Relationships of Selected Key Logistics Factors and Logistics Performance Index of Sub-Saharan African Countries

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Logistics and supply chain bottlenecks are magnified with inefficient business processes and can result in increases of trade costs. Logistics Performance Index is a measure of how well different countries perform in their logistics activities to increase trade efficiencies. This study tries to explore the relationship of critical logistics factors with logistics performance index (LPI) developed by the World Bank. By taking Rwanda as a case study, the paper also explores the performance differences in logistics between landlocked and coastal countries, among countries within the same region, and income group. It shades light how a landlocked and low-income country was able in a decade to improve its logistics performance. The findings of two-stage least square provides a single estimated logistics index. It can explain the multiple logistic indicators which can be used to improve the ability to compete and improve logistics performance. Moreover, countries in the study, as well as other countries can utilize this estimated index to target policy actions to improve logistics operations.

Keywords: Logistics Performance Index, LPI, Sub-Saharan Countries, Two Stage Least Squares Regression, World Trade

INTRODUCTION

According to World Trade Organization (WTO) 2018 report, Africa total trade volume, compared to the developed world and the rest of the world, is relatively small, about $951 billion or 2.17% in 2017 but steadily growing especially with China, India and other Asian countries. Intra- Africa trade is still small but growing. It grew to 19.6% of Africa's total trade, up from 15.2% in 2014 and 10.3% in 2008. For skilled trade to occur, a well-developed logistics system is a must as it is associated with trade expansion, diversification, and ability to attract foreign investments resulting in economic growth (De Faria et al., 2009). The infrastructure of roads, river ways, ports, rail system, airports, and developed business processes can alleviate the bottlenecks in a logistics chain (Markovits-Somogyi, A., and Zoltan Bokor (2014). A single bottleneck for a landlocked country, for example, can cause a bullwhip effect throughout the supply chain and can result in less trade outcome. Inefficient logistics are caused by poor infrastructure of rail, port, roads, custom clearance, which may cause to slow businesses' ability to conduct trade with international partners (Harrington, 2003).

Despite recent high growth rates of trade in the sub-Saharan region of Africa, Africa's merchandise exports are bedeviled with a multitude of issues. The most critical are high costs related to poor quality of infrastructure and logistics, low processing capacity and the overwhelming dominance of primary commodities and natural resources in Africa's exports, which expose the region to recurrent adverse commodity terms-of-trade shocks (World Bank, 2018). Despite the challenges, Africa's trade grew by 10.6 percent in 2017, compared to 4.7 percent in the rest of the world (World Trade Statistical Review 2017/18). Relatively speaking the volume of trade in Africa is still minuscule about 2.7% of global trade. Efficient logistics is vital in supporting the movement of goods and services according to the World Trade Statistical Review (2017/2018) to make supply chains more efficient and reduce total trade-related operating costs. Inadequate trade-related infrastructure and supply chain bottlenecks which logistics is the significant component and are the primary determinants of trade costs; reducing them by half would raise global trade by an estimated 15 percent and global production by 5 percent (World Bank, 2018). The rest of the paper will review relevant literature to LPI, explore data analysis from World Bank, and compare selected performance of sub-Saharan countries' logistics performance over a decade (2007, 2018). It will use a two-stage least squares regression model to test hypotheses on the relationship of logistics performance and six key independent variable that are thought to be important in the performance of logistics, and finally provide insights and conclusions.

LITERATURE REVIEW

The network of services that supports the movement of goods, trade across borders, and commerce is commonly known as physical logistics. Logistics is one of the primary factors of a country's competitiveness (Mustra 2011). Currently, the common utilization of integrated software to facilitate the competent service of logistics is as important as the physical movement of goods (Changbing, 2010). The activities that encompass logistics include integrated software to facilitate the sharing of data and information with trade partners, vendors, customers, and customs agencies. The traditional activities such as transportation, warehousing, brokerage facilitators, terminal operators for land, sea, and air are components of logistics. The volume of activities related to this industry is estimated to be close to $5 trillion US dollars in 2018 (World Bank, 2018). African countries' logistics performance is one of the most critical factors for their development goals and growth of their economy and competitiveness. Arvis et al., (2018) argues: “International logistics is increasingly intertwined with domestic logistics. Policymakers and stakeholders deal with a wide range of policies. Growing concerns include spatial planning; skills and resources for training; the environmental, social and economic sustainability of the supply chain; the resilience of the supply chain to disruption or disaster- physical or digital."

