports are performing efficiently. Port performance is a key indicator of trade efficiency that determines connectivity and trade costs (UNCTAD 2020). African ports have been seen to be performing badly compared to other regions. Table 1 below shows the highest and lowest ranked economies in terms of median time spent in ports.

Table 1. Ten highest- and lowest-ranking economies: median time spent in port by container ships.

Country	Ranking from Fastest to Slowest	Median Time in Port (Days)	Total No. of Ports Calls in 2018
Peru	1	0.11	2521
Japan	2	0.31	44,382
Gibraltar	3	0.35	1252
Germany	4	0.36	14,394
Cyprus	5	0.39	909
Faroe Islands	6	0.45	125
Iceland	7	0.48	242
Netherlands	8	0.49	41,843
Panama	9	0.49	2713
Denmark	10	0.49	1171
Madagascar	142	2.77	131
Reunion	143	2.86	33
Senegal	144	2.96	265
Congo	146	2.97	36
Somali	147	3.53	56
Iraq	148	3.80	1380
Nigeria	149	4.31	1507
Tanzania	150	6.48	236
Maldives	151	6.49	87

Source: UNCTAD (2019).

Table 1 shows that none of the African countries are in the top ten performing countries. Most African countries are in the bottom ten². In other words, several African countries have low ranks when it comes to the median time spent by container ships. This suggests that the median time spent by container ships at ports in Africa is high. This length detention of goods in ports shows that port efficiency is poor, and it has been a major complaint from various users of ports within Africa (Kahyarara 2020). Figure 1 gives a much clearer picture of the median time spent by all ships (passenger ships, wet bulk ships, container ships, dry bulk ships, etc.).

NB: The mean time spent in port for the world is 0.88 days. The mean time spent in port for African countries is 2 days.

Figure 1 shows that only three African countries compare to the global average of 0.88 days: Cape Verde (0.83), Djibouti (1), Morocco (1.1) and Sierra Leone (1.05). Most African countries have a median time of at least 2 days. This may suggest that port performance³ is generally poor in African countries. A report by PwC (2018), Tralac (2018), TradeMark East Africa (2019) also came to a similar conclusion. The TradeMark East Africa (2019) argues that many of the handling inefficiencies and long container dwell times are a result of poor port infrastructure, poor port management, customs and associated container clearing procedures, as well as inadequate landside networks which prevent containers from leaving ports without delay. Saggia (2017) states that African ports face the major challenges of poor and dilapidated infrastructure, usage of dated equipment and low levels of mechanization, and container and cargo theft. UNCTAD (2018b), cited in Kahyarara (2020), confirmed that port inefficiency is portrayed by longer container dwell time, interruptions in vessel traffic clearance, protracted documentation handling, lesser container per crane hour (with the

exception of South Africa) as one of the critical binding constraints on African ports. This makes most African ports “fail to match global industry standards” (Jaferi 2019).

