The Interaction Between Foreign Trade and the Logistics Performance Index in BRICS Countries

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Abstract: BRICS is an international organization that brings together several countries with significant emerging national economies. Initially referred to as "BRIC," this formation was established in 2001 based on the belief that these nations would have a notable impact in terms of economic potential and growth. South Africa joined as a member in 2010, becoming the fifth country to form BRICS. Until recently, the group consisted of Brazil, Russia, India, China, and South Africa. However, as of January 1, 2024, the membership increased to 10 with the inclusion of new member states: Saudi Arabia, the United Arab Emirates, Iran, Egypt, and Ethiopia. These countries have come together, recognizing their shared economic, political, and strategic interests. The primary objectives of BRICS include influencing the global economic order, fostering development cooperation, and addressing issues such as global security. The member countries advocate for a fair restructuring of the governance of international financial institutions like the IMF and the World Bank, aiming for greater representation and influence of developing nations. BRICS member countries convene annually through a summit to discuss economic, political, and security matters. Additionally, they collaborate on issues such as economic cooperation, trade, and investment opportunities. Over time, BRICS has gained increasing influence, exerting more weight in the global economy. This study examines the relationship between BRICS' macroeconomic indicators, as shaped by its latest composition, and the logistics performance index. With the inclusion of new member states, BRICS has become even more powerful, significantly impacting the global economy, thereby underscoring the importance of this research. Furthermore, no prior study has been conducted on BRICS in its final composition as of 2024, enhancing the relevance of this work in contributing to the existing literature. The analysis reveals that the independent variables have a positive and supportive impact on the logistics performance index. It is observed that BRICS is progressing in line with its intended objectives.

1. Introduction

The BRICS group, composed of emerging economies that shape global trade, has transformed into a broader economic cooperation platform encompassing 10 countries as of January 1, 2024. In its expanded form, BRICS aims to increase its influence on the global economy by enhancing its contribution to the global GDP. Notably, the inclusion of energy-rich countries like Saudi Arabia and the UAE is expected to strengthen BRICS' influence in energy markets and its strategic significance. Another goal of the union is to bolster economic and political cooperation among developing nations. It seeks to promote and develop a more multipolar world order, as an alternative to the current global order led by the West. The expansion of BRICS paves the way for a significant shift in the political and economic

structure of the world. This enlargement is also expected to contribute to developing countries gaining greater influence on the global stage, both in international trade and the logistics sector. This study aims to examine the relationship between the logistics performance index (LPI) and international trade within BRICS, a group composed of member countries at varying levels of development. A Tobit analysis was conducted using the logistics performance index scores and certain macroeconomic indicators (GDPPC, FDI, EXP, IF, MF) for the period between 2007 and 2022. The values for economic freedom, one of the variables forming the model, were obtained from the Heritage Foundation website, while the values for the other variables were sourced from the World Data website. According to the analysis results, it was observed that GDPPC and economic freedom within BRICS have a significant and positive effect on the LPI. However, FDI and EXP were found to be statistically insignificant.

2. Conceptual Framework

There are numerous studies conducted on BRICS countries across various fields, utilizing datasets from different periods and countries as well as various econometric methods. Among these studies, some have explored the relationships between logistics, international trade, and economic freedoms. A selection of these studies is provided below.

The relationship between economic growth and human capital has been examined in Turkey and BRICS countries. A panel data analysis was conducted to assess the level of long-term economic growth during the period from 1995 to 2011. The findings indicate that there is a long-term relationship between human capital and economic growth in both Turkey and the BRICS countries. In this context, it has been revealed that human capital is a significant factor in promoting economic growth in this group of countries (Manga et al., 2015).

In Aşcı's (2019) study, Turkey and the BRICS countries are compared based on key economic and social indicators. The relationships between Turkey and its two largest trading partners, Russia and China, are examined in terms of advantages and disadvantages. Due to the effects of globalization, countries are forming alliances in commercial and financial sectors to become more active in the world economy. These alliances may sometimes be based on geographical partnerships and at other times may not rely on geographical proximity. BRICS has emerged as a bloc that is not based on regional partnership.

