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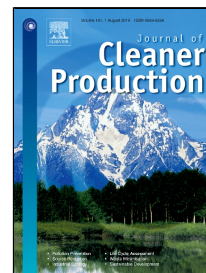
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Determinants of Green Logistics in BRICS Countries: An Integrated Supply Chain Model for Green Business

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Determinants of Green Logistics in BRICS Countries: An Integrated Supply Chain Model for Green Business

Abstract

The objective of the study is to identify the main determinants of integrated supply chain management for green business growth, controlling socio-economic and environmental factors for BRICS countries, using a time series data from 1995-2015. The results show the positive relationship between green logistics indices and country's per capita income, which confirmed that supply chain management is integrated with country's economic growth and corporate environmental policies that is imperative for sustained payoffs. On the other side, logistics indices linked with high mass carbon emissions, social factors, and trade openness, which need sustainable cleaner instruments for achieving broad-based growth. The results of panel causality confirmed the two-way linkages between country's per capita income and logistic indices, and socio-economic factors and logistics indices, while there is one –way causal relationship running from carbon-fossil emissions to logistics indices across countries. The study confirmed the 'neutrality hypotheses' in between FDI, trade, and logistics indices during a given time period. The overall results emphasized the need of an integrated supply chain model to support environmental sustainability agenda and provoked for 'go-for-green' business.

Keywords: Logistics performance index; Per capita income; Trade openness; CO₂ emissions; Fossil emissions; BRICS countries.

1. Introduction

The relationship between logistics performance indicators and growth factors has been widely discussed area in Supply Chain Management (SCM) literature; however, still there have a room to critically discussed and empirically evaluate logistics performance indicators with the socio-economic & environmental factors to assess the supply chain management practices across the globe. Lai et al. (2004) conducted the cross-sectional survey for three transport logistics industries, including sea and air transport, third party logistics and freight forwarding, and found that all these three sectors are economically mature and have a sustained impact on SCM performance in transport sectors. Rao and Holt (2005) evaluated 'green supply chain management (GSCM)' in relation with the socio-economic and environmental factors in a sample of South East Asian countries and concluded that green management helpful to integrate different phases of SCM that ultimately leads to increase economic competitiveness. Jha and Iyer (2006) critically evaluated the different potential factors that affecting quality indicators of construction projects including project participant's conflicts, unpredictable climatic changes, aggressive social factors, hostile economic environment, insufficient project knowledge, project conceptualization errors, and competitive era. Petrini and Pozzebon (2009) suggested that sound business intelligence support systems helpful to monitor sustainable practices in organizational competitiveness. Ruamsook et al. (2009) identified three main supply sources in a comparative study of low cost countries and developed countries, and found that lack of communication infrastructure, imperfect business practices and unsatisfactory production supplier are the major issues of supply sourcing. Sarkis et al. (2010, P.337) argued that, "*The social and ethical dimensions of sustainability, particularly as they apply to reverse logistics, are emerging topics*".

Nikolaou et al. (2013) introduced an integrated model for ‘corporate social responsibility’ based on the socio-economic and environmental factors under the premises of reverse logistics and concluded that for overall sustainability and resolving financial matters, reverse logistics have a considerable role to strengthen the green management practices in an organizational settings. Bensassi et al. (2015) investigated the relationship between trade, transport infrastructure and logistics in a panel of 45 countries and 19 Spanish regions, by using the time span from 2003–2007 and found that logistics performance indicators have a considerable impact on international trade, while the quality of logistics significantly influence the export flows at the regional level. Yang and Zhao (2016) by using the transaction cost theory on 264 firms and concluded that operational performance and integration both considerably improves outsourcing performance in terms of business and financial performance. Zaman and Shamsuddin (2017) discussed GSCM practices under different logistics activities to derive the national scale economic indicators that largely influenced to country’s economic growth, energy demand, and environmental degradation in a panel of 27 European countries by using the data from 2007-2014. The results show that international shipments and tracking assignments both increases fossil emissions that deteriorates the European climate. The results show that industrialization and trade liberalization policies both increase carbon-fossil emissions that partially confirmed the existence of dirty polluting industries across countries. The results conclude that logistics activities should be linked with the country’s national sustainability agenda, which is prerequisite for healthy and prosperous global environment. Nassani et al. (2017) evaluated Environmental Kuznets Curve (EKC) for different air pollutants under macroeconomic factors including, financial development, energy demand, transportation services, and economic growth in a panel of BRICS countries. The results confirmed the inverted U-shaped relationship between financial

development and nitrous oxide emissions, and U-shaped relationship between economic growth and GHG emissions. The results further evident the positive association between transportation services and fossil emissions that deteriorate the country's sustainable agenda. The results conclude that the policies should be determined in order to reduce the environmental damages by green transportation and go-for-green financial development across countries. Khan et al. (2017a) considered the panel of 15 heterogeneous countries to determine the relationship between logistics indicators, environmental factors, and sectoral value added and found that logistics activities substantially improves the country's economic growth via resource depletion. The policy to conserve natural resources and environmental factors is imperative to promote sustainability agenda across the globe.

