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Does Trade Facilitation Matter for Human Development in Lower-Middle-Income Countries?

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Abstract: *This study aims to examine the impact of trade facilitation measures on human development in lower-middle-income countries. For this purpose, we employ panel data analysis for the 2007-2019. We estimate the relationship using four models: feasible generalized least squares, incorrect generalized least squares, panel-corrected standard errors, and Driscoll-Kraay. Our findings demonstrate that trade facilitation measures, particularly those related to port infrastructure quality and maritime transport efficiency, significantly contribute to human development in lower-middle-income countries. Based on these results, we recommend that the governments of these countries should prioritize implementing these measures, particularly those that enhance the port and maritime transport sector as a promising strategy to achieve human development.*

Keywords: Human Development; Trade Facilitation; Panel Data Approach; Lower-Middle-Income Countries

JEL Classification: F130, O15

Introduction

Trade remains a cornerstone of human activity and progress. Throughout history, it has supported livelihoods, driven innovation, and improved quality of life (UNDP,

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2011). Additionally, it has significantly affected the quality of the environment (Hamid, I et al., 2020). However, realizing these benefits depends largely on Trade Facilitation (TF)[1]. Several studies (Wilson et al., 2003; Portugal-Perez and Wilson, 2009; Mbekeani, 2010; Portugal-Perez and Wilson, 2012) have explored this crucial aspect of trade.

The surge in trade flows, the rise of global value chains, and advancements in information and communication technology (ICT) all contribute to the growing importance of TF within international trade. This significance is reflected in the establishment of the Trade Facilitation Agreement (TFA), the first and only multilateral trade agreement ratified under the World Trade Organization (WTO). The TFA positions TF as a key element of the second generation of free trade, following decades of focus on trade liberalization.

The TF encompasses a wide range of strategies and procedures that reduce trade costs throughout the supply chain (Moïsé et al., 2011). It goes beyond customs control operations or border procedures, encompassing the efficiency of customs, transport, banking, and insurance services, along with the underlying infrastructure (Duval, 2007).

Numerous empirical studies investigate the direct impact of TF on international trade. However, the indirect impacts of TF on other economic outcomes and its influence on social development remain understudied. Prior research has primarily concentrated on two areas not directly linked to the Human Development Index (HDI).

First, studies examine the impact of TF on trade costs. An OECD report (2015) estimates that full implementation of the TFA would reduce global trade costs by 16.5%, 17.4%, and 14.6% for low-income countries, lower-middle-income countries (LMICs)[2], and upper-middle-income countries, respectively. Partial implementation would result in lower reductions: 12.6%, 13.7%, and 12.8%, respectively.

Second, research explores the impact of TF on trade flows. A study by Beverelli, Neumueller, and Teh (2015) estimates that with TF, sub-Saharan Africa and Latin America and the Caribbean could see export diversification. The number of products exported according to export destination could increase by up to 15.7% and 12.2%, respectively, and the number of export destinations according to product could rise by up to 34.9% and 26.9%, respectively.

This paper examines the impact of TF measures on human development (HD)[3] in LMICs. It particularly focuses on the roles of ports, customs, and maritime transport within the TF framework. We employ a panel data approach to estimate the relationships between these variables and the HDI using four models: feasible generalized least squares (FGLS), incorrect generalized least squares (FGLS-igls), panel-corrected standard errors (PCSEs), and the Driscoll-Kraay method.

We empirically tests the effect of TF measures on HD for a sample of 24 LMICs from 2007 to 2019. The sample includes countries: Algeria, Egypt, Mauritania, Morocco, Tunisia, Senegal, Bangladesh, El Salvador, Sri Lanka, Benin, Ghana, Nicara-

gua, Tanzania, Cambodia, Honduras, Nigeria, Cameroon, India, Pakistan, Ukraine, Côte d'Ivoire, Kenya, the Philippines, and Vietnam.

Empirical research plays a crucial role in guiding policymakers. It helps them direct their efforts towards specific sectors and distinguish between various initiatives, prioritizing implementation based on their effectiveness. Therefore, selecting indicators for TF in empirical research that meet the needs of policymakers is critical.

This study examines four TF variables that measure the effectiveness of efforts in three key sectors: customs, ports, and maritime transport. Customs have evolved into major players in international trade, acting as a crucial pillar of TF by ensuring efficient goods movement. Their role has expanded beyond the traditional focus on tax collection and border control. Today, customs authorities must strike a balance between this control function and the need to avoid hindering the free flow of goods between countries. To assess customs efficiency, this study utilizes the burden of customs procedure index as a representative indicator.

Developed ports play a vital role in economic performance. Historically, maritime trade has stimulated the emergence of monetary economies, urban population growth, and local market development (Wang and Ducruet, 2013). To reflect this sector, the quality of port infrastructure index is chosen as a key measure.