International logistics is closely associated with domestic logistics as global logistics is an extension of most domestic logistics operations. Policymakers have to cover a wide range of related issues such as personnel training in updating skills in logistics, adequacy of infrastructure, environmental issues including green supply chains, social, economic and sustainability and resilience of the supply chain to unexpected shocks. Effective logistics is a crucial factor in the country's development aspirations (Michael, 1957). Developed countries invariably fare better in logistics performance than low and middle-income countries. Marti et al. (2014) using the LPI as an indirect measure for trade facilitation found the more complex goods have a greater influence on transportation logistics. However, the gap in performance has lessened in the late 2000s (Arvis, et al., 2018). The biannual report of Connect to Compete 6th edition provided the Logistics Performance Index (LPI) for 160 countries through a survey of logistics performance. This publication has its start in 2007 and was updated every two years with its latest issue of LPI in 2018. Logistics performance index measures key logistical dimensions in customs, infrastructure, international shipments, logistics competence, tracking and tracing, and timeliness (Bentyn, 2017). It encourages trade facilitation, improved agriculture processes, and commercial best practices to help developing countries mitigate existing differences between developed and least developed countries. Data envelopment methods were used to explore the importance of the six LPI index (Puertas et al., 2017), and the study suggests that the logistics performance depends largely on

income and geographical area. According to Puertas, et al., (2017), LPI is different than Doing Business Ranking and argues, "Differ in several respects, and so are not interchangeable." Specifically, the Doing Business ranking makes use of data on regulations that are "on the books"; while the LPI draws on surveys of logistics professionals who answer to questions about their experiences in different countries. In this way, it seeks to capture the day-to-day reality facing the private sector much more accurately.

Kwok (2011) demonstrated the index development process for green logistics (GL) and compared the performance of two countries using the proposed index. Econometrics techniques using LPI data evaluated the impact of key macroeconomic variables on the quality of the logistics sector. Regression results showed a strong relationship between the development of the services sector and the logistics performance of a country (Basarab, 2008). Shaik and AbdulKader (2012), proposed an Analytical Hierarchy Process (AHP) method to prioritize the LPI dimensions.

COMPARISON OF LOGISTICS PERFORMANCE FOR SELECTED COUNTRIES

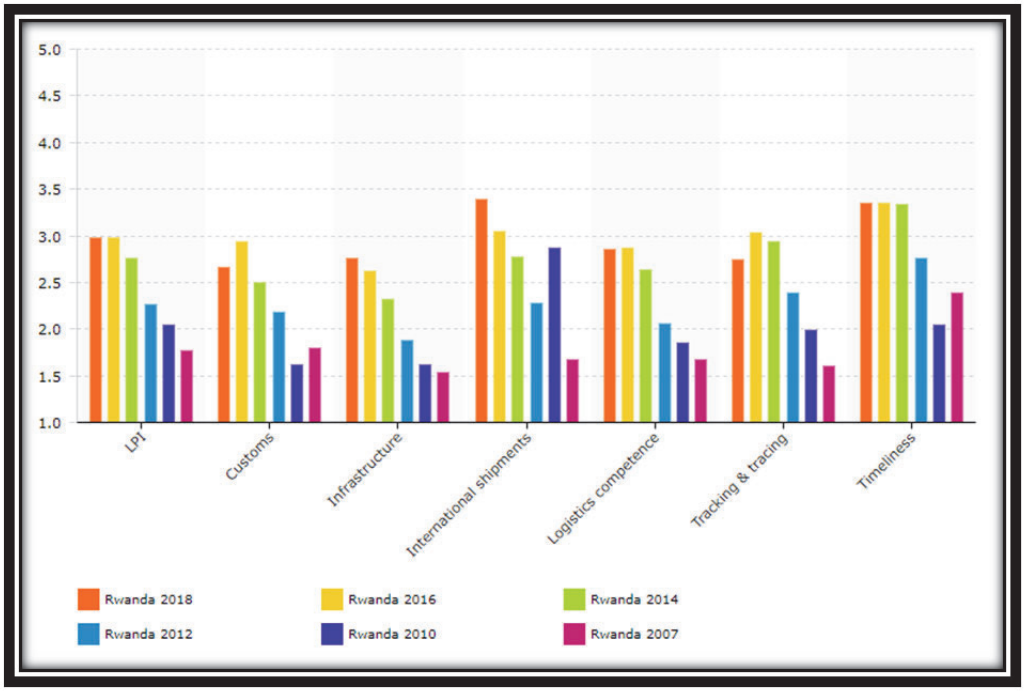
We selected a sub-Saharan country-- Rwanda-- to compare its logistics performance between 2007 and 2018. We used the logistics dimensions and how it fared in this time period and provided insights into why the logistics performance improved. Table 1 shows Rwanda's LPI improvement from 2007 to 2018. Its logistic performance rank improved from 148 in 2007 to 57 in 2018. Figure 1 shows Rwanda's different logistics dimensions measured over time from 2007 to 2018. Its effectiveness in international shipment doubled within a decade. Table 2 depicts the LPI for the selected countries of Rwanda, Djibouti, Kenya, Uganda, the aggregate LPI of sub-Saharan countries, and low-income countries' LPI.

