Causal Relationship of Logistics Performance Gross Domestic Product and Governance

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This study investigates the short-run and long-run relationship between a country's logistic performance, GDP, and governance. Although several studies have explored the relationship between governance indicators and economic growth, up to now, no attempt has been made to quantify the relationship and direction of causality between logistic performance, GDP, and governance for African countries. Using data from forty-seven African countries for the period 2007-2018, we conduct our empirical analyses using the panel error correction model. The contribution of this study is by using a panel-data approach to a variety of factors, it attempted to explain the variance in the LPI for the selected countries.

Keywords: logistic performance, GDP, governance, panel causality tests

INTRODUCTION

Globalization has increased logistics activities (by an increased interconnection through technology) manifested by critical human and spatial interactions (Kleindorfer and Visvikis, 2007). Trade depends on efficient logistics that play significant roles in facilitating the movement of goods and services. It is one of the vital activities of supply chains that can influence its efficiency to reduce total operational costs. Infrastructure is the backbone of the trade, and weak infrastructure can make the supply chain ineffective and wasteful. A robust infrastructure of roads, railroads, ports, and other critical infrastructure investments in technology and telecommunication can minimize supply chain bottlenecks. Private firms typically manage logistics to serve the needs of other private and public enterprises. Logistics activities are essential drivers of economic growth as measured by the level of economic activities to increase a country's gross domestic product (McKinnon A. et al., 2017). Effective and efficient global supply chains are the backbone of development, trade, innovations, and competitiveness.

This paper aims to assess the relationship of LPI to GDP and governance on trade efficiency using the logistics performance index (LPI) with a model that includes variables that consider the mediator effect of the global competitiveness index. The article is structured by first reviewing the relevant literature on LPI, GDP, and governance, then follows the research methodology used in this study. Finally, discussions, conclusions, and recommendations for future research are provided.

LITERATURE REVIEW

Logistics is an important sector of the economy in most parts of the world, commanding roughly 10% of the gross domestic product (D'Aleo, V. and Sergi, B (2017). Logistics major activities include transportation, warehousing, cross-border clearance, integrated payment systems, and other activities that producers and retailers don't deem as their core competencies are outsourced to logistics providers. Specialized logistics providers such as third-party logistics are much more efficient because of the scale of economies and lower costs. Lean and efficient logistics and supply chains are the foundation of strong economic growth, competitiveness, and trade. In free-market economies, logistics services are usually managed by private and third-party logistics companies. The efficiency, effectiveness, and overall quality of these services are regulated by government policies with business leaders' representation that affects the entire economy (McKinnon, 2017). Invariably, the governance quality of the country has a significant influence on the quality and efficiencies of the logistics performance. The World Bank regularly surveys countries about their logistics performances and publishes the result on a biennium basis (World Bank). Beamon (1999) argued that logistics and supply chain flexibility and performance measurement are necessary to assess logistics and supply chain management. Lai, Kee Hung, et al. (2002) used 26-item measurement instruments to measure the performance of logistics and supply chain; these items, according to the study, suggested the measurement instrument is reliable and valid. D'Aleo, V. and Sergi, B (2017) found a positive relationship between the global competitiveness index as a mediator variable to GDP growth. Furthermore, they argue that the human factor is far more important than infrastructure and institutions for improving the logistics performance index. Using a linear regression model, Civelek et al. (2015) showed LPI's contribution to the relationship between the global competitiveness index and GDP. An analysis of the importance of LPI in developing countries that are not landlocked was conducted by Marti and Puertas (2015) showed investing and improving logistics infrastructure is critical to trade activities.