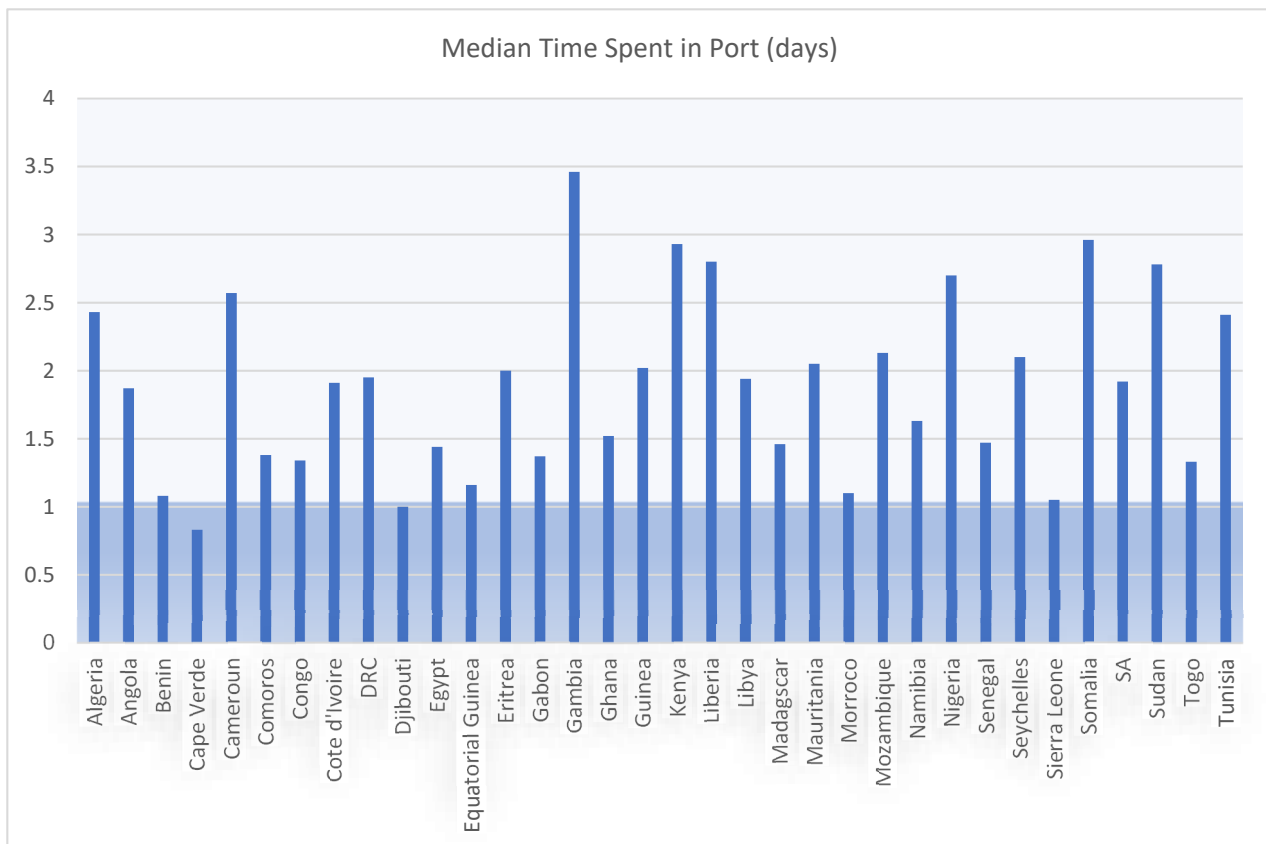


Figure 1. Median time spent in port. Source: author’s own computation using UNCTAD (2019).

This poor performance of ports has negative consequences. Saggia (2017) states that inefficient operations at ports lead to significant losses in potential revenue, and “the ports’ inefficiencies have for years allowed corruption from middlemen promising to clear goods for a fee” (Jaferi 2019). High port logistics costs, lack of consistency and low economies of scale in trade volumes have an adverse effect on trade growth in Africa (Doe 2018; Ramaphosa quoted in (RSA 2020). Resourceful and well-connected container ports enabled by frequent and regular shipping services are key to minimizing trade costs, including transport costs, linking supply chains and supporting international trade (Benamara et al. 2019). It should be realized that when more consideration is given to ports through infrastructure investment and port maintenance, ports are likely to contribute positively to trade and economic growth. Well-maintained and well-functioning ports are vital for trade and development. Despite such importance, the impacts of port performance on Africa’s trade and economy have been largely overlooked in the existing literature.

3. Literature Review

3.1. Theoretical Literature

Martin and Rogers (1995) came up with a theoretical model of firm location that looked at technology and trade. In their theory, trade integration implied that in the existence of economies of scale, firms are likely to locate in countries with better national infrastructure, as they offer lower costs to serve all markets. Better international infrastructure increases the industrial relocation of firms toward a country with better national infrastructure. Investment in national infrastructure will help the relocation of firms to developing countries, which become more attractive (Olarreaga 2016). However, investment in international

infrastructure will make it more attractive to serve the developing country market from countries with better national infrastructure.

3.2. Empirical Literature

Ways to measure port efficiency and performance are very diverse (Ducruet et al. 2014). A commonly used gauge providing comprehensions into the functioning of ports and their capability to entice business is volumes handled by ports (UNCTAD 2018b; Lei and Bachmann 2020; United States Department of Transportation 2021). As cargo flows are largely determined by changes in demand, port volumes help take the pulse of the world economy and inform about potential transport infrastructure needs and investment requirements. As such, port cargo throughput, including all cargo types, can serve as a leading economic indicator (Talley 2011; UNCTAD 2018b). This is known as the port throughput, and it measures the amount of cargo or number of vessels the port handles over time (United States Department of Transportation 2017).

Deng et al. (2013) completed a study in China and showed that there was a positive relationship between value-added operations at ports and economic activity. Bottasso et al. (2013) completed a study in 10 West European countries and showed that port efficiency, as measured by port throughput, increased growth and employment opportunities. Shan et al. (2014) completed a study in China and showed that port efficiency increased growth in a country and also in its neighboring countries. Poor efficiency in ports was also seen to be a significant contributor to poor economic performance in South Africa (Chang et al. 2014). Sánchez et al. (2003) showed that port efficiency is a major determinant of freight costs; efficient ports are associated with lower freight rates. Clark et al. (2004) concur and state that port efficiency and port infrastructure determine freight transport costs, and they also assist businesses in accessing global markets.