Birol and Demirgil conducted a study to understand the relationship between economic growth and economic freedoms in the BRICS countries. Using panel cointegration tests for the period from 1995 to 2018, a long-term relationship analysis of the variables was performed. The results of the study revealed the existence of a cointegration relationship between economic growth and economic freedoms. They noted that, based on the coefficient estimation from the cointegration relationship, the effect of economic freedoms on economic growth is negative but insignificant (Birol and Demirgil, 2020).

The relationship between financial advancement and economic growth in the BRICS countries and Turkey has been investigated over a twenty-nine-year period from 1988 to 2017. The study employed panel data analysis. The analysis revealed that supply-side assumptions are valid in the short term, while feedback assumptions hold in the long term. The feedback assumption was found to be significant in the Chinese economy among the member countries. Conversely, the demand-side assumption was deemed significant in the Brazilian economy (Ergür and Özek, 2020).

The effects of the informal economy and corruption, public expenditures, trade openness, foreign direct investment, inflation, and tax revenues on economic growth in the BRICS countries are examined for the period from 1991 to 2017. The dataset for the research was constructed using

data from the World Bank, Transparency International, and the Heritage Foundation. The findings indicate that public expenditures could enhance the economic growth of BRICS countries by 75.69%, while trade openness could contribute an increase of 67.11%. Additionally, controlling the informal economy and corruption is highlighted as having a positive impact on the economic growth of BRICS countries (Nguyen and Duong, 2021).

Ateş and Çaha (2023) examined the relationship between energy consumption and economic growth in BRICS-T countries. In this context, the effects of energy consumption on per capita gross domestic product (GDP) were investigated. The study analyzed data from BRICS-T countries for the period from 1990 to 2020. It was observed that there is a cointegration between per capita primary energy consumption and per capita GDP. The findings indicated that, while no long-term cointegration was found for Turkey and China, the cointegration results were significant for the other countries in the study.

Upon reviewing the literature on the subject, it is noteworthy that most studies have primarily focused on economic growth and development in BRICS countries. However, this study examines the relationship between the logistics performance index and international trade in BRICS member countries. Additionally, as the studies found in the literature do not include the new member countries, a direct comparison or discussion with the existing literature would not be meaningful. This is because the present study addresses the current composition of BRICS, incorporating its new member states. With this distinctive approach, it makes a significant and valuable contribution to the literature.

3. Logistics Performance Index and Economic Freedoms of BRICS Countries

The BRICS countries were originally composed of the five founding member countries: Brazil, Russia, India, China, and South Africa. As of January 1, 2024, Saudi Arabia, the United Arab Emirates (UAE), Iran, Egypt, and Ethiopia officially joined the group as full members. Thus, with the addition of these new member countries, the total number of BRICS member countries has increased to ten.

Logistics encompasses the management process of both forward and reverse flows of materials and information between production and consumption. Due to the accelerating trend of liberalization in global trade and transportation, the logistics sector has emerged as a strategic industry. Led by the World Bank, professionals from the business world and academic experts have developed the Logistics Performance Index, which evaluates and ranks countries based on their logistics performance (Yapraklı and Ünalan, 2017).

The World Bank has published the Logistics Performance Index reports, initially in 2007 and subsequently in 2010, 2012, 2014, 2016, 2018, and 2022, to assess the status of countries in terms of global logistics. In conducting this assessment, it is based on six sub-criteria.

According to the Logistics Performance Index, there are six components that determine the ranking of countries. These are:

- Efficiency of customs and border procedures,

- Quality of trade and transportation infrastructure,

- Ease of arranging competitive-priced shipments,

- Quality and sufficiency of logistics,

- Ability to track and trace shipments,

- Frequency of shipments reaching consignees on time (World Bank, 2024).

The overall scores of the BRICS countries in the Logistics Performance Index, evaluated based on the sub-criteria in all published reports, are presented in Table 1.