According to Grosse et al. (2015), human factors are crucial, especially in logistics processes like accurate picking and packaging, that can influence the efficiency, effectiveness, and quality of the logistics operations. A study compared Brazil's LPI to its major competitors in trade and found poor governance and sclerotic bureaucracy hinder logistics performance (Faria et al., 2015). Professional experience in the logistics sector is the most critical factor for successful logistics, as Kotzab and Wunshe (2015) demonstrated. The weight of the global competitiveness index (GCI) affects LPI, according to Erkan (2014). A study about competitiveness in the Indian logistics sector found that logistics management influences global competitiveness in that country (Mohan, 2013). Furthermore, the study revealed that reduction in logistics costs and improvement of logistics service could increase the overall efficiency of the logistics sector. Padilha et al. (2012) studied ports in Brazil and found that weak governance and infrastructure could be a significant obstacle to the development goals of countries such as Brazil. A study about human factors in the logistics sector discovered the importance of emotional capabilities in conjunction with technical capabilities is a crucial determinant for an effective logistic manager (Van Hoek, Chatham, and Wilding (2002). According to Sanchez et al. (2003), port efficiency is influenced by public policy. Fournou studied the importance of information technology in the logistics sector (2002) and found the prevalence of advanced integrated IT in the industry can provide a competitive advantage. Lai and Cheng (2002) developed an instrument to measure supply chain performance in transportation logistics and found operations efficiency for transport providers, service effectiveness for shippers, and service effectiveness for consignees.

DATA METHODOLOGY

The analysis in this study focuses on the multivariate relationship between logistics performance, GDP, and governance for 47 African countries from 2007 to 2018. World Bank Logistics Performance Index (*LPI*), Mo Ibrahim Governance Index (GOV), and accurate Gross Domestic Product *(GDP)*, which is expressed in real per capita terms, constitute the variables used in the analysis. *GDP* and LPI are in natural logarithms in the investigation.

The motivation of the research is to test the causal relationship between GDP, governance, and logistics. The panel data was used for the panel Granger causality model. The Granger causality test assumes that a variable Granger causes can be better predicted by its past values and past values (Granger, 1969). A vector error correction model is computed after the panel unit root and cointegration tests. The test significance of different coefficients is assumed as the source of causation.

PANEL UNIT ROOT TESTS

Non-stationary data can result in inaccurate causality test results. Because of this, we start our analysis by applying panel unit root tests. Many panel unit root methodologies have been proposed (Maddala & Wu, 1999; Baltagi & Kao, 2000; Hadri, 2000; Levin et al., 2002; Im et al., 2003). In this paper, we use the panel unit root tests proposed by Levin et al. (2002), later referred to as LLC, Im et al. (2003), hereafter referred to as IPS, and Hadri (2000) [1]. For each estimation method, we test for unit roots in the panel using levels and first differences of all the variables with and without a deterministic trend.The results of the IPS, LLC and Hadri panel unit root tests for the series *LGDP, LLPI and GOV* are shown in table 1

TABLE 1
PANEL UNIT ROOT RESULTS FOR LGDP, LLPI, AND GOV 2007-2018

Variable	IPS Test		LLC Test		Hadri Test	
	No Trend	**Trend**	**No Trend**	**Trend**	**No Trend**	**Trend**
LGDP	-6.08***	0.90	-27.95***	-18.37	9.56***	50.05***
LLPI	-2.53***	-0.53	-12.74****	-26.85***	9.73***	48.61***
GOV	0.57	1.32	-7.57***	-11.39***	9.87***	67.3***
ΔLGDP	-3.57***	-6.56***	-15.94***	-46.26***	11.74***	63.69***
ΔLLPI	-8.75***	-10.86***	-32.71***	-109.49***	10.56***	60.89***
ΔGOV	-2.47***	0.023	-10.31***	-19.11***	11.16***	68.00***

Note: *** indicate rejection of the null hypothesis at the 1% significance level.

PANEL COINTEGRATION

The second step of our empirical work involves investigating the long-run relationship between logistics performance (LPI), GDP, and governance. In this study, three types of panel cointegration tests are employed: Pedroni (1999), Kao (1999), and a Fisher-type test based on the Johansen methodology (Maddala & Wu, 1999). We start with the Pedroni cointegration test.