Wilmsmeier and Hoffmann (2008) estimated the role of liner shipping connectivity (LSC) and port infrastructure in determining freight rates in the Caribbean. Their study concluded that an increase in port infrastructure and LSC resulted in reduced freight rates. This reduction in costs can promote more production and increase economic growth. Yeo et al. (2008) found that quality of port service, logistics costs, regional connectivity, hinterland condition and port accessibility contribute significantly to a port's competitiveness. Abe and Wilson (2008) completed a study on how infrastructure affected trade. They found that port efficiency was a major determinant of trade performance. Their study concluded that poor port efficiency, measured by port congestion, has significantly increased the cost of transportation from the USA and Japan to East Asia. Puertas et al. (2014) found that improvement in port efficiency leads to an increase in its export volume. An analysis by the PwC in 2018 revealed that a 25% upgrade in port efficiency might increase growth by 2%, demonstrating the close relationship between port effectiveness and trade competitiveness (Booth 2018; Niselow 2018).

Munim and Schramm (2018) completed an investigation into the broader economic influence of seaborne trade from a port infrastructure quality and logistics performance perspective in 91 countries with seaports. The study used a structural equation model (SEM) to examine the impact of port quality on trade. The study showed that port quality is vital for trade performance. The study concluded that port quality improves trade and economic growth. Chang et al. (2014) used a gravity model to study the ex-post effect of trade agreements. A gravity model was constructed using worldwide trade data for 2007, 2010 and 2015. The study showed that port performance had a positive effect on trade and logistics performance.

4. Methodology

4.1. Data Sources

In order to examine the impact of port performance on trade, an econometric analysis was completed across 10 African countries (Gambia, Liberia, Nigeria, Kenya, Cameroun, Ghana, Ivory Coast, Senegal, South Africa and Morocco). Data were sourced from the

UNCTAD and the World Bank. Panel data covering the period between 2005 and 2018 were used in the study. The sample period and countries included in this study were chosen on the basis of data availability. In other words, the composition of the sample is restricted due to unavailability of data and the necessity for a balanced panel.

4.2. Estimation Technique

The ARDL model (autoregressive distributed lag) is employed because of its adequacy to this study's data set. First, it allows for the combination of variables integrated in the order of $I(0)$ and $I(1)$ (Belloumi 2014; Yakubu et al. 2014). It is also suitable for studies with small sample size (Olayungbo and Quadri 2019). In this study, there was a mix of $I(0)$ and $I(1)$ variables, and the study's sample size was small, and this made the panel ARDL approach more than appropriate. The ARDL model provides estimates of the corresponding error correction model (Ghatak and Siddiki 2001; Pesaran et al. 2001; Yakubu et al. 2014; Ogbechie and Anetor 2016). Furthermore, the panel ARDL approach provides consistent estimates of the parameters' averages. It allows the parameters to be freely independent across groups and does not consider potential homogeneity between groups (Bangake and Eggoh 2011). The analysis in this study followed 3 steps that are usually followed when carrying a panel ARDL approach. The series of steps in the ARDL procedure is the investigation of (i) stationarity, (ii) cointegration and panel ARDL estimation (Menegaki 2019). The study also used the Fixed Effects and Ransom Effects models to corroborate the findings obtained from the ARDL models.

4.2.1. Cross-Dependence, Unit Root and Cointegration

Pesaran (2007) argues that panel unit root tests can lead to spurious conclusions if they fail to take account of significant degrees of cross-section dependence. A shock witnessed in one of the panel units can greatly affect the other units. This is known as cross-section dependence in econometrics (Aktürk and Özyeşil 2019). Cross-sectional dependence can also be caused by other factors such as common shocks and model misspecification (Chudik and Pesaran 2013). If cross-sectional dependence is ignored, the regression results can be biased and unreliable (Phillips and Sul 2003). In order to avoid these problems, the study had to perform a cross-dependence test. The study used the Breusch-Pagan LM, and the Pesaran CD tests were used.

After performing the cross-dependence test, the next test was to perform unit root tests. There are a number of tests that can be used to test for unit root. These include Levin, Lin and Chu test (2002), Im, Pesaran and Shin test (2003), Fisher-type tests, Bai and Ng (2004) and Phillips and Sul (2003). First-generation unit root tests were employed because results from the cross-dependence test had revealed that there is no cross-dependence. In this regard, the Levin, Lin and Chu Test and LM, Pesaran and Shin test were used to test for unit root.

After the results from the unit root showed that the variables were of different order of integration, the next step was to test for cointegration. The study used the Pedroni and the Kao Residual Cointegration test. Pedroni (1999, 2004) introduced seven test statistics that test the null hypothesis of no cointegration in nonstationary panels. The seven test statistics allow heterogeneity in the panel, both in the short-run dynamics as well as in the long-run slope and intercept coefficients (Neal 2014).