The quality and performance of logistics services differ markedly across these countries. Rwanda's logistics performance was lower when compared to sub-Saharan countries, Uganda, Kenya, and Djibouti in 2007. These variations in time and cost across countries stem from differences in the quality and cost of infrastructure, governance, corruption, services as well as differences in policies, procedures, and institutions (Hausman, W, Le, H., and Subramanian, U., 2005). For example, some of these countries have rigid policies of inspection to export and import activities; whereas others have scores of approval signatures for export transaction that delays the shipment substantially. These non-value-added activities have a significant effect on dragging a country's trade competitiveness. In 2007 Uganda's performance is included as a baseline as it adjoins Rwanda and is similar in economic, social, political, and both are landlocked countries. In 2007 Kenya exceeded Rwanda's performance as well as the sub-Saharan African countries' average performance in logistics competence, tracking and tracing as well as in overall the logistics performance index. Limão and Venables (2001) estimated a strong statistical correlation link between transport costs and international trade flows. Furthermore, they found a strong association between the quality of infrastructure and transport costs to conclude that infrastructure investments are good predictor for export-led economic growth. In 2018 Rwanda performance exceeded both the sub-Saharan average and the comparison countries selected. Rwanda's investment in infrastructure, liberalization of its economy, and overall reduced corruption than the countries compared is more robust than the neighboring country. Table 3 show logistics data for selected African countries based on region, and income. The question is, what are the factors that pushed Rwanda's performance in a decade, particularly when Rwanda went through political and ethnic turmoil a decade earlier. Good governance with little corruption and external investment in Rwanda is believed to have improved its logistics performance a decade later, in 2018. Moreover, reducing non-value-added bureaucratic steps such as erroneous practices of requiring transaction approval signatures and the wrongheaded regime of 100% inspection of goods for export and import can influence economic liberalization and technological development negatively. Reduction on nonproductive logistics steps can add value to gross domestic product and in turn can stimulate investment and enhance logistics performance.

TABLE 1
RWANDA LPI 2007-2018

Country	Year	LPI Rank	LPI Score	Customs	Infrastructure	International shipments	Logistics competence	Tracking & tracing	Timeliness
Rwanda	2007	148	1.77	1.8	1.53	1.67	1.67	1.6	2.38
Rwanda	2010	151	2.04	1.62	1.62	2.88	1.85	1.99	2.05
Rwanda	2012	139	2.27	2.19	1.88	2.27	2.06	2.39	2.76
Rwanda	2014	80	2.76	2.5	2.32	2.78	2.64	2.94	3.34
Rwanda	2016	62	2.99	2.93	2.62	3.05	2.87	3.04	3.35
Rwanda	2018	57	2.97	2.67	2.76	3.39	2.85	2.75	3.35

FIGURE 1
RWANDA'S LOGISTICS PERFORMANCE OVERTIME

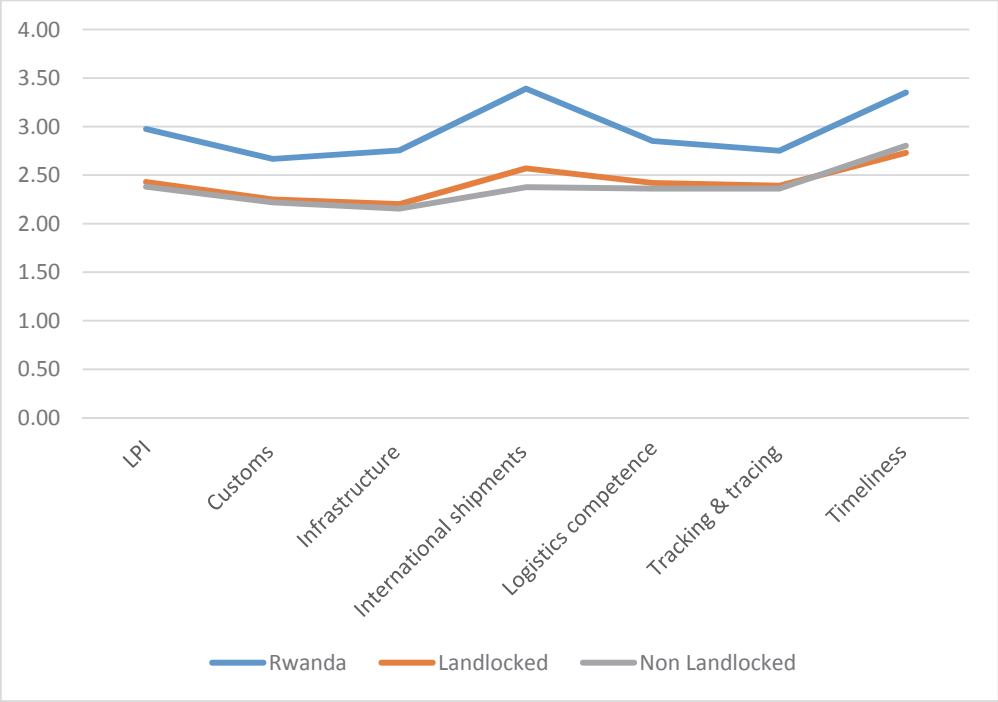


Rwanda is a landlocked country and compared to coastal countries, all landlocked countries face major logistics challenges that constrain their trade competitiveness. They face from 8%-250% cost penalty and 9%-130% time penalty (Arvis et al 2010). Hight logistics costs depend on low logistics reliability and predictability which in turn is a result mostly from rent-seeking and governance issues (prone to proliferate in low volume environments (Arvis et al 2010).