1.1. Research Questions

The above discussions confined the need to address the following set of research questions, i.e.,

- Green Logistics and Environmental Factors:

Does logistics performance indicator have ecological footprints with supply chain management practices?

The research question discussed widely in different economic settings with different variety of organizations in previous literatures (see, Van Hoek 1999, Acquaye et al. 2014, 2017, Kim and Min 2011, Mariano et al. 2017, etc), which confirmed the viability of green logistics performance indicators to achieve sustainability targets.

- Green Logistics and Growth Factors:

Does logistics performance indicator supported by country's economic growth in GSCM practices?

This research question emphasized the need to go-for-green business by growth –specific measures, which is imperative for achieving environmental sustainability agenda across countries (see, Puertas et al. 2014, Marti et al. 2014a, Bolumole et al. 2015, etc).

- Green Logistics and Social Factors:

Does logistics performance indicator influenced to social factors with GSCM practices?

The wide variety of aspects has been deal with this research question, as community based violence is one of the volatile aspect that substantially influenced logistics activities to not reach consignments on time (see, Lutz and Gady 2004, Kovács 2017, Zaher-Rutherford et al. (2018) etc).

1.2. Research Contribution(s) and Objectives of the Study

The study has a wider research contribution in the existing available research work, which shows the strong appearance in green supply chain management (GSCM) literature, i.e., the previous studies limited to primary research by using different manufacturing firm’s data and evaluated the perceived value of line managers and different stakeholders about GSCM practices, reverse logistics, sustainable supply chain, etc., and linked up with policy inferences (see, Zhu and Sarkis 2004, Zhu et al. 2008, Green et al. 2012, Mitra and Datta 2014, Zhu et al. 2017, Kaur et al. 2018, etc), while some other studies only limited to confined by few socio-economic and environmental factors with GSCM practices, including, green purchasing and eco-designing (see, Khan et al. 2017b, Khan and Qianli, 2017), FDI, industrialization, energy demand (see, Zaman and Shamsuddin 2017), carbon-fossil-GHG emissions (see, Khan et al. 2017a). The previous literature is filled by numerous logistics indices, including, institutional and operational performance indices (Lai and Wong, 2012), supply chain functions (Green Jr. et al. 2008), reverse logistics (Sbihi and Eglese, 2010), competitiveness (Rao and Holt, 2005), green

innovations (Lin and Ho, 2008), regulatory control and green practices (Lin and Ho, 2011), green product designing (Wang, 2018), non-green energy sources (Khan et al. 2018), environmental cost of doing business (Zaman, 2018), environmental sustainability (Wang et al. 2017), green logistics (Arslan and Sar, 2017), etc.

This study is distinct from the previous studies in many aspects, i.e., first, the study used six logistics performance indices, which we mentioned with LP-1 for consignments tracking performance indicator, LPI-2 for quality service logistics control, LPI-3 for shipments competitive price, LPI-4 for check the customs clearance process, LPI-5 for checking the consignments schedule within the stipulated time period, and LPI-6 for analyzing the trade and transport activities. These indices fairly estimated by 5- Likert scale ranging from '1' is 'low' to '5' is for 'high' logistics performance. The index data is available on World Development Indicators for countrywide assessment for drawing policy inferences. Secondly, the study used carbon-fossil emissions as environmental factors to assess the country's green logistics activities in integrated supply chain management systems, and finally, the study used some growth – specific measures, including crime rate, per capita income, inbound FDI, and trade openness for covered the social aspects of green logistics activities across BRICS countries. The empirical contribution is further increase the scope of the study, i.e., the study used panel cointegration techniques, including stationary check, cointegration process, short- and long-run coefficient estimates, and causal relationships between the socio-economic, environmental and green logistics indices for modeling the integrated GSCM practices across countries. As per our knowledge, the study is first in its nature to amalgamate the sustainability factors, including, social sustainability, economic sustainability and environmental sustainability with GSCM practices via green logistics indices in a panel of selected countries. Further the study support

the causal framework between the variables for robust policy inferences in a panel of BRICS countries.