4.2.2. Panel ARDL

Pooled Mean Group Estimator (PMG)

Pesaran et al. (1999), cited in Olayungbo and Quadri (2020), proposed the PMG estimator associated with pooling and averaging of the coefficients over the cross-sectional units. This technique was chosen in this study because it accommodates a combination of stationary and nonstationary variables, and it is also appropriate when there is a small sample size (Olayungbo and Quadri 2019). Fayissa and Nsiah (2020) state that a pertinent advantage of the PMG is that the underlying auto-regressive distributed lag (ARDL)

structure dispenses with the importance of the unit root pre-testing of the variables in question. Pesaran et al. (1999) propose an estimation approach in which the long-run coefficients on the explanatory variables (x_{it}) are the same across units:

$$\Delta y_{it} = \theta_i (y_{i,t-1} - \beta' x_{i,t-1}) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{q-1} \gamma'_{ij} \Delta x_{i,t-j} + \mu_i + \varepsilon_{it} \quad (1)$$

The error correction parameter is denoted by θ_i and it is indicative of the speed of adjustment (Oyelami and Ogundipe 2020). The positive sign of the θ_i implies return to the long-run relationships (Blackburne and Frank 2007) from points above the regression line. The negative sign also shows the return to long-run equilibrium but in opposite direction (from below). The θ_i is expected to be statistically significant as the insignificant coefficient of θ_i (i.e., $\theta_i = 0$) implies the absence of long-run equilibrium (Masih and Majid 2013).

Mean Group (MG) Estimator

Fauzel et al. (2012) state that the MG calls for estimating separate regressions for each country and calculating the coefficients as unweight means of the estimated coefficients for the individual countries. Chu and Sek (2015) state that MG estimator has the least restraining process and it permits heterogeneity of all the parameters where no cross-country restriction is imposed. The MG estimator derives the long-run parameters from autoregressive distribution lag (ADRL) models for individual countries. The ARDL is as follows:

$$Y_{it} = \alpha_i + \gamma_1 y_{i,t-1} + \mu_{it} \quad (2)$$

The MG estimators for the panel model is, therefore, given by:

$$\hat{\theta} = \frac{1}{N} \sum_{i=1}^N \theta_1 \quad (3)$$

$$\hat{\alpha} = \frac{1}{N} \sum_{i=1}^N \alpha_1 \quad (4)$$

According to Rafindadi (2013), the above equations reveal how the model estimates separate regressions for each country and calculates the coefficients as unweighted mean of the estimated coefficients for the individual countries. This does not impose any restrictions.

Gravity Model

The second model used a gravity model. The gravity model approach is a standard method to measure different effects on trade flows. Tinbergen (1962) and Pöyhönen (1963) invented the gravity model to investigate the effect of economic mass and distance on trade flows between countries. Tinbergen and Pöyhönen use the gross domestic product as a proxy for economic proportions, and the distance between the countries is used as a space measure.

$$T_{ij} = C * \frac{Y_i Y_j}{D_{ij}} \quad (5)$$

T_{ij} is hereby the trade between country i and j . Y_i and Y_j are the mass coefficients and show the size of the country, often defined by GDP. D_{ij} is the variable for the distance between both countries and stated in the distances between the capitals. Equation (5) can be converted into log-linear form as:

$$\ln T_{ij} = c + \alpha \ln Y_i + \beta \ln Y_j - \theta \ln D_{ij} + \delta Z + \mu_{ij}$$

The c term is a regression constant; the variable δZ represents any hidden factors that could affect export performance, while μ_{ij} is the stochastic term. The model for this study was presented as follows:

$$\ln X_{ijt} = \alpha_1 + \alpha_2 \ln GDP_{ijt} + \alpha_3 EXCH_{ijt} + \alpha_4 \ln D_{ij} + \alpha_5 B_{ij} + \alpha_6 PP_{ijt} + \mu_{ijt}$$

where X is total exports, GDP is economic growth, $EXCH$ is exchange rate, D is the physical distance between the locations of economic hubs within the trading partner countries, B_{ij} equals to one if a common border exists between two trading partners and zero otherwise and the variable δZ represents any hidden factors that could affect export performance. The gravity model was used because bilateral trade patterns are well described empirically by the so-called gravity equation. Africa has recently made efforts and signed regional trade agreements in order to promote interregional trade. Interregional trade between African states still has large room for growth.

4.3. Model Specification

The study modified [Munim and Schramm \(2018\)](#)⁴ and came up with the following model:

$$TR = f(INF, PP, GDP, EXCH, D) \quad (6)$$

where TR is trade, INF is inflation, PP is port performance, GDP is economic growth, $EXCH$ is exchange rate and D ⁵ is a dummy variable. The description of the variable presented in Equation (6) above is presented in Table 2 below.

Table 2. Summary of variable descriptions.