TABLE 2
LPI OF LANDLOCKED AND NON-LANDLOCKED COUNTRIES

	Rwanda		Landlocked		Non-Landlocked	
LPI Dimension	**2007**	**2018**	**2007**	**2018**	**2007**	**2018**
Overall LPI	1.77	2.97	2.23	2.43	2.38	2.38
Customs	1.8	2.67	2.08	2.25	2.22	2.22
Infrastructure	1.53	2.76	1.92	2.20	2.15	2.15
International shipments	1.67	3.39	2.27	2.57	2.37	2.37
Logistics competence	1.67	2.85	2.21	2.42	2.36	2.36
Tracking & tracing	1.6	2.75	2.12	2.39	2.36	2.36
Timeliness	2.38	3.35	2.77	2.73	2.81	2.80

FIGURE 2
LANDLOCKED VERSUS COASTAL AFRICAN REGIONS:2018



In 2007, Rwanda was performing below landlocked and coastal countries in all LPI dimensions, but it turned the page in 2018 and was the most efficient performer compared to the average of other landlocked and coastal African countries. Even though, all LPI dimensions improved, it seems Rwanda made a concerted effort to improve its international shipments and timeliness dramatically (Table 2 and Figure 2). Table 3 depicts the LPI for selected countries of Rwanda, Djibouti, Kenya, Uganda, the aggregate LPI of Sub-Saharan countries, and low-income countries' LPI. The quality and performance of logistics services differ markedly across these countries. Rwanda's logistics performance was sub-par when compared to sub-Saharan countries, Uganda, Kenya, and Djibouti on all measures in 2007. These variations in time and cost across countries stem from differences in the quality and cost of infrastructure, governance, corruption, services as well as differences in policies, procedures, and institutions (Hausman, W, Le, H., and Subramanian, U., 2005). For example, some of these countries have rigid policies of inspection to export and import activities; whereas others have scores of approval signatures for export transaction that delays the shipment substantially. They have a significant effect on trade competitiveness. Uganda's performance is included as a baseline comparison as it adjoins Rwanda and is similar in economic, social, political, and both are landlocked countries.

TABLE 3
REGIONAL AND INCOME GROUP COMPARISON: 2007

Country	Year	LPI Rank	LPI Score	Customs	Infra-structure	International shipments	Logistics competence	Tracking & tracing	Timeliness
Rwanda	2007	148	1.77	1.8	1.53	1.67	1.67	1.6	2.38
Djibouti	2007	145	1.94	1.64	1.92	2	2	1.82	2.3
Kenya	2007	76	2.52	2.33	2.15	2.79	2.31	2.62	2.92
Uganda	2007	83	2.49	2.21	2.17	2.42	2.55	2.33	3.29
Sub-Saharan Africa	2007		2.35	2.21	2.11	2.36	2.33	2.31	2.77
Low income Countries	2007		2.22	2.08	2	2.24	2.22	2.16	2.65