The Pedroni (1999) cointegration technique allows for heterogeneity among individual members of the panel. The panel technique is handy with a small sample size and thus increases the number of degrees of freedom. The Pedroni (1999) cointegration test is based on the estimated residuals from the following long run model.

$$LGDP_{it} = \alpha_i + \delta_t + \beta_1 LLPI_{it} + \beta_2 GOV_{it} + \varepsilon_{it}$$

GDP, *LPI*, and *GOV* are the observable variables of gross domestic product, logistics performance index, and governance, respectively (GPD and LPI are in log form) that are believed to be integrated of order 1; are time periods; are panel members; denote country-specific effects, is the deterministic time trend, and is the estimated residual. With the null hypothesis of no cointegration, the Pedroni (1999) test uses the residuals from the equation above and tests whether they are integrated of order 1. Conceptually, the Pedroni panel cointegration test tests for the presence of unit roots in the estimated residuals, generating seven statistics. Pedroni divides the seven statistics into two categories. The first statistics are known as the "within dimension" or panel statistics test and includes the following three test statistics: (i) the panel statistics, (ii) the panel -statistics (rho-statistic), (iii) the panel non-parametric statistics; and (iv) the panel Augmented Dickey-Fuller parametric statistics (ADF-statistics). The second set of statistics defined by Pedroni (1999) is the "between dimension" or group statistics tests, and this includes the following three statistics:(i) the group- statistics; (and (iii) the group ADF-statistics. Table 2 presents the results of this test.

Table 2 reports the within and between results of the Pedroni (1999, 2004) panel cointegration tests. As shown below, the tests give strong evidence for rejecting the null of no cointegration. It leads us to conclude that GDP, LPI, and GOV move together in the long run.

TABLE 2
PEDRONI PANEL CO-INTEGRATION RESULTS, 2007-2018

Statistic	**LGDP**	**LLPI**	**GOV**
	Intercept and no time trend	**Intercept and no time trend**	**Intercept and no time trend**
	Within-dimension		
Panel v-stat	**-0.08**	**-1.68**	**-0.66**
Panel Rho-stat	**3.61**	**2.07**	**2.88**
Panel PP-stat	**−0.435*** **	**−13.49*** **	**−6.05*** **
Panel ADF-stat	**−0.578*** **	**−9.57*** **	**−5.15*** **
	Between-dimension		
Group Rho-stat	**6.46**	**5.50**	**6.81**
Group PP-stat	**−6.90*** **	**−16.00*** **	**−4.41*** **
Group ADF-stat	**−6.69*** **	**−10.64*** **	**−3.37*** **

Note: *, **, *** indicates significant at 10%, 5%, and 1% level respectively

For a robustness check of the cointegration results, this study presents results of Kao (1999)[1] in Table 3. The test overwhelmingly rejects the null hypothesis of no cointegration. This indicates that *LLPI* have a long run relationship with GOV and L*GDP* respectively. Having determined that the variables have a long-run relationship, or are cointegrated, we perform the Granger causality tests by employing the panel error correction model (ECM).

TABLE 3
KAO RESIDUAL COINTEGRATION TEST

	LGDP	**LLPI**	GOV
	t-Statistic	**t-Statistic**	
ADF	-3.4***	-5.98***	-1.49***

Note: *** indicates significant at 1% level

PANEL GRANGER CAUSALITY

Theoretically, if the variables are cointegrated, then causality exists between the two series implying that the two variables move together in the long run. But this doesn't show the direction of causality. To test for Granger causality in the short-run and long-run, we use the Error Correction Model (ECM).[2,3] The dynamic error correction model takes the following form:

$$\Delta LGDP_i = \alpha_1 + \beta_1 ECT_{t-1} + \beta_2 \Delta LGDP_{t-1} + \beta_3 \Delta LGDP_{t-2} + \beta_4 \Delta LLPI_{t-1} + \beta_5 \Delta LLPI_{t-2} + \beta_6 \Delta GOV_{t-1} + \beta_7 \Delta GOV_{t-2} + \varepsilon_1 \quad (1)$$

$$\Delta LLPI_i = \alpha_2 + \delta_1 ECT_{t-1} + \delta_2 \Delta LGDP_{t-1} + \delta_3 \Delta LGDP_{t-2} + \delta_4 \Delta LLPI_{t-1} + \delta_5 \Delta LLPI_{t-2} + \delta_6 \Delta GOV_{t-1} + \delta_7 \Delta GOV_{t-2} + \varepsilon_2 \quad (2)$$

$$\Delta GOV_i = \alpha_3 + \gamma_1 ECT_{t-1} + \gamma_2 \Delta LGDP_{t-1} + \gamma_3 \Delta LGDP_{t-2} + \gamma_4 \Delta LLPI_{t-1} + \gamma_5 \Delta LLPI_{t-2} + \gamma_6 \Delta GOV_{t-1} + \gamma_7 \Delta GOV_{t-2} + \varepsilon_3 \quad (3)$$

where Δdenotes the difference operator; *GDP* and LPI are expressed in natural logarithms, ECT is the lagged error correction term derived from their long run cointegrating relationship; $\beta_1, \delta_1,$ and $\gamma_1$are adjustment coefficients; and ε_1, ε_2,and $\varepsilon_3$are disturbance temers.

Equations (1), (2), and (3) are estimated using a Vector Error Correction Model (VEC). VEC has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the *error correction* term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

The sources of causation are identified by testing for the significance of the coefficients on the lagged dependent variables in equations (1), (2), and (3). To evaluate weak (short-run) Granger causality: in equation (1), from LLPI we test $H_0: \beta_4 = \beta_5 = 0$ from GOV we test $H_0: \beta_6 = \beta_7 = 0$ all i; in equation (2), from LGDP we test $H_0: \delta_2 = \delta_3 = 0$, from GOV we test $H_0: \delta_6 = \delta_7 = 0$ for all i; in equation (3), from LGDP we test $H_0: \gamma_2 = \gamma_3 = 0$ and from LLPI $H_0: \gamma_4 = \gamma_5 = 0$ for all i. The weak Granger causality can be interpreted as a short-run causality in the sense that the dependent variable responds only to short term shocks.

After testing for short-run causality, the long-run causality is tested by looking at the significance (t-statistics) of the coefficient of the error correction terms (β_1, δ_1, and γ_1) in equations (1), (2) and (3). Formally, the hypotheses for the long-run causality are stated as:$H_0: \beta_1 = 0$ for all i in equation (8), $H_0: \delta_1 = 0$ for all i in equation (2), and $H_0: \gamma_1 = 0$ for all i in equation (3). When $\beta_1 = \delta_1 = \gamma_1 = 0$ for all$i$, this would be interpreted as means that there is no Granger causality in the long-run. These coefficients represent how fast deviations from the long-run equilibrium are eliminated following changes in each variable. Movements along this path are considered permanent because changes in the endogenous variables are not only caused by the lagged values but also by the disequilibrium in the previous period.

Besides examining the short-run and long-run relationships of the two variables, we conduct a joint hypothesis test of $H_0: \beta_1 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$ for all i in equation (1), $H_0: \delta_1 = \delta_2 = \delta_3 = \delta_6 = \delta_7 = 0$ for all i in equation (2), and $H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$ for all i in equation (3). This test is referred to as the strong Granger causality test and is used for determining the variables which bear the burden of short-run adjustment to re-establish long-run equilibrium, following a shock to the system (Asafu-Adjaye, 2000). A result of no causality in either direction indicates that the variables have a neutral effect on each other. The variable *X* is said not to Granger-cause the variable *Y* if all the coefficients of lagged variables in equations (1), (2), and (3) are not significantly different from zero.