2. Data Source and Methodology

The study considered six indices for logistics performance including LPI-1 indicates Logistics performance index i.e., consignments tracking, LPI-2 indicates logistics quality services, LPI-3 indicates competitive priced shipments, LPI-4 indicates customs clearance process, LPI-5 indicates consignments schedule to reach within expected time, LPI-6 indicates transport and trade infrastructure, with the index value ranging from 1=low to 5=high. These indices served as endogenous variables for the study, while the study used six socio-economic and environmental factors including, crime rates (per 100,000 people), GDP per capita (constant 2005 US\$), inbound FDI (% of GDP), Trade (% of GDP), CO₂ emissions (metric tons per capita), and Fossil emissions (% of total), which served as explanatory variables for the study. The unbalanced panel data of the studied variables have been available on World Bank (2015) data base. The study used forward and backward interpolation technique in majority of the variables' series to fill the gaps for certain time periods. Crime rates are used for measuring the human's cost modeling (i.e., social factor), while per capita GDP, FDI inflows, and trade factor is used as a proxy for macroeconomic economic factors. Environmental factors traced out by carbon-fossil emissions, while LPI-1 to LPI-6 used as a key factors for measuring the SCM performance in a BRICS nations. Logistics performance is one of the key components to measure SCM performance in different organizational settings (Stank et al. 2001, Lai et al. 2002, Gunasekaran and Kobu 2007, Green et al. 2008, Prajogo and Olhager 2012, Ülgen and Forslund 2015 etc.).

Equations (1) to (6) shows green logistics determinants in a panel of BRICS countries i.e.,

$$\ln(LPI1)_{i,t} = \alpha_0 + \alpha_1 \ln(CRIME)_{i,t} + \alpha_2 \ln(GDPPC)_{i,t} + \alpha_3 \ln(FDIINF)_{i,t} + \alpha_4 \ln(TOP)_{i,t} + \alpha_5 \ln(CO_2)_{i,t} + \alpha_6 \ln(FFUEL)_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$\ln(LPI2)_{i,t} = \alpha_0 + \alpha_1 \ln(CRIME)_{i,t} + \alpha_2 \ln(GDPPC)_{i,t} + \alpha_3 \ln(FDIINF)_{i,t} + \alpha_4 \ln(TOP)_{i,t} + \alpha_5 \ln(CO_2)_{i,t} + \alpha_6 \ln(FFUEL)_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$\ln(LPI3)_{i,t} = \alpha_0 + \alpha_1 \ln(CRIME)_{i,t} + \alpha_2 \ln(GDPPC)_{i,t} + \alpha_3 \ln(FDIINF)_{i,t} + \alpha_4 \ln(TOP)_{i,t} + \alpha_5 \ln(CO_2)_{i,t} + \alpha_6 \ln(FFUEL)_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$\ln(LPI4)_{i,t} = \alpha_0 + \alpha_1 \ln(CRIME)_{i,t} + \alpha_2 \ln(GDPPC)_{i,t} + \alpha_3 \ln(FDIINF)_{i,t} + \alpha_4 \ln(TOP)_{i,t} + \alpha_5 \ln(CO_2)_{i,t} + \alpha_6 \ln(FFUEL)_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$\ln(LPI5)_{i,t} = \alpha_0 + \alpha_1 \ln(CRIME)_{i,t} + \alpha_2 \ln(GDPPC)_{i,t} + \alpha_3 \ln(FDIINF)_{i,t} + \alpha_4 \ln(TOP)_{i,t} + \alpha_5 \ln(CO_2)_{i,t} + \alpha_6 \ln(FFUEL)_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$\ln(LPI6)_{i,t} = \alpha_0 + \alpha_1 \ln(CRIME)_{i,t} + \alpha_2 \ln(GDPPC)_{i,t} + \alpha_3 \ln(FDIINF)_{i,t} + \alpha_4 \ln(TOP)_{i,t} + \alpha_5 \ln(CO_2)_{i,t} + \alpha_6 \ln(FFUEL)_{i,t} + \varepsilon_{i,t} \quad (6)$$

Where, LPI1 indicates Logistics performance index i.e., consignments tracking, LPI2 indicates logistics quality services, LPI3 indicates competitive priced shipments, LPI4 indicates customs clearance process, LPI5 indicates consignments schedule to reach within expected time, LPI6 indicates transport and trade infrastructure, CO₂ indicates carbon emissions, FDIINF indicates FDI inflows, FFUEL indicates fossil emissions, GDPPC indicates GDP per capita, CRIME indicates crime rate proxy by intentional homicides rate, TOP indicates trade openness, ‘i’ shows BRICS countries, ‘t’ indicates time period, i.e., 2007-2015, and ‘ ε ’ indicates error term.