Table 1. Logistics Performance Index Scores of BRICS Countries

Logistics Performance Index Scores of BRICS Countries (2007-2022)							
Countries	**2007**	**2010**	**2012**	**2014**	**2016**	**2018**	**2022**
Brazil	2,75	3,20	3,13	2,94	3,09	2,99	3,2
Russia	2,37	2,61	2,58	2,69	2,57	2,76	2,6
India	3,07	3,12	3,08	3,08	3,42	3,18	3,4
China	3,32	3,49	3,52	3,53	3,66	3,61	3,7
South Africa	3,53	3,46	3,67	3,43	3,78	3,38	3,7
Saudi Arabia	3,02	3,22	3,18	3,15	3,16	3,01	3,4
UAE	**3,73**	**3,63**	**3,78**	**3,54**	**3,94**	**3,96**	**4,0**
Iran	2,51	2,57	2,49	**2,35**	2,60	2,85	2,3
Egypt	2,37	2,61	2,98	2,97	3,18	2,82	3,1
Ethiopia	**2,33**	**2,41**	**2,24**	2,59	**2,38**	**2,25**	**2,1**

Upon examining Table 1, it can be observed that the Logistics Performance Index scores of the BRICS countries are widely dispersed. According to the Logistics Performance Index scores, the United Arab Emirates (UAE) is the most advanced country in terms of logistics among the BRICS member countries. This situation can be attributed to the fact that the UAE, with its developed economy, has sufficient resources for investments in all logistics performance criteria. It can be said that the logistics infrastructure is well-developed and that necessary logistics investments are made at adequate levels.

Looking at the historical logistics performance scores, it is evident that the UAE's score of 3.73 in 2007 has increased with each subsequent report. According to OPEC data, the UAE is the sixth-largest country in the world in terms of oil reserves. Oil and petroleum products account for 29% of its exports. Consequently, the country, which continues to increase its logistics investments each year, has seen a corresponding rise in its Logistics Performance Index scores. In the most recently published report, it achieved its highest logistics performance score of 4.0. Following the UAE, South Africa and China also have high logistics performance scores that are very close to each other. Both of these countries are strong, developed economies in their respective continents.

Among the BRICS member countries, the lowest score in 2024 was recorded by Ethiopia, a new member of the group. The country, which has a weak economy, has received the lowest score in almost all reports due to its inadequate logistics infrastructure. Ethiopia achieved its highest logistics performance score of 2.38 in 2016. Its lowest score of 2.1 was recorded in the most recently published report in 2022. Overall, Ethiopia exhibits a fluctuating low logistics performance score. As a newly joined member, Ethiopia is expected to better reflect its strength in the logistics sector over time with the support it will receive from the union. The logistics scores of the BRICS member countries presented in the table vary significantly, as each country has a different level of development. Furthermore, there are differences in the priority given to logistics investments among these countries. The Economic Freedom Index is an annual index and ranking established in 1995 by The Heritage Foundation and The Wall Street Journal to measure the degree of economic freedom in countries around the world. It assists researchers in tracking the progress of economic freedom, welfare, and opportunities in various countries and helps disseminate these ideas in their homes, schools, and communities. With the assistance of the Economic Freedom Index, one can easily analyze a country's levels of economic freedom or categorize them into similar groups (Erilli, 2018). Economic freedoms are evaluated on a scale from 1 to 100.

Table 2. Economic Freedom Data of BRICS Countries

Countries	Freedom	2007	2010	2012	2014	2016	2018	2022
Brazil	MF	73	76	76	70	64	71	78
Brazil	IF	50	45	50	55	55	50	60
Russia	MF	63	63	66	69	63	61	68
Russia	IF	30	25	25	25	25	30	30
India	MF	77	68	63	66	73	74	70
India	IF	40	35	35	35	35	40	40
China	MF	77	68	63	66	73	76	70
China	IF	40	35	35	35	35	40	40
South Africa	MF	77	68	75	73	63	71	75
South Africa	IF	40	40	55	50	45	45	45
Saudi Arabia	MF	80	63	65	68	69	74	79
Saudi Arabia	IF	30	45	40	45	45	45	45
UAE	MF	80	62	65	69	69	74	79
UAE	IF	30	45	40	40	40	40	45
Iran	MF	62	55	62	47	51	60	42
Iran	IF	10	0	0	0	0	0	5
Egypt	MF	67	64	62	61	66	70	71
Egypt	IF	50	50	65	45	55	60	65
Ethiopia	MF	72	60	67	59	66	67	58
Ethiopia	IF	50	25	25	20	20	35	30