Table 4 summarizes the panel causality estimates for the three tests specified in the section above. The short-run results are mixed. In the LLPI and GDP equations, the coefficients of the lagged governance variables are not significant. This implies that there is no short-run transitory relationship running from governance to logistics performance and GDP. We also find that there is no short-run relationship running from logistics performance to GDP and from GDP towards logistics performance. But in the governance equation, we see that the coefficients of the lagged logistics performance index and GDP variables are significant. This implies that there is a short-run transitory relationship running from both logistics performance index and GDP to governance in the SSA countries during the study period.

TABLE 4
RESULTS OF PANEL CAUSALITY TESTS

Dependent Variable	Sources of Causation						
	Short Run			Long-run	Strong causality (Joint Test for short-run and long-run causality)		
	ΔLLPI	ΔLGDP	ΔGOV	ECT(-1)	ΔLLPI, ECT(-1)	ΔLGDP, ECT(-1)	ΔGOV, ECT(-1)
ΔLLPI		2.12	0.69	-0.42***		27.71***	20.58***
ΔLGDP	3.61		2.06	6.25E-05	3.67		2.08
ΔGOV	8.36****	5.94***		-0.33***	12.94***	11.06***	

*Significant at 10%, **Significant at 5%, and ***Significant at 1%

The long-run results are also mixed. The coefficient of the error correction term (*ECT*) was expected to be significant and negative. But we found a negative and significant in the LLPI and GOV equations but positive and insignificant in the GDP equation. This means there is a long-term relationship that runs from GDP and GOV towards LLPI and from LLPI and GDP towards GOV but not from LLPI and GOV towards GDP. In addition, in both the LLPI and GOV equations, the joint test for the short-run and long-run relationship is significant. From these findings, we conclude that governance responds to short and long-term shocks coming from both logistics performance and GDP. LLP also responds in the long term but not to short-term shocks. But GDP doesn't seem to respond to short and long-term changes in governance and logistics performance. This may be because the countries in our study lack adequate logistics infrastructure, have weak customs institutions, and lack advanced technology that integrates logistics activity with other business functions. We plan to further investigate this issue in our future studies.

CONCLUSIONS

The purpose of this study was to test for Granger causality among logistics performance, governance, and GDP within a multivariate framework for the 47 African countries. The central hypothesis in this study was to test whether logistics performance and governance granger causes GDP growth and vice versa. This study establishes that there is a long-run relationship between the variables.

The study found mixed results in both short and long-run time frames. In the short run, there is a transitory relationship running from both logistics performance and GDP to governance in sub-Saharan

African countries during the study period. This implies improvements in logistics activity like customs, transportation infrastructure, and GDP growth positively impact the governance of the countries in the study. But we didn't find any short-run transitory relationship running from governance to logistics performance and GDP or a from logistics performance towards GDP and from GDP towards logistics performance.

Regarding the long-run permanent relationship and the strong causality tests, we find evidence of a long-term relationship that runs from GDP and GOV towards LLPI and from LLPI and GDP towards GOV but not from LLPI and GOV toward GDP. In addition, in both the LLPI and GOV equations, the joint test for the short-run and long-run relationship is significant. From these findings, we conclude that governance responds to short and long-term shocks coming from both logistics performance and GDP.

ENDNOTES

1. For details of the test, read Kao, C. (1999). Spurious Regression and Residual-Based Tests for Cointegration in Panel Data, Journal of Econometrics 90, 144
2. The lag length in the dynamic panel error correction model is based on the Akaike and Schwarz Bayesian Information criteria and both criteria indicate that two lags as the optimal lag length.
3. The lag length in the dynamic panel error correction model is based on the Akaike and Schwarz Bayesian Information criteria and both criteria indicate that two lags as the optimal lag length.

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