Variable	Description and Unit of Measurement	Source
PP	Port performance. The port throughput was used to measure port performance. Port throughput measures reflect the amount of cargo or number of vessels the port handles over time	UNCTAD
TR	Trade. This was measured using the contribution of trade to GDP	World Bank
INF	Inflation, as measured by the consumer price index, reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals	World Bank
GDP	Economic growth. This is the annual percentage growth rate of GDP at market prices based on constant local currency	World Bank
EXCH	Real effective exchange rate. Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs	World Bank
D	The dummy variable was used to capture the unevenness of port performance in Africa. The countries included were divided into two categories: best performers and worst performers. Those that were included under the better-performing category had a median waiting time of at most 1 day, and those under the worst-performing category had a median time of at least 2 days. The dummy variable took a value of one if a country had a median waiting time of at most 1 day (South Africa, Gambia, Senegal, Ivory Coast, Morocco), and 0 otherwise (Liberia, Cameroun, Nigeria, Kenya, Ghana)	
TRV	This is the sum of exports and imports for all the countries under investigation	World Bank

5. Presentation of Results

5.1. Descriptive Statistics

It is imperative to check the descriptive statistics before analyzing the data series in order to observe the variability and distribution of the variables as shown (Olayungbo and Quadri 2019). The descriptive statistics for the data used in this study are presented in Table 3.

Table 3. Descriptive statistics.

	GDP	EXCH	INF	TR	PP
Mean	4.139128	103.7092	1.51647	8.3608	49.5013
Median	4.216180	107.2992	1.16492	3.8108	46.0455
Maximum	10.39246	163.8752	4.47842	4.9809	89.3700
Minimum	−2.320827	31.08235	1.29736	1.46094	18.9980
Std. Dev.	2.791483	37.56983	1.08256	1.0209	17.0361
Skewness	0.052081	−0.211397	0.88093	1.81535	0.54836
Kurtosis	2.781121	1.973902	3.07000	6.45846	3.04690
Jarque–Bera	0.171377	3.592262	9.068221	73.33366	3.514667
Probability	0.917880	0.165940	0.010736	0.000000	0.172504

The results show that the mean value of EXCH (103.7092) was higher than all other mean values, and the INF (1.516473) variable had the lowest mean value. Results also further show that the EXCH variable had the highest variability, as shown by the standard deviation value of 37.56983. EXCH had the highest maximum value (163.8752), and the INF variable had the lowest minimum value (1.297362). The TR variable (1.815353) showed some deviation from the standard skewness of 0, and it also had a value that was above the standard kurtosis of 3.

5.2. Cross-Dependence and Unit Root Tests

In order to test for panel cross-dependence, the Breusch–Pagan LM and the Pesaran CD tests were used. Results are shown in the table.

According to the findings in Table 4, there is no cross-sectional dependence among the countries included in this study. In other words, a shock in one of these countries does not affect the others. Having found no evidence of cross-dependence, first-generation panel data analysis methods were used in this analysis.

Table 4. Panel cross-dependence.

Test	Statistic	Prob
Breusch–Pagan LM	5.42231	0.6583
Pesaran CD	−0.365654	0.7146

5.3. Stationarity Tests

The first step was to test the stationarity of the variables. This was completed using the test of LM, the Pesaran and Shin test and the Levin Test. Results are shown in Table 5.

Table 5 shows that, under the Levin, Lin and Chu Test, GDP and INF were stationary at levels. EXCH, PP and TR became stationary at the first difference. Under the LM, Pesaran and Shin test, only GDP was stationary at levels. The rest of the variables became stationary at being differenced once. Since some variables were seen to be nonstationary at levels, there was a need to test for cointegration.

Table 5. Stationarity tests.

Variable	Levin, Lin and Chu t		Lm, Pesaran and Shin W-Stat	
	Stat.	Prob.	Stat.	Prob.
EXCH	−1.50297	0.0964	1.21149	0.8871
	−3.22889	0.0006 ***	−4.5678	0.0000 ***
GDP	−15.2034	0.0001 ***	−4.83437	0.0000 ***
INF	−3.82112	0.0001 ***	−1.30127	0.0966
			−3.67890	0.0001 ***
PP	0.67931	0.7515	1.95663	0.9748
	−8.06331	0.0000 ***	−2.98681	0.0014 **
TR	−2.31698	0.08345	0.01139	0.5045
	−3.61700	0.0001 ***	−3.5672	0.0035 **

Note: *** denotes significance at 1% level and ** denotes significance at 5%.

5.4. Cointegration Tests

The second step involved the testing of the presence of a long-run association among the variables (cointegration). This was completed using the Pedroni test (the Kao test was completed as a robustness test). Results are shown in Tables 6 and 7.

Table 6. Pedroni cointegration test.