FIGURE 3
REGIONAL AND INCOME GROUP COMPARISON: 2007

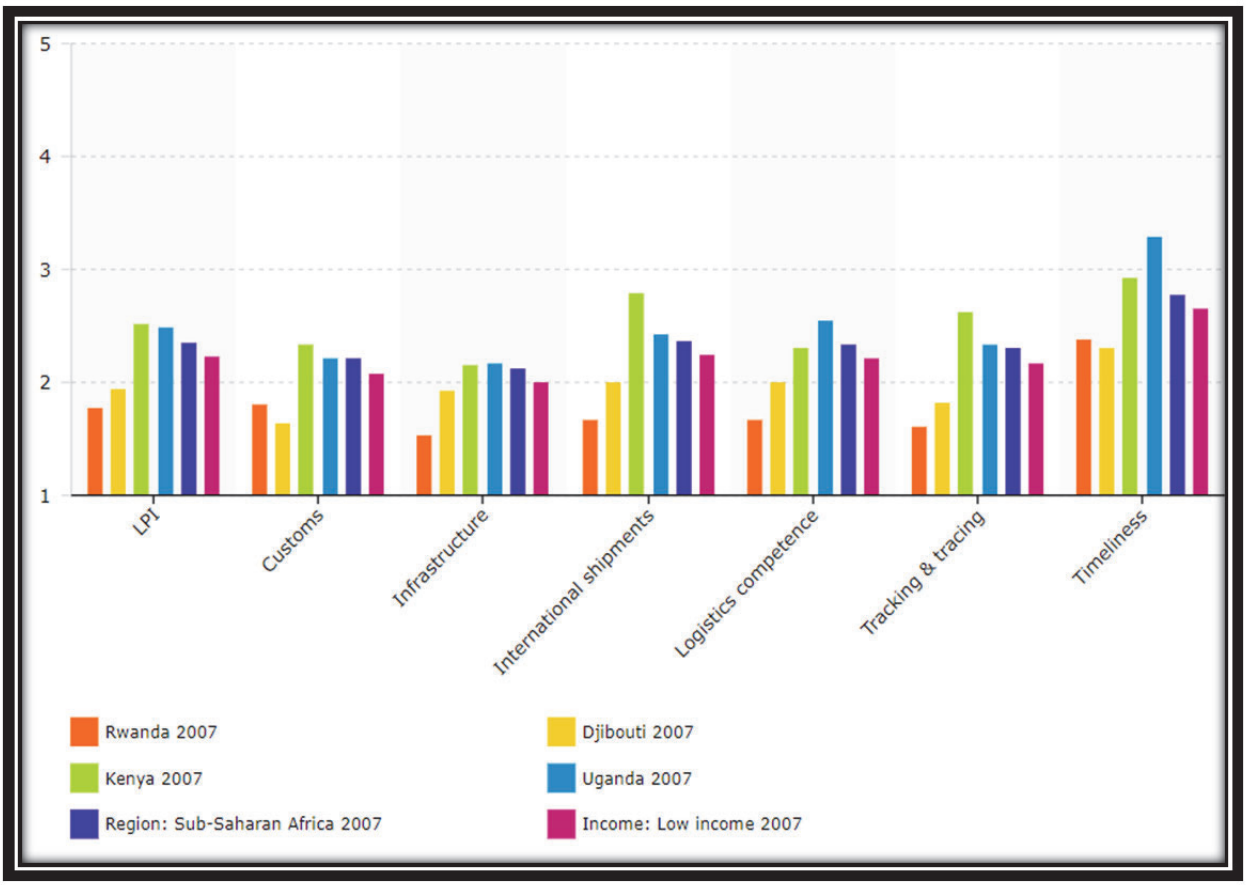
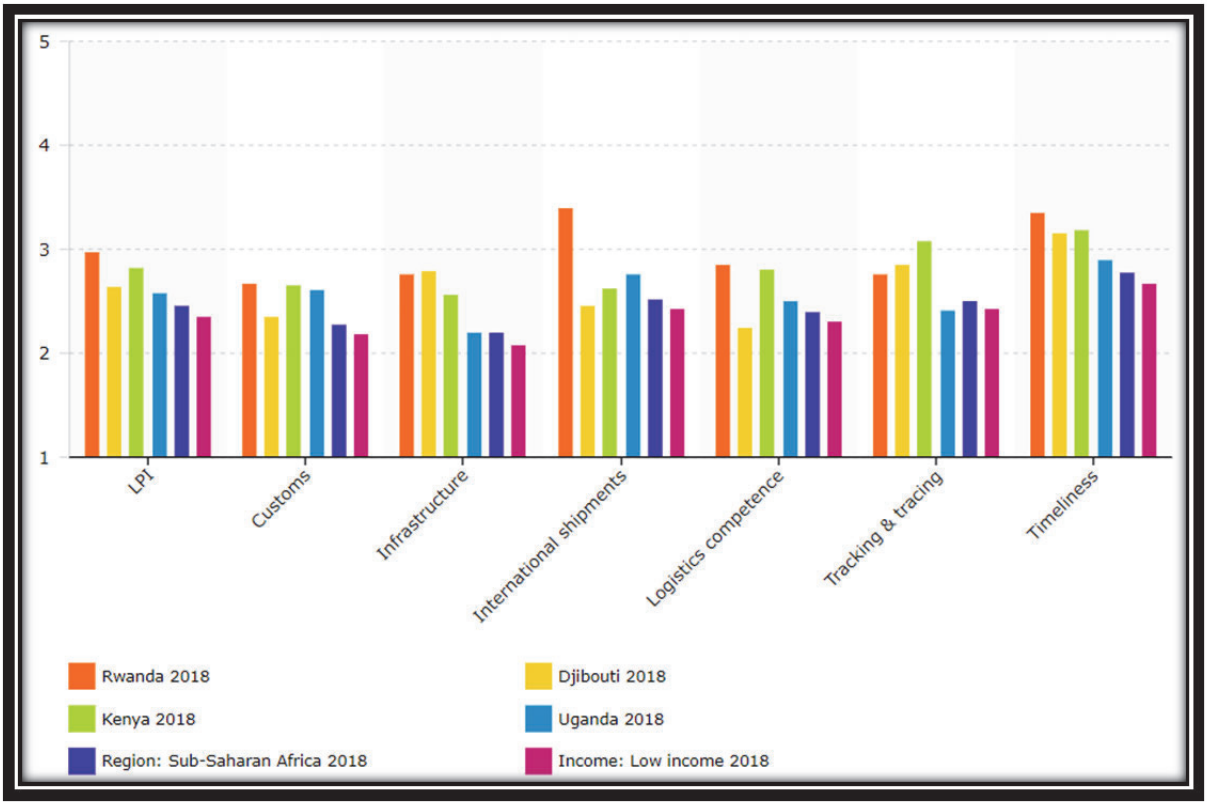


Table 4 and Figure 4 below show data for selected African countries based on region, and income for 2018. The question is, what are the factors that pushed Rwanda's performance in a decade, particularly when Rwanda went through political and ethnic turmoil a decade earlier. Good governance with little corruption and external investment in Rwanda is believed to have improved its logistics performance a decade later in 2018. Moreover, lessening mindless bureaucratic steps such as egregious practices of requiring transaction approval signatures and the practice of 100% inspection of goods for export and import can retard economic liberalization and technological development without adding value to the effort to stimulate investment and enhance logistics performance.