The study used panel econometric tests to evaluate the long-run and causal relationship between logistics performance indices and socio-economic & sustainable development factors in

a panel of BRICS countries. Before we going to parameter estimates for the above six equations, the study first assessed the stationary process of the studied variables. For this purpose, the study used four different panel unit root test including LLC (2002), IPS (2003), ADF and PP Fisher Chi-square tests. After panel unit root test, the study moves to assess the long-run cointegration between the variables via employed Pedroni (1997, 1999) cointegration in a multivariate framework. Pedroni developed four '*within-dimension*' and three '*between-dimension*' panel statistics for evaluating the null hypothesis of no cointegration in a panel of BRICS countries.

After establishing the long-run cointegration relationship between the logistics performance indices and socio-economic & sustainable development factors, the study used non-parametric panel FMOLS and parametric approach of DOLS estimators for robust parameter estimates. Pedroni (2000, 2001) developed a single-equation approach to measure cointegration vector for panel data set including FMOLS and DOLS, where FMOLS corrected the problem of serial correlations in the regression errors and removing possible endogeneity from the regression estimates, while DOLS estimator used leads and lags in the regression apparatus and using parametric approach to handle serial correlation and possible endogeneity from the given models. Finally, the study employed Dumitrescu and Hurlin (2012) panel Granger non-causality test in heterogeneous panels. The following four panel Granger non-causality possibilities exist in the given model i.e.,

- i) There is one-way causality running from logistics performance indices to socio-economic and environmental factors,
- ii) There is a reverted one-way causality running from socio-economic and environmental factors to logistics performance indices,

- iii) There is feedback causality between logistics performance indices and socio-economic and environmental factors, and
- iv) There is no cause-effect relationship between logistic performance indices and socio-economic and environmental factors in a panel of BRICS countries.

The null hypothesis of no causality is rejected on the basis of significant probability values of W-Statistics and Zbar-Statistics.

3. Results

Table 1 shows the summary of panel unit root test and found CO₂ emissions and inbound FDI are first order integrated variables i.e., I(1) at LLC, IPS, and ADF test while, PP-test shows zero order integrated series. i.e., I(0). Crime rate, LPI-2 and trade confirmed the I(1) variables, while LPI-3, LPI-4, and LPI-5 confirmed the I(0) series except PP-test that shows the inverted results. Except ADF test, fossil emissions and LPI-6 shows I(1) series. GDP per capita shows I(0) series at LLC while I(1) series at PP-test.

Table 1: Panel Unit Root – Summary

Variables	LLC		IPS		ADF		PP	
	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
CO ₂	-1.022	-2.690*	-1.024	-1.733**	14.928	19.532**	16.871***	42.737*
FDIINF	-0.196	-3.060*	-0.430	-2.475*	13.132	22.657**	25.174*	56.629*
FFUEL	1.495	-2.294*	1.822	-1.496***	2.008	16.295	3.551	50.802*
GDPPC	-1.397***	0.036	0.296	0.747	6.438	8.428	4.558	17.963***
CRIME	-0.716	-1.600***	1.039	-1.654**	5.107	19.402**	4.468	45.480*
LPI1	-0.113	-3.180*	-2.903*	-6.079*	29.495*	42.438*	5.322	55.360*
LPI2	1.690	-3.905*	2.275	-4.208*	6.857	36.044*	4.314	69.650*
LPI3	-4.612*	-11.684*	-4.798*	-9.196*	36.546*	44.227*	6.653	74.838*
LPI4	-3.154*	-7.825*	-2.459*	-8.043*	25.428*	59.487*	5.290	75.425*
LPI5	-3.737*	-7.686*	-2.175**	-5.784*	20.352**	47.413*	9.771	72.856*
LPI6	-0.173	-4.789*	-0.098	-5.273*	18.520**	41.262*	3.682	72.017*
TOP	-0.813	-2.770*	-0.323	-2.116**	13.350	20.350**	7.043	48.657*

Note: CO₂ indicates carbon emissions, FDIINF indicates FDI inflows, FFUEL indicates fossil emissions, GDPPC indicates GDP per capita, CRIME indicates crime rates, LPI-1 indicates Logistics performance index i.e., consignments tracking, LPI-2 indicates logistics quality services, LPI-3 indicates competitive priced shipments, LPI-4 indicates customs clearance process, LPI-5 indicates consignments schedule to reach within expected time, LPI-6 indicates transport and trade infrastructure, and TOP indicates trade openness. *, **, and *** indicates 1%, 5%, and 10% level of significance. Trend Assumption: Individual Intercept and Individual Trend.

The overall results confirmed that although, there is a mixture of order of integration among the variables' series, however, it is indicated that these variables are differenced stationary in at least of the prescribed unit root tests, hence we conclude that the variables possess I(1) series.

Table 2 described the estimates of panel cointegration by Pedroni's non-parametric approach and found that in majority of the cases, Panel and Group ADF and PP statistics are significant at least 10% level, thus it conclude with the rejection of no cointegration in all 6 models.