Table 2 presents the values of economic freedoms—specifically investment freedom and monetary freedom—of BRICS countries for the years in which the Logistics Performance Index was published. Analyzing the freedom data, it is observed that countries with higher levels of development tend to exhibit high monetary freedom values. However, there are countries with very low or nonexistent investment freedom values, influenced by their geographical context and the regimes in place. Iran serves as an example of this situation among the BRICS countries. In contrast, Brazil and Egypt can be cited as examples of countries with the greatest investment freedom. Regarding monetary freedom, Brazil, China, Saudi Arabia, and the UAE stand out as the most liberated countries within the BRICS framework.

4. Materials and Methods

This study investigates the relationship between the Logistics Performance Index and the international trade of BRICS countries. The BRICS countries included in the analysis, which constitute the universe of the study, are presented in Table 3.

Table 3. BRICS Countries Included in the Analysis

Former Member Countries	Brazil, Russia, India, China, South Africa
New Member Countries	Saudi Arabia, UAE, Iran, Egypt, Ethiopia

The time frame for the countries under study covers the period from 2007 to 2022. A dataset has been prepared comprising the Logistics Performance Index, Gross Domestic Product per Capita, Gross Capital Formation, Export values, as well as values for Investment Freedom and Monetary Freedom for the period of 2007-2022.

The data for the Logistics Performance Index, Gross Domestic Product per Capita, Gross Capital Formation, and Export values were obtained from the World Bank data source. The freedom values were sourced from the Heritage Foundation database.

The Logistics Performance Index (LPI) was published seven times between its initial release in 2007 and the last report year in 2022. Since the independent variable, LPI is considered in seven series, the data for the corresponding independent variables were reduced to seven series by calculating their moving averages. After all variables were reduced to seven series, the analysis was conducted. This way, the impact of short-term fluctuations in the independent variables included in the model on the LPI was measured. Descriptive statistics were first performed on the variables in the created dataset, and then the relationships between the variables were tested using Tobit analysis. The Tobit Model is an econometric analysis developed by the Nobel Prize awarded economist James Tobin. Tobit models refer to censored or truncated regression models where the range of the dependent variable is somehow restricted (Amemiya, 1985). In determining the analysis for this study, the choice of Tobit analysis was influenced by the fact that the dependent variable of the model created for the analysis is the Logistics Performance Index, which takes on a small value between 1 and 5.

Equation 1: The model created for Tobit analysis is provided below.

$$LPI = \beta_0 + \beta_1\, GDPPC + \beta_2\, GCF + \beta_3\, EXP + \beta_4\, IF + \beta_5\, MF + \varepsilon$$

In the model created for the analysis, the dependent variable is the LPI, while the independent variables are GDPPC, GCF, EXP, IF, and MF. To better understand the model, descriptive information about the variables used is presented in Table 4.

Table 4. Abbreviations and Meanings of Variables Included in the Model

LPI	Logistics Performance Index
GDPPC	Gross Domestic Product per Capita
GCF	Gross Capital Formation
EXP	Export
IF	Investment Freedom
MF	Monetary Freedom

Table 4 presents the abbreviations created for the dependent and independent variables included in the model on which the Tobit analysis will be applied, along with the meanings of these abbreviations. The considerations taken into account in determining the variables that form the model of the analysis can be summarized as follows: Some of the countries in question are classified as developed, while others fall into the category of developing countries. In this context; Per capita gross domestic product is expected to align with logistics performance. Understanding how this expectation holds within the heterogeneous group of BRICS countries is crucial for this study. Gross capital formation is significant because investments should be made considering logistics performance, as both variables are expected to complement each other. Exports, on the other hand, should be positive on a country-specific basis and should support the logistics performance index. Economic freedoms are also important in terms of encouraging investment and production. Therefore, the effects of these macroeconomic variables on the logistics performance index are examined.