TABLE 4
REGIONAL AND INCOME GROUP COMPARISON: 2018

Country	Year	LPI Rank	LPI Score	Customs	Infrastructure	International shipments	Logistics competence	Tracking & tracing	Timeliness
Rwanda	2018	57	2.97	2.67	2.76	3.39	2.85	2.75	3.35
Kenya	2018	68	2.81	2.65	2.55	2.62	2.81	3.07	3.18
Djibouti	2018	90	2.63	2.35	2.79	2.45	2.25	2.85	3.15
Uganda	2018	102	2.58	2.61	2.19	2.76	2.5	2.41	2.9
Sub-Saharan Africa	2018		2.45	2.27	2.2	2.52	2.39	2.5	2.77
Low income Countries	2018		2.35	2.19	2.07	2.42	2.3	2.42	2.67

FIGURE 4
REGIONAL AND INCOME GROUP COMPARISON: 2018



MODEL AND DATA DESCRIPTION

The data used for the analysis is from World Bank's connecting to Compete: Trade Logistics in the Global Economy, 2018 edition. The interdisciplinary World Bank project goal was to develop simple comparisons of efficient supply chains to connect firms to markets. The collection of logistics performance index started in 2007 and continued until 2018 on biannual frequency. High logistics performance (top 10) is correlated with a highly established supply chain industry which is invariably located in Europe, Japan, North America and some Asian countries. High per capita income countries consistently rank in the top ten of all countries in the world. The lowest quintile in LPI is in less developed countries in Africa, Latin America, Caribbean and Asian countries. Most of these countries are afflicted with corruption, bad governance, and political turmoil. The data collected will explore whether infrastructure, income level, region, and being landlocked significantly affect the performance in logistics performance. The targeted countries for the study are sub-African countries and will try to find insights using 2-stage least squares regression on the logistics performance between landlocked and non-landlocked. The factors used to measure LPI were chosen based on current theoretical and empirical research and on the practical experience of logistics professionals involved in international freight forwarding (The World Bank, 2018). We used two-stage linear regression to model the logistics related data for sub-Sahara countries as standard linear regression models assume that errors in the dependent variable are uncorrelated with the independent variable(s). The logistics index data for the logistics scores are highly correlated. Two-stage least-squares regression by using instrumental variables was used to minimize the correlation of error terms to estimate the predictor values and then use the computed values to determine the linear regression model of the dependent variable. The resulted values are dependent on variables that are not correlated with error terms. The technique provides a model that is optimal with

uncorrelated errors with the computed values. The dependent variable is the logistics performance index (LPI) score; independent variables scores are customs, international shipment, logistics competence, and tracking and tracing. The instrumental variables used for the 2-stage least squares regression model are infrastructure, being landlocked or not, income level, and regional location.

The research hypothesis to be tested is logistics performance index is significantly related to customs, international shipment, logistics competence, and tracking and tracing. The difficulty with the model is the independent variable(s) each can influence the dependent variable (logistics performance), and in turn, the dependent variable (logistics performance) can influence the independent variable — for example, logistics performance vs. customs and vice versa. A two-stage least-squares regression model might use infrastructure to calculate a proxy for international shipment, for example, that is uncorrelated with the measurement errors in logistics performance. This proxy is substituted for international shipment in the initially specified model, which is then estimated. The other instrumental variables are utilized in the same manner to evaluate proxy variables which are then used in the original model for estimation.

It is assumed that each value of the independent variable and the dependent variable are normally distributed (see figure). The variance of the distribution of the dependent variable is constant for all values of the independent variables. The relationship between the dependent variable and each independent variable are linear.

The general form of the sample regression equation is:

$$\mathbf{Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon}$$

In the equation: $\boldsymbol{\beta_0}$ is the intercept; $\boldsymbol{\beta j}$ is the partial regression coefficient. We test for seven hypotheses as shown below.