Test Statistics	Statistic	Prob.	Statistic	Prob.
Panel v-statistic	−3.514046	0.0000 ***	−3.84618	0.0347 **
Panel rho-statistic	−2.600100	0.9953	−3.39934	0.8316
Panel PP-statistic	−2.602853	0.0046 ***	−1.36234	0.0000 ***
Panel ADF-statistic	−0.284821	0.3879	−2.83521	
Group Panel rho-statistic	3.887045	0.0254 **	-	-
Group PP-statistic	−8.102665	0.0000 ***	-	-
Group ADF-statistic	−1.125355	0.0165 **	-	-

Note: *** denotes significance at 1% level and ** denotes significance at 5%.

Table 7. Kao residual cointegration test.

ADF	t-Statistic	Prob
	−2.863301	0.0021 ***

Note: *** denotes significance at 1% level.

Results from the Pedroni test show that seven of the eleven statistics reject the null hypothesis of no cointegration at the conventional size of 0.05. This shows that there is a long-run association among the variables. The Kao test was also performed for robustness purposes. Results from the Kao test are shown in the table below. Table 7 shows the results from the Kao panel cointegration test.

Results show that the p-value turned out to be 0.0021, and this rejects the null hypothesis of no cointegration at the conventional size of 0.05. This also confirms the presence of a long-run association among the variables. After detecting cointegration, the study proceeded to estimate the short-run and long-run relationships using the panel ARDL technique. A PMG was estimated, and the results are shown in Table 8 below.

5.5. Regression Results

The study performed two dynamic models (PMG and MG) and two static models (FE and RE). Results are shown in the tables below (Tables 8 and 9).

Table 8. Pooled mean group results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long-run coefficients				
PP	0.30939	0.0442452	7.288148	0.0000 ***
INF	0.081945	0.008846	9.2636	0.0000 ***
GDP	0.402653	0.283949	1.418046	0.1609
EXCH	−0.05678	0.019174	−2.9616	0.0043 ***
D	0.31146	0.042331	7.35789	0.0000 ***
Short-run coefficients				
Error correction	−0.5867	0.04648	−12.6224	0.0000 ***
ΔPP	1.8934	0.43217	4.38117	0.0000 ***
ΔINF	0.5966	0.58993	−1.01290	0.3149
ΔGDP	1.6695	0.18484	9.03238	0.0000 ***
ΔEXCH	−0.0277	0.01144	−2.4233	0.0182 **
D	0.4460	0.0611	7.2950	0.0000 **

Note: *** 1% level and ** 5% level.

Table 9. Mean group results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long-run coefficients				
PP	0.326139	0.066460	4.907288	0.0000 ***
INF	0.124027	0.163496	0.758593	0.4533
GDP	0.028726	0.003803	7.553704	0.0000 **
EXCH	−0.232600	0.052078	−4.466393	0.0001 ***
D	0.761561	0.035494	21.45596	0.0000 ***
Short-run coefficients				
Error correction	0.420432	0.150135	−2.800363	0.0084 ***
ΔPP	−0.316449	0.260617	−1.214228	0.2330
ΔINF	0.006057	0.001897	3.192568	0.0031 ***
ΔGDP	0.005882	0.002336	2.517874	0.0165 ***
ΔEXCH	−0.880387	0.140909	−6.247907	0.0000 ***
D	−0.703066	0.091301	−7.700561	0.0000 **

Note: *** 1% level and ** 5% level.

Having estimated the PMG and MG model, the Hausman test was employed to determine which of the two models is the most consistent and suitable model in establishing the impact of port performance on trade. Results are shown in Table 10 below.

Table 10. Hausman test.

Chi-Square	p-Value
8.23	0.734

The calculated Hausman Test is 8.23 with a *p*-value of 0.734. It can thus be concluded that a null hypothesis cannot be rejected, and the PMG estimator is preferred. Under the null (slope homogeneity), the PMG estimator is consistent and efficient (Bardi et al. 2019). The study only reports the findings from the PMG estimator because the Hausman test chose it as the preferred model. PMG was also chosen due to its advantage over the static models (FE and RE).

The PMG results displayed in Table 8 show that there is a statistically significant positive relationship between PP (port performance) and trade. This result is consistent with the literature. The literature views ports and terminals as key engines for economic growth (Dwarakish and Salim 2015; PwC 2018; Munim and Schramm 2018). Efficient and well-connected container ports enabled by frequent and regular shipping services are key

to minimizing trade costs, including transport costs, linking supply chains and supporting international trade (PWc 2018). Ports are also important for the support of economic activities in the hinterland since they act as a crucial connection between sea and land transport. The transportation sector is a strong factor in terms of economic and regional balanced development, as well as also having a great influence on national integration to the world economic market (Dwarakish and Salim 2015). A study by Munim and Schramm (2018) revealed that it is vital for developing countries to continuously improve the quality of port infrastructure as it contributes to better logistics performance, leading to higher seaborne trade, yielding higher economic growth.