5. Results and Discussion

Descriptive statistics are used to determine the fundamental characteristics of data obtained on any subject. It is a statistical method used to understand around which type of value the data is concentrated or how the distribution of the data is structured.

Table 5. Descriptive Statistics

	LPI	GDPPC (US$)	GCF (US$)	EXP	IF	MF
Mean	3.061594	10596.68	6.09E+11	4.09E+11	36.85714	67.60000
Median	3.093992	6852.671	1.67E+11	2.43E+11	40.00000	68.00000
Maximum	45054.14	5.85E+12	2.57E+12	65.00000	80.00000	81.00000
Minimum	2.100000	250.9868	8.59E+09	4.29E+09	0.000000	42.00000
Std. Dev.	0.491776	11890.76	1.28E+12	6.09E+11	15.39743	7.417957
Skewness	-0.049439	1.788030	2.990350	2.570114	-0.830109	-0.784382
Kurtosis	2.005355	5.354853	10.73529	8.564040	3.556264	4.317562
Jarque-Bera	2.914031	53.47282	278.8437	167.3598	8.941786	12.24122
Probability	0.232930	0.000000	0.000000	0.000000	0.011437	0.002197
Sum	214.3116	741767.3	4.27E+13	2.86E+13	2580.000	4732.000
Sum Sq. Dev.	16.68723	9.76E+09	1.13E+26	2.56E+25	16358.57	3796.800
Observations	70	70	70	70	70	70

Table 5 presents the descriptive statistics for the variables in the model used in the analysis of the study, namely the LPI, GDPPC, GCF, EXP, IF, and MF. The variables are reported in terms of mean, median, maximum, minimum, standard deviation, skewness, and kurtosis. The standard deviation values for GDPPC, GCF, and EXP are relatively close to each other, while the standard deviation values for LPI, IF, and MF are not closely aligned. This discrepancy arises because the economic freedom variables range between one and one hundred, whereas the LPI ranges between one and five, resulting in smaller values. When examining the skewness values of the variables, we find that their values are close to zero, allowing us to express them as symmetric. If we express the values of several variables, the mean for LPE is 3.06, the highest value is 4.00, the standard deviation is 0.49, and the probability value is 0.23. For another variable, exports, the highest value is 2.57, the standard deviation is 6.09, and the probability value is observed to be 0.00.

Table 6. Results of the Tobit Analysis of the Logistics Performance Index

Dependent Variable: LPE

Method: ML - Censored Normal (TOBIT) (Newton-Raphson / Marquardt steps)

Sample: 2007-2022

Included observations: 70

Variable	Coefficient	Std. Error	z-Statistic	Prob.
GDPPC (US$)	1.97E-05	3.76E-06	5.236040	0.0000
GCF (US$)	1.04E-13	1.65E-13	0.630470	0.5284
EXP	6.81E-14	3.45E-13	0.197709	0.8433
IF	0.008314	0.002981	2.789084	0.0053
MF	0.014961	0.006410	2.333924	0.0196
C	1.444253	0.370185	3.901439	0.0001
Error Distribution				
SCALE:C(7)	0.304966	0.025774	11.83216	0.0000

Mean dependent var	3.061594	**S.D. dependent var**	0.491776
S.E. of regression	0.321462	**Akaike info criterion**	0.662766
Sum squared resid	6.510291	**Schwarz criterion**	0.887616
Log-likelihood	-16.19681	**Hannan-Quinn info criterion**	0.752079
Avg. Log-likelihood	-0.231383		
Left censored obs	0	**Right censored obs**	0
Uncensored obs	70	**Total obs**	70

Table 6 presents the results of the Tobit analysis measuring the effects of gross domestic product per capita, gross capital formation, exports, investment freedom, and monetary freedom on the logistics performance index for BRICS countries.