Table 2: Results of Panel Cointegration Test

Panel Statistics	LPI - 1	LPI - 2	LPI - 3	LPI - 4	LPI - 5	LPI - 6
Panel v-Statistic	-1.020	-0.686	0.103	-1.010	-0.571	-0.995
Panel rho-Statistic	3.372	2.485	2.336	2.730	2.666	2.631
Panel PP-Statistic	-3.504*	-3.617*	-2.735*	-4.284*	-3.423*	-4.498*
Panel ADF-Statistic	-3.609*	-1.399***	-0.517	-1.396***	-0.889	-1.717**
Group rho-Statistic	3.354	2.397	2.630	2.591	2.840	2.473
Group PP-Statistic	-18.497*	-7.905*	-4.679*	-7.165*	-8.980*	-8.946*
Group ADF-Statistic	-2.887*	-0.941	0.128	0.130	-0.832	-0.835

Note: LPI-1 indicates Logistics performance index i.e., consignments tracking, LPI-2 indicates logistics quality services, LPI-3 indicates competitive priced shipments, LPI-4 indicates customs clearance process, LPI-5 indicates consignments schedule to reach within expected time, and LPI-6 indicates transport and trade infrastructure. *, **, and *** indicates 1%, 5%, and 10% level of significance.

Table 3 presented FMOLS and DOLS estimators to obtain robust parameter estimates. The results show that fossil emissions have a significant and negative impact on LPI-1, while per capita income support to increase LPI-1 in a panel of BRICS countries. The results imply that along with increase per capita income, there is substantial increase in the LPI-1, however, on the other side, environmental factor i.e., fossil emissions have a greater share in order to decrease LPI-1 as compared to the per capita income i.e., -0.648 percentage points. These results obtained from panel FMOLS estimator, while the results of DOLS estimator only confirmed that per capita income has a positive impact on LPI-1 variable, while the results related with environmental factors are disappeared. The negative impact of fossil emissions on logistic indicators confirmed that environmental factors substantially decreases the quality of consignments tracking and have an ecological footprints, while the positive impact of per capita

income on logistic indicators confined that country's economic growth is imperative to support logistics activities, which strengthen the supply chain mechanism in a panel of BRICS countries.

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Table 3: Results of Panel FMOLS and Panel DMOLS Estimator

Variables	Panel FMOLS Estimator						Panel DOLS Estimator					
	ln(LPI1)	ln(LPI2)	ln(LPI3)	ln(LPI4)	ln(LPI5)	ln(LPI6)	ln(LPI1)	ln(LPI2)	ln(LPI3)	ln(LPI4)	ln(LPI5)	ln(LPI6)
ln(CO ₂)	0.027	0.086***	0.124**	-0.010	0.186**	0.125***	0.033	0.060	0.177*	0.044	0.271*	0.174**
ln(FDIINF)	0.003	0.005	0.001	-0.001	0.007	-0.0008	0.003	0.001	-0.007	-0.010	-0.002	-0.009
ln(FFUEL)	-0.648***	-0.578*	-0.356**	-0.070	-0.651*	-0.473*	-0.419	-0.538*	-0.375**	-0.085	-0.666*	-0.435***
ln(GDPPC)	0.177**	0.001	0.061	0.081*	0.026	0.061	0.155***	0.025	0.035	0.053***	-0.007	0.048
ln(CRIME)	0.079	-0.026	0.098*	-0.006	0.057	-0.018	0.080	-0.025	0.130*	0.002	0.090**	0.003
ln(TOP)	-0.018	-0.002	-0.014	-0.044*	0.028	-0.049**	-0.050	-0.015	-0.002	-0.027	0.020	-0.056
Statistical Tests												
R-squared	0.886	0.964	0.946	0.984	0.813	0.949	0.895	0.982	0.975	0.991	0.919	0.972
Adjusted R-squared	0.874	0.959	0.940	0.983	0.792	0.944	0.884	0.980	0.973	0.991	0.911	0.970
S.E of regression	0.060	0.025	0.031	0.022	0.0450	0.035	0.058	0.017	0.021	0.016	0.029	0.025
Long-run variance	0.005	0.0006	0.001	0.0006	0.001	0.001	0.006	0.0004	0.0005	0.0003	0.0009	0.0008

Note: CO₂ indicates carbon emissions, FDIINF indicates FDI inflows, FFUEL indicates fossil emissions, GDPPC indicates GDP per capita, CRIME indicates crime rates, LPI-1 indicates Logistics performance index i.e., consignments tracking, LPI-2 indicates logistics quality services, LPI-3 indicates competitive priced shipments, LPI-4 indicates customs clearance process, LPI-5 indicates consignments schedule to reach within expected time, LPI-6 indicates transport and trade infrastructure, and TOP indicates trade openness. *, **, and *** indicates 1%, 5%, and 10% level of significance.