Results show that there is a statistically significant positive relationship between INF (inflation) and trade. This may suggest that when inflation is increasing, trade tends to also increase. These results are consistent with a number of studies. For instance, Evans (2011) proposed that trade openness enhanced a country's incentive to create inflation by estimating data through regression from 1973 to 1987 and 1988 to 2002. He concluded that openness was inflationary between developed countries in which monetary policy can roughly be approximated by controlling for imperfect competition and inelasticity of labor supply within the country. Babatunde (2017) showed that there is a significant positive long-run relationship between inflation and trade openness and a robust negative link between openness and inflation in the short run. However, other studies that were conducted on the same subject area arrived at different conclusions. For instance, Aron and Muellbauer (2007) showed that increased trade openness has significantly reduced the mean inflation rate and has also reduced the exchange rate pass-through into wholesale prices. Yihevis and Musila (2018) found that inflation exerts no significant effect on the trade balance.

The study does not find any evidence of a statistically significant relationship between GDP (economic growth) and trade. The result is insignificant, as reflected by the p value (0.1280) which is higher than 0.05. This shows that there is no relationship between the two variables (GDP and trade). The result is surprising because economic growth is supposed to result in more trade. Countries with higher rates of GDP growth also tend to have higher rates of growth in trade as a share of output (Ospina 2018). However, other studies have shown that the relationship between growth and trade can be confusing. The relationship between trade and GDP is complicated (World Economic Forum 2016).

The study shows that when there is a depreciation of the domestic exchange rate, the contribution of trade to GDP declines. This result goes against the traditional exchange rate and exports notion. It is widely expected that the depreciation of exchange rates would improve export performance. The result is consistent with Liewa et al. (2016), who found that devaluation-based adjustment policies may not achieve the desired effects of nominal exchange rate changes (devaluation) on the balance of trade. In other words, the exchange rate cannot be used solely in managing external balances. Furthermore, a Financial Times (2015) study found that the "benefits of depreciation on exports may have evaporated". The argument is based on the apparent lack of a correlation between exports and US dollar exchange rates for emerging markets since 2013. The dummy variable (D) is significant, and this reinforces the result that port performance has a positive relationship with trade. Port performance is a critical factor that can shape countries' trade competitiveness. Every hour of port time saved by ships translates into savings in port infrastructure expenditure for ports, ship capital costs for carriers and inventory holding outlays for shippers (PWc 2018). This will then contribute positively to trade.

In the short run, the results show that the speed of adjustment parameter (-0.586) is negative and significant, which implies that 59% of the last year's disequilibrium is corrected this year. The fact that the coefficient of the error correction (-0.586) is negative confirms the existence of the long-run relationship between port performance and the regressors that were used in this study. The short-run results were almost similar to the results that were obtained in the long-run analysis. However, in the short run, there is an improvement in the explanatory power of some of the indicators. This may suggest that

the impact of the explanatory variables is much bigger in the short run than in the long run. However, INF was seen to be having an insignificant relationship with trade performance. This may suggest that inflation does not affect trade performance in the short run.

Furthermore, the gravity model was used to conducted to affirm the findings of PMG. Two models were conducted using the gravity model. The first model had exports as its dependent variable, and the second model had trade volume (exports and imports) as its dependent variable. However, it must be noted that the sign of the main variable of interest (port performance) is the same in all the models. This reinforces the findings in the PMG that port performance contributes positively to trade performance. Results are presented in Table 11 below.

Table 11. Gravity Model results.

VARIABLES	Model 1	(RE)	Model 2	(GMM)
	(FE) IEXP	IEXP	(RE) ITRV	ITRV
LGDP	0.120022 *** (0.017799)	0.023919 *** (0.002443)	0.366856 *** (0.015056)	0.306785 ** (0.125832)
LEXCH	−0.112920 *** (0.00885)	−0.166363 ** (0.044773)	−0.318134 *** (0.025391)	−0.567366 *** (0.036009)
B	0.163309 (0.157431)	−0.111827 *** (0.012086)	0.001309 (0.008817)	−0.152243 (0.024761)
LPP	0.377338 *** (0.016272)	0.324568 *** (0.017913)	0.720484 ** (0.041165)	0.413370 ** (0.206904)
D	0.063534 (0.427973)	0.476554 (0.427532)	0.008206 (0.015820)	−0.014655 *** (0.001649)

Note: *** 1% level and ** 5% level.

The Hausman test was performed, and the results showed a Hausman statistic of 18.34, and it was significant at a 5% significance level. This shows that the Random Effects performed better than the Fixed Effects model. This is the reason the RE model was chosen in the second model (Model 2).