When examining the effect of the independent variable GDPPC on the LPI, it is observed that it is significant with $p < 0.05$ and has a positive impact due to its positive coefficient. In other words, holding all other variables constant, a one-unit increase in the independent variable GDPPC increases the dependent variable LPI by 1.97. Higher levels of exports and income indirectly contribute to an increase in LPI.

The effect of the independent variable GCF on the dependent variable LPI is insignificant, as $p > 0.05$. This can be explained by the fact that investments are made outside the country within this group of countries.

EXP, although positive in effect, is insignificant as $p > 0.05$. In the countries under analysis, the rate of export growth outpaces the development of the LPI. As a result, in this group of countries, it is concluded that exports have an insignificant but positive effect. Investments in logistics infrastructure tend to slow down in developed countries after a certain stage. For countries focused on continuously increasing exports, this process is viewed positively. When examining the effects of IF and MF on the LPI in the countries in question, it is observed that they are significant with $p < 0.05$ and positively impact the LPI due to their positive coefficients. Moreover, GDPPC has already shown a positive and significant result. Without these positive effects in terms of freedoms, GDPPC would not have exhibited positive impacts. The SCALE value represents the error distribution, and in the Tobit analysis, SCALE: C(7) was obtained with a probability value of 0.0000 and a standard error of 0.025774. The other indicators in the Tobit results table are model selection criteria. In Table 6, the information criteria are as follows: Akaike Information Criterion (AIC) 0.662766, Schwarz Information Criterion (SIC) 0.887616, and Hannan-Quinn Information Criterion (HQIC) 0.752079. In the literature, the criterion with the lowest value among these three is considered the better model. The Tobit analysis automatically determines the lag length, and in this analysis, the Akaike Information Criterion was used. Based on the values, it is observed that the lowest value belongs to the Akaike Information Criterion.

6. Conclusions

The results of the Tobit analysis indicate that GDPPC, investment freedom, and monetary freedom have significant and positive effects on the LPI in BRICS countries. In contrast, GCF and EXP, although showing a positive relationship, are statistically insignificant. These findings suggest that economic growth, supported by investment and monetary freedoms, plays a crucial role in enhancing logistics performance. Additionally, the study highlights that the pace of export growth in these countries surpasses the development of logistics infrastructure, which may explain the insignificant effect of exports. The number of member countries in the BRICS group has increased, consisting of nations with varying levels of development and different demographic characteristics. Consequently, the data related to the variables used in the analysis exhibit significant differences across countries. Due to the substantial disparities in the levels of development among these countries, the priorities for investments in logistics infrastructure vary for each nation. The inflow of foreign investments that contribute to growth is only possible under the right conditions. These conditions include infrastructure, political and economic stability, a secure environment within the country, streamlined processes, and the rights granted to foreign investors, among others. One of the objectives of BRICS is to facilitate the advancement of developing countries, making them more visible in the global economy and enabling them to have a greater voice. Aware that they cannot achieve this alone, weaker countries that join the

alliance receive support for trade and, consequently, logistics infrastructure investments after the accession process. Additionally, they are supported in becoming more free and prosperous countries in terms of economic freedoms. From the perspective of the developed member countries within BRICS, the increase in the BRICS population enhances their power to influence global trade, providing a competitive advantage for advanced economies such as China and Russia. BRICS is a formation characterized by rapidly growing economies, possessing the potential to alter global economic balances.

Based on the findings of this study, the factors influencing the Logistics Performance Index (LPI) in BRICS countries are found to be positive and supportive. In line with BRICS's objective to empower developing nations, it is expected that newly joined member states will address their infrastructural shortcomings and contribute to economic growth. However, given that these countries only recently became members (as of January 1, 2024), a transitional period is necessary to attract and implement the required logistics investments. Activities such as establishing logistics networks, improving existing infrastructure, constructing new customs facilities, and streamlining and accelerating customs procedures require substantial time and financial resources. Therefore, it is recommended that member countries develop long-term strategies to expedite these processes. Furthermore, future studies could conduct comparative analyses of the relationship between international trade and the LPI, particularly focusing on interactions between BRICS member states and Turkey, which would offer valuable contributions to the literature.

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