In a second regression apparatus, LPI-2 served as endogenous variable and the results show that environmental factor i.e., CO₂ emissions increases along with the increase LPI-2 factor, while on other side, fossil emissions decreases along with increase LPI-2 factor in case of panel FMOLS, however, the results of panel DOLS confirmed that ‘logistics quality services’ significantly improve the environmental quality, while it has no such deteriorating impact on carbon emissions in a BRICS nation. The negative impact of fossil emissions publicize the ecological footprint of logistics quality services, while the positive impact of carbon emissions infer the need to adopt sustainability instruments to improve logistics quality services with carbon-tax policies. The results support the notion of “Green Logistics management’ publicized by Lai et al. (2012), Dekker et al. (2012), Ahi and Searcy (2013), Fahimnia et al. (2015), Laari et al. (2016) etc.

In a third regression apparatus where LPI-3 served as an endogenous variable and found that crime rates and CO₂ emission both influenced by ‘competitive priced shipments’, as 1% increase in CO₂ emissions and crime rates, LPI-3 factor increases by 0.124% (and 0.177% in case of DOLS) and 0.098% (and 0.130% in case of DOLS) respectively. Fossil emissions however, decrease the LPI-3 factor in a panel of BRICS countries. The positive impact of CO₂ emissions and human cost modeling confirmed the higher prices of logistic shipment, while the negative impact of fossil emissions is linked with logistics ecological footprints in a panel of BRICS countries. Miao et al. (2012) identified different antecedents of logistics social responsibility including business norms, family culture, customers’ pressure, competitions, and business regulations and confined that these factors essential to entail logistics social responsibility for SCM practices. Ho et al. (2012) concluded that human and financial resources

significantly impact on ‘reverse logistics’, while tangible resources have a weaker influence on the companies implementation of ‘reverse logistics’.

The results further show that per capita income is significantly associated with the LPI-4 factor, while trade liberalization policies does not supported the ‘customs clearance process’, as 1% increase in GDP per capita and trade openness, LPI-4 factors increases by 0.081% (0.053% in case of DOLS) and decreases by -0.044% (and -0.027, $p > 0.05$ in case of DOLS) respectively, in a panel of BRICS countries. The positive impact of per capita income confirmed the viability of custom clearance process while the negative impact of trade confined the need to correct the custom clearance process in order to reduce taxation charges on imported goods. Ng et al. (2013) emphasized the role of strong institutional framework to strengthen the bureaucratic roles and dissipating their logistical roles in regional development. Hausman et al. (2013) argued that logistics performance in terms of cost, time, and flow of goods have a considerable impact on increased trade that ultimately impact on organizational performance.

The results of LPI-5 factor show that socio-environmental indicators have a strong linkage with the ‘scheduled or expected time for reaching consignments’, as crime rates (in case of DOLS estimator only) and carbon emissions both have a positive association with the LPI-5 factor, while fossil emissions have a negative correlation with the LPI-5 factor in a panel of BRICS countries. The results argued that socio-environmental factors have a devastating impact on logistics performance that need to be correct by spending on social infrastructure across countries (Gopal and Thakkar 2012, Vlachos 2014, Amiri-Khorheh et al. 2015 etc).

Finally, the results for LPI-6 factor indicate that carbon emissions significantly increases ‘transport and trade infrastructure’, while fossil emissions and trade liberalization policies (only in case of DOLS estimator) both decrease LPI-6 factor across countries. The positive impact of

carbon emissions is subject to the higher transport and trade activities, which support the carbon footprint in a panel of countries, while the negative impact of trade and fossil emissions on quality of overall transport is account of unsustainable transportation and production across countries. Saslavsky and Shepherd (2014) suggested that policymakers should have to develop a strong international network for trade logistics across the developed and developing countries in order to enhance trade related activities between the countries. According to Tongzon (2012, p.5), *“Trade liberalization is increasingly accompanied by efforts to liberalize logistics services as nations have realized the importance of logistics services in achieving economic progress and integration”*. Marti et al. (2014b) argued that goods’ transportation is one of the viable form of logistic indicators that may influenced if there has a complex transport route for flow of goods across the countries.

The overall results come to the conclusion i.e., per capita income dignified to increase logistics performance indices, while trade liberalization policies should be devise in a way to strengthen the logistics indicators. The policymakers should have to confine sustainable policies related with the green logistics management, as environmental factors associated with the logistics indicators during the studied time period. Table 4 further analyzed the panel causality in a panel of BRICS countries.