Research Hypotheses

1) Hypothesis for Intercept: H_0: $\beta_0=0$ vs. H_1: $\beta_0\neq0$
2) Hypothesis for Customs: H_0: $\beta_1=0$ vs. H_1: $\beta_1\neq0$
3) Hypothesis for International Shipment: H_0: $\beta_2=0$ vs. H_1: $\beta_2\neq0$
4) Hypothesis for Logistics Competence: H_0: $\beta_3=0$ vs. H_1: $\beta_3\neq0$
5) Hypothesis for Tracking and Tracing H_0: $\beta_4=0$ vs. H_1: $\beta_4\neq0$
6) Hypothesis for Infrastructure H_0: $\beta_5=0$ vs. H_1: $\beta_5\neq0$
7) Hypothesis for Timeliness H_0: $\beta_6=0$ vs. H_1: $\beta_6\neq0$

TABLE 5
2- STAGE LEAST SQUARE MODEL VARIABLES

Variable	Type of Variable
LPI Score	Dependent
Customs Score	Independent
International Shipment Score	Independent
Logistics Competence Score	Independent
Tracking and Tracing Score	Independent
Infrastructure Score	Independent
Timeliness	Independent
Landlocked	Instrumental
Income Level	Instrumental
Region	Instrumental

TABLE 6
2-STAGE LEAST SQUARE ESTIMATION

Variable	Regression Coefficient b_i	Standard Error Sb_i	T Value b_i/Sb_i	P-Value
Intercept	0.0181	0.1168	0.155	0.8779
CUSTOMS	0.1682	0.0055	30.359	0.0000
INFRASTRUCTURE	0.1473	0.00831	17.813	0.0000
INT-SHIPMENT	0.1801	0.0060	30.233	0.0000
LOGISTICS-COMP	0.1730	0.0089	19.542	0.0000
TRACK_TRACE	0.1566	0.0082	19.165	0.0000
TIMELINES	0.1700	0.0062	27.389	0.0000

TABLE 7
ANALYSIS OF VARIANCE

Term	DF	Sum of Squares	Mean Square	F-Ratio	P-Value
Intercept	1	222.457	222.457		
Model	7	3.149	0.450	44179.532	0.001
Error	28	0.000	0.000		
Total (Adjusted)	35	3.149			
Multiple R	0.958				
R-Square	0.918				
Adjusted R-Square	0.916				

The residual histogram depicts a somewhat normal distribution of the data used. Therefore, our assumption of normality is reasonable and our choice of model is appropriate. The histogram in Appendix C shows the normal probability plot of residuals of the LPI's and is approximately linear and again the assumption of the normal distribution is supported by the condition that the error terms are normally distributed.

DISCUSSION OF MODEL RESULTS

The two stage least squares regression model resulted in significant relationships between the independent variables and the dependent variable-- logistics performance index. The p-value for the respective coefficients is significant with the correct signs. Therefore, Hypothesis 2, 3,4,5,6, and 7 are rejected that the regression coefficients are equal to zero. The intercept was not significant; therefore, it will have the value of zero for estimating the logistics performance index. Appendix A shows the actual and estimated logistics performance index for all the sub- Sahara countries. These regression coefficients can be helpful for policy decision-makers as they can use the parameters estimated to manage their limited resources as they would be able to predict what the effects of increasing or decreasing targeted resources and the expected impacts on the overall logistics performance. The model used the 2018 data. Therefore, additional data should be used to check its consistency and validity to measure logistics performance for sub-Saharan countries and beyond.

CONCLUSION

The results of this empirical research show that the regression model with logistics performance index as the dependent variable and the six-logistics independent variable were significantly related to the dependent variable except for the intercept. The model resulted in accurate prediction of logistics index as shown in Appendix A. The logistics coefficients can be complementary in the management of logistics performance and efficient allocation of resources for planning purposes. The method of this study can be useful in forecasting logistics performance and is worth to popularize and apply in the prediction of overall logistics effectiveness in road port transported goods and trade volume prediction. The prediction method can provide a reliable reference for highway network, infrastructure planning, customs business processes, tracking and tracing processes, and even the development of sophisticated international shipment. The estimated parameters should encourage public and private organizations that have direct or indirect power over logistics performance to giving attention to effective resource allocation. In turn, it can improve a country's ability to compete in today's global economy. Moreover, since the logistics metrics are directly related to operational performance, countries can use these metrics to target actions to improve or introduce innovations in logistics operations and gauge progress in their implementations.

REFERENCES

Arvis, J-F., Saslavsky. D., Ojala, L., Shepherd, B., Busch, C., & Raj, A (2014). *Connecting to compete for 2014: trade logistics in the global economy – The Logistics Performance Index and its indicators.* The World Bank, Washington DC.

Arvis, J-F., Raballand, G., & Marteau, J-F. (2010). *The cost of being landlocked: logistics costs and supply chain reliability*. The World Bank, Washington DC.

Basarab, G. (2008). An analysis of explanatory factors of logistics performance of a country. *Journal, Academy of Economic Studies - Bucharest, Romania*, 10(24), 143-156.

Bentyn, Z. (2017). Logistics Performance Development of the Countries on the Northern Corridor of the New Silk Road. *European Transport*, 63(4), 1-15.

Brautigan, D. (1997). Institutions, Economic Reform, and Democratic Consolidation in Mauritius. *Comparative Politics*, 30(1), 45-62.

De Faria, R. N., De Souza, C. S., & Vieria, J. G. V. (2015). Evaluation of Logistics Performance Indexes of Brazil in the International Trade. *Ram, Rev. Adm. Mackenzie*, 161, Sao Paulo, Jan/Feb.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society*, A120, 253–290.

Harrington, L. H. (2003). Trading Blocks. *Logistics Today*, 44(10), 32-36.