The results suggest that the LGDP, EXCH and LPP are the powerful positive determinants of bilateral trade. These results are inconsistent with the results from the PMG estimator except for LGPD, which was found to be insignificant in the PMG estimator. For LGDP, the result seems to be reasonable, and it is consistent with the literature. For instance, [Songwe \(2019\)](#) shows that when African countries trade with themselves, they exchange more manufactured and processed goods, have more knowledge transfer and create more value. Trade is the key to long-term, sustainable economic growth and development in sub-Saharan Africa ([Farahane and Heshmati 2020](#); [US Government 2021](#)). [Osei-Assibey and Dikgang \(2018\)](#) found that both imports and have the potential to positively impact economic growth in African countries.

The distance variable (D) has a negative sign (on the GMM model) and is insignificant in all other regressions. This is inconsistent with the gravity model. Conventional wisdom suggests that transportation costs go up along with the increase in distance. However, this is not the case in Africa. The share of internal trade in Africa remains very low. Intra-African exports were 16% of total exports in 2018 ([Jarreua 2018](#); [Tralac 2019](#); [UNCTAD 2019](#); [Fitch Ratings 2021](#)). This is because it is much costlier for African states to trade with each other than for them to trade with Europe, Asia and America ([BBC 2021](#)). The continent's railways and roads often lead towards the ports rather than link countries across regions. To fly from one African country to another, it is often easier to pass through Europe ([UN 2020](#)). This explains why many African countries prefer to trade with Europe, Asia and America. This is caused by such constraints as high trade costs, expressed through a lack of access to credit and finance, inefficient border processes, poor physical infrastructures such as road and railway networks, customs systems, security issues and communication barriers ([Luke 2020](#); [BBC 2021](#)). The border variable (B) is insignificant in all regressions.

This shows that sharing the same border does not influence trade in the countries under investigation. This is explained by the fact that Africans trade the least with each other than all the other continents (Songwe 2019; US Government 2021). Furthermore, a large share of regional trade in Africa is informal, i.e., not recorded in official data (Bensassi et al. 2019; World Bank 2020). This makes it difficult to include such trade in official trade statistics.

6. Conclusions and Recommendations

The main aim of this study was to examine the impact of port performance on trade in Africa. The study drew from the fact that, globally, ports are gateways for over 70% of merchandise trade by volume and value. Efficient ports set the ground for trade, and ports can also enhance a country's growth prospects. It can thus be said that port efficiency is important to improving trade facilitation. However, in Africa, the functioning and concatenation of ports in Africa's wider transport logistics chains remain poor. Others fall behind in terms of available facilities, dependability and effectiveness in the handling of freight, which increase supply chain costs. The inconsistencies in port performance affect Africa's transport logistic chains and make African countries less efficient than they should be. Africa still makes up just a small percentage of global trade, with problems continuing at its ports from capability issues to inefficient handling time, poor security and, in some places, corruption.

The results from the study showed that port performance has a positive impact on trade in Africa. The findings were consistent with the empirical literature. This study argues that the success of Africa's ports and transport logistic chains is critical to Africa's transformation of economic potential to growth. The transportation system is a vital factor in terms of economic growth as well as having a major influence on Africa's integration into the global market. This has not been acknowledged by several governments; they have failed to recognize ports as vital facilitators of international trade. Africa must change its understanding of the part ports can play. Based on the findings, the study recommends that African governments must invest heavily in port infrastructure. This study argues that African ports require modern infrastructure to be able to compete successfully. Africa needs to pursue an intensive course of infrastructure development so as to maintain economic growth and improve port efficiency and trade competitiveness. At the moment, African ports are inefficient, and there is congestion partly because the ports cannot accommodate further expansion without serious investments. Investment in infrastructure will ensure the accommodation of vessel arrivals/departures and safe and efficient loading/unloading.

It should also be noted that Africa must not only invest in port infrastructure but also on shoreside infrastructure and intermodal connections that serve ports. In other words, consideration should also be given to highway or rail infrastructure that develops or extends intermodal connectivity and intermodal facilities. This will ensure access to efficient transport modes of sufficient capacity. Congested transport corridors place an additional burden on ports which might make goods arrive at and leave ports slowly. Investment in Africa's port infrastructure and the intermodal connections that serve seaports foster prosperity and provide an opportunity to bolster Africa's trade.

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Notes

- ¹ South Africa's President, Cyril Ramaphosa, also echoed a similar sentiment in his 2020 State of the Nation Address. Mr. Ramaphosa stated that South Africa's ports were congested and inefficient, and this resulted in delays and increased costs of conducting international business (Ramaphosa quoted in (RSA 2020)).
- ² This is also in line with the 2018 Lloyd list of Top 100 global container port: from Africa, only four container ports, in Morocco, Egypt and South Africa, were listed (Jaferi 2019).
- ³ A shorter time in the port is generally indicative of high port efficiency and trade competitiveness (UNCTAD 2019).
- ⁴ Munim and Schramm (2018) completed a study that tested the impacts of port infrastructure and logistics performance on economic growth and showed that port infrastructure contributes to higher seaborne trade.

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