Table 4: Panel Causality Test

Models	CO₂	FFUEL	GDPPC	FDIINF	TOP	CRIME
LPI-1	←	←	←	≠	≠	←
LPI-2	←	←	↔	≠	≠	→
LPI-3	≠	≠	←	≠	≠	↔
LPI-4	≠	≠	←	≠	≠	←
LPI-5	≠	←	←	≠	≠	≠
LPI-6	≠	≠	←	≠	≠	≠

Note: CO₂ indicates carbon emissions, FDIINF indicates FDI inflows, FFUEL indicates fossil emissions, GDPPC indicates GDP per capita, CRIME indicates crime rates, LPI-1 indicates Logistics performance index i.e., consignments tracking, LPI-2 indicates logistics quality services, LPI-3 indicates competitive priced shipments, LPI-4 indicates customs clearance process, LPI-5 indicates consignments schedule to reach within expected time, LPI-6 indicates transport and trade infrastructure, and TOP indicates trade openness. ← shows unidirectional causality running from sustainability factors to LPIs, → shows unidirectional causality running from LPIs to sustainability factors, ↔ shows bidirectional causality, and ≠ shows no causality between them. Null hypothesis are rejected on the basis of significance probability values of W-Statistics and Zbar-Statistics respectively.

The results confirm the unidirectional causality running from carbon-fossil emissions, per capita income, and crime rates to LPI-1 factor, while there is no cause-effect relationship been determine between LPI-1, trade and FDI inflows during the studied time period. Environmental factors including carbon-fossil emissions have a unidirectional causality relationship with the LPI-2 factor, while per capita GDP has a feedback relationship with them. LPI-2 factor homogenously cause social factor while FDI inflows and trade liberalization fail to determine any causality relationship with LPI-2 factor. GDP per capita homogenously cause LPI-3 factor, while there is bidirectional causality between social factor and LPI-3 variable. Per capita income and crime rates both have a unidirectional causality relationship with LPI-4. Fossil emissions and per capita income both homogenously cause LPI-5 but not vice versa. Finally, there is a unidirectional causality running from per capita income to LPI-6 factor but not other way

around. The causality analysis confirms the different cause-effect relationship between socio-economic & environmental factors and logistics performance indices. The causality analysis would be helpful to devise strong SCM practices by logistic indicators in a panel of BRICS countries.

4. Discussions

The results confirmed the significance of stated research questions and prescribed research objectives in a panel of BRICS countries. The results confirmed the importance of green logistics in achieving environmental sustainability agenda by improving socio-economic and environmental factors, which is imperative for go-for-green business in BRICS countries. The carbon-fossil emissions substantially influenced quality services, competitive price shipments, increase the risk of time lag to reach consignments in the stipulated time, and transport and trade infrastructure. While the similar results are obtained in causality framework where carbon-fossil emissions Granger cause some logistics indices across countries. The results are in line with the previous studies, i.e., Shaw et al. (2010) discussed green performance measures in SCM practices in organizational setup and proposed an integrated environmental modeling to support all the 3 pillars of sustainability, including, socio, economic and environmental sustainability with diversified GSCM practices. Halldórsson and Kovács (2010) confirmed that environmental sustainability is achieved by energy efficiency and logistics infrastructure that is imperative for green growth. Fahimnia et al. (2018) emphasized the need of carbon pricing scheme to improve overall potential of reduction in carbon emissions that minor increases in overall cost of logistics activities, which is helpful to integrated economic agenda with environmental objectives to activate sustainable mode of transportation across countries. Mariano et al. (2017) evaluated transport logistics behavior towards carbon emissions and confirmed its volatility to achieve sustainable

agenda that need to be controlled by economic policies to reduced GHG emissions across the globe.

The impact of GDP per capita on logistics performance indices including consignment tracking and customs clearance process is positive that support further in causality framework by a mean of growth led logistics activities in a panel of BRICS countries. The results are in line with the previous studies, i.e., Liu et al. (2007) confirmed the positive relationship between logistics performance indicators and economic development, which infer that logistics volume increment in the country's economic growth under the jurisdiction of peaceful and healthy environment under the rule of change in a country. Lean et al. (2014) found the causal linkages between logistics transport infrastructure and economic growth and confined the two –way linkages between them, while railways transportation is a one-way linkages with the road's and waterway transportation in a country. Kuzu and Önder (2014) confirmed the positive relationship between logistics sector development and country's economic growth and confirmed the causal relationship that is running from economic growth to logistics development but not the other way around. The results confirmed the need to sustained country's per capita income in order to develop logistics infrastructure, which is imperative for long-term growth.

The study empirically analyzed the human cost modeling by using crime rate, which is considered as a proxy for community based violence in BRICS countries and found that domestic violence Granger cause competitive price shipments and consignments related risks, which is the forefront challenges for logistics industry that need substantial reforms to prevent the economic damages. Zaher-Rutherford et al. (2018) discussed the violent incident in the logistics sector that need psychological and physical therapy that is imperative for handling complex and delicate situations.