Hausman, W., Lee, H., & Subrmanian, U. (2005, November). *World Bank Policy Research Working Paper 3773.* Retrieved August 29, 2019, from http://documents.worldbank.org/curated/en/313001468328178815/pdf/wps3773.pdf

Jiang, C. (2010). Research on logistics network infrastructure based on HCA and DEA-PCA approach. *Journal of Computers*, 5, 533–540.

Lau, K. H. (2011). Benchmarking green logistics performance. Benchmarking. *Benchmarking: An International Journal*, 18(6).

Limão, N., & Venables, A J. (2001). Infrastructure, Geographical Disadvantage, Transport Costs and Trade. *World Bank Economic Review*, 15, 451–79.

Markovits-Somogyi, R., & Bokor, Z. (2014). Assessing the logistics efficiency of European countries by using the DEA-PC methodology. *Transport*, 29, 137–145.

Marti, L., Martin, J. C., & Puertas, R. (2017, May). A DEA-Logistic Performance Index. *Journal of Applied Economics*, XX(1), 169-192.

Marti, M. L., Puertas, R., & García, L. (2014) Relevance of trade facilitation in emerging countries' exports. *The Journal of International Trade and Economic Development*, 23, 202– 22.

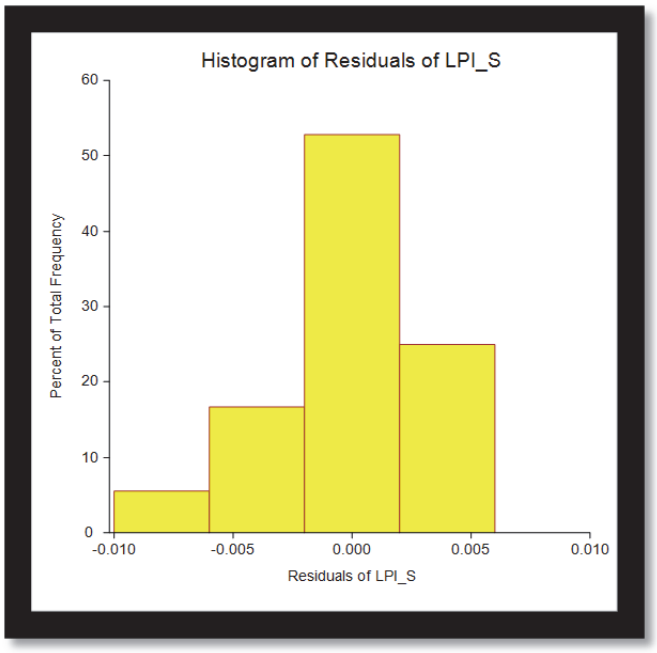
Mustra, M. A. (2011) *Logistic Performance Index, connecting to compete for 2010, in UNESCAP Regional Forum and Chief Executives Meeting*. The World Bank, Cairo.
Shaik, M., & Abdul-Kader, W. (2012). Performance measurement of reverse logistics enterprise: a comprehensive and integrated approach. *Measuring Business Excellence*, 16(2), 23-34.
The World Bank. (2018). Retrieved March 6, 2019, from https://lpi.worldbank.org/international
World Trade Organization. (2017). Retrieved March 31, 2019, from https://www.wto.org/english/res_e/statis_e/wts2017_e/wts2017_e.pdf
World Trade Statistics Review. (2018). Retrieved March 31, 2019.

APPENDICES

APPENDIX A
PREDICTED VALUES AND RESIDUALS

Row/ Sub-Saharan	Actual LPI	Predicted LPI	Residual
1	2.590	2.588	0.002
2	2.480	2.483	-0.003
3	2.880	2.882	-0.002
4	2.400	2.399	0.001
5	3.510	3.509	0.001
6	2.000	2.000	0.000
7	2.060	2.062	-0.002
8	2.340	2.337	0.003
9	2.560	2.566	-0.006
10	2.590	2.591	-0.001
11	2.730	2.728	0.002
12	2.590	2.569	-0.006
13	2.670	2.671	-0.001
14	2.650	2.652	-0.002
15	2.200	2.199	0.001
16	2.350	2.347	0.003
17	2.210	2.212	-.0.002
18	2.290	2.290	0.000
19	2.930	2.928	0.002
20	2.400	2.403	-0.003
21	2.300	2.296	0.004
22	2.600	2.595	0.005
23	2.340	2.340	0.000
24	2.190	2.187	0.003
25	2.110	2.114	-0.004
26	2.210	2.209	0.001
27	2.950	2.950	0.000
28	2.430	2.431	-0.001
29	2.890	2.890	0.000
30	2.380	2.375	0.005
31	2.330	2.327	0.003
32	2.510	2.511	-0.001
33	2.430	2.433	-0.003
34	2.650	2.646	0.004
35	2.180	2.181	-0.001
36	2.560	2.559	0.001

APPENDIX B
HISTOGRAM OF RESIDUALS OF LPI



APPENDIX C
DISTRIBUTION PLOTS OF RESIDUALS