The results show that logistics quality service indicator have a two-way linkages with the country's economic growth, which confirmed the findings of Beyzatlar et al. (2014), as they showed that economic growth and transportation infrastructure causally found a bidirectional relationship between them, thus it is imperative to device a strong policy for transport infrastructure that supports country's economic growth while growth strategies further escalate country's transport infrastructure that reap economic benefits for sustained and broad-based growth. Thus, this study has menagulf inferences in available literature, which moves forward for sound policy inferences across countries.

5. Conclusions

The objective of the study is to examine the dynamic linkages between socio-economic & environmental factors and logistics performance indices in a panel of BRICS countries, for the period of 1995-2015. The study employed panel unit root tests, panel cointegration test, panel FMOLS, panel DOLS, and panel causality test for evaluating the dynamic impact of socio-economic and environmental factors on six logistics performance indices. The unit root tests confirm the order of cointegration i.e., differenced stationary, which followed by the long-run cointegration relationship exists between the variables. The panel cointegrated estimators show that carbon emissions, per capita income and crime rates significantly associated with the different logistics performance indices, while fossil emissions and trade liberalization policies does not supportive with the logistics performance indices in a panel of countries. The causality analysis confirmed the bidirectional relationship between per capita income and 'quality of logistics services' and between social factor and 'competitive priced shipments'. The rest of the causality results reveal that there is a unidirectional causality running from socio-economic and

environmental factors (except FDI inflows and trade openness) to logistics performance indices but not vice versa.

The real contribution of the study is to include all six possible logistics indices in a single study as a response variable, followed by, including all the three pillars of sustainability indicators, i.e., social sustainability, economic sustainability, and environmental sustainability as regressors in this study, under the premises of GSCM practices. This study covered time series secondary data in country's perspectives, while previous studies largely worked on primary source of data in different manufacturing setups. The study used carbon-fossil emissions as environmental factors, while social sustainability covered by human cost modeling where crime rate is taken as a proxy for community based violence that largely affect logistics performance indices. The economic factors comprises GDP per capita, trade openness, and FDI inflows that work as a catalyst to control the dynamic mechanism of green growth in a panel of BRICS countries. Thus, we believe that, this is the first study by in its nature that includes all the possible factors of green logistics under environmental sustainability framework to support green growth.

The scientific value addition of this study is to identify the socio-economic and environmental factors of green logistics that is imperative for long-term sustainable growth across BRICS countries. The logistics ecological footprint is quite visible in the form of high mass carbon emissions and fossil fuel emissions, which is one of the major causes of climate change. The empirical modeling is further enforced the robust inferences, which is imperative for policy inferences. The compilation of logistics data from World Bank and extracted the meaningful inferences is one of the biggest task that were successfully done in this study by applying sophisticated econometric modeling. The future arena would be worked on larger pool

of developed and developing countries and compared the results for more robust inferences for the viability of green logistics all across the globe.

6. Policy Implications

The overall results come to the following policy conclusions that mainly based upon short-term, medium-term and long-term policies i.e.,

- **Short-term policy:** Social factor have a confirmatory role in order to influenced logistics performance indices, while it has some joint association with the logistics index (in case of causality analysis) that indicates the importance of supply chain process by human (social) factors involvement in the logistics development. The policies should be device to consider social factors along with economic factors to intensify the supply chain process for long-term support to the quality infrastructure in a panel of BRICS countries.

- **Medium-term policy:** Trade liberalization policies should be formulated in a way to reap the maximum economic gains from trade across the borders. Logistics development among the developed and developing countries may play a vital role to strengthen the supply chain process in order to flourish their businesses in the domestic as well as international market. FDI inflows should be traced out and attract it by the quality of logistics services and trade & transport quality infrastructures. Economic policies should be device in a way to attract FDI inflows, liberalize trade policies and improved logistics services for deployment of quality gains.

- **Long-term policy:** The SCM practices should be based upon 'green management practices' that would attract the environmental players to standardize the products according to international standard operating procedures, which would ultimately helpful to attract the global market by importing quality products.

The sound and effective logistics management is the desirable policy tool that would strengthen the supply chain management practices for green business by quality of trade and transport infrastructure across countries.

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Highlights

- To identify the main determinants of GSCM in a panel of BRICS countries.
- Carbon emissions influenced to logistics quality, trade and transport infrastructure.
- Per capita income increases logistics consignments tracking and customs clearance process.
- Bidirectional casual relationship is found between logistics quality services and per capita income.
- Logistics footprint is found with carbon-fossil emissions.