Maritime transport relies heavily on container port traffic, which has become the backbone of the global economy. Increased efficiency in this sector directly translates to higher trade levels. A recent UNCTAD study (2020) found that developing economies continue to dominate global maritime trade, both in terms of exports and imports. In 2019, they handled a significant share of global trade, loading 58% and unloading 65% of the total volume. Developing economies in Asia and Oceania have been the most significant contributors to this share (UNCTAD, 2020). To represent this sector, two indicators are chosen: the liner shipping connectivity index and container port traffic.

The importance of our study appears, firstly: it discusses the issue of TF, which is a relatively recent topic of contemporary trade and is considered one of the second-generation issues in trade policies after the issue of trade liberalization. Secondly, it examines the relationship between TF and HD, which has rarely been examined in previous studies.

This paper contributes to the field by highlighting the potential economic gains associated with TF measures, particularly for LMICs. These gains are often overlooked by policymakers, despite the significant need for such measures in these developing economies.

The remainder of this paper is structured as follows: In the second section, this study describes theoretical and empirical studies. Data sources and methodology are explained in the third section. In the fourth section, empirical findings and discussion are presented. Finally, the study ends with the conclusion, policy recommendations, limitations, and scope for further research.

Literature review

Davies and Quinlivan (2006) examined the extent to which trade affects people's well-being as measured by the HDI. Their study used annual data for 154 countries from 1975 to 2002. The results generally showed a positive relationship between policies that lead to increased trade volume and improvements in HD. Since governments play a crucial role in advancing HD through investments in healthcare, education, and infrastructure, implementing effective TF measures can act as a powerful force for progress, uplifting a nation's overall well-being (Jagadish Shettigar et al., 2023). If we consider civil liberties and political rights as dimensions of HD, the study by Ishfaq and Pabitra (2021) found no statistically significant causal relationship between these two dimensions and trade openness in India. Shepherd and Pasadilla (2011) found that the liberalization of trade in services could directly enhance HD and have indirect effects through the income channel. Hamid and Amin (2013) concluded that trade in the Organization of Islamic Cooperation is linked to HD primarily through income channels and not through other HDI components like longevity, literacy, and educational attainment. Sakyi et al. (2018) examined the contribution of TF to improving social welfare in a sample of 40 African countries for 2010–2015. They found that a 1 percent improvement in infrastructure quality increases net primary school enrollment by 6.4 percent, life expectancy at birth by 0.7 percent, and reduces the under-five mortality rate by 2.8 percent. Hamid et al. (2023) found that institutional quality in the South Asian Association for Regional Cooperation countries not only shapes the trajectory of FDI inflows but also lays the foundation for broader economic development. Effective institutional reforms, which could include TF measures, should thus be a priority for policymakers. The Ishaq (2023) study recommended that India take continuous steps to ensure an enabling business environment through TF and other measures to improve its attractiveness as an investment destination and global manufacturing hub.

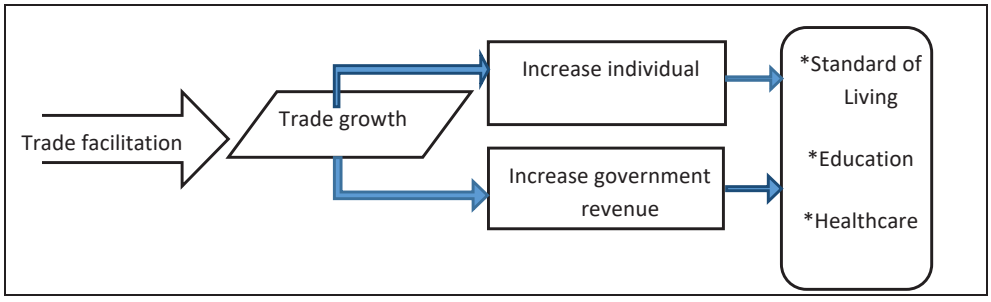
Our review of the existing literature reveals that previous studies have generally focused on trade policies, rather than specifically on TF measures (Davies and Quinlivan, 2006; Hamid and Amin, 2013; Pasadilla, 2011). Saki et al. (2018) is one of the few exceptions that directly addresses TF, highlighting a significant gap in the current body of research on this topic. Existing studies also exhibit wide variation in their geographical and temporal scopes, encompassing both global analyses and regional focuses, such as studies on African countries and the Organization of Islamic Cooperation (OIC) using panel data. In contrast to this prior research, this study adopts an income-based approach, focusing on LMICs. Our aim is to explore the nature of the relationship between TF and HD specifically within this income group.

Theoretical framework

Economic theory suggests potential linkages between international trade facilitated by TF measures and HD. By reducing trade costs, these measures can stimulate production, economic growth, and ultimately, income levels. However, the relationship between economic growth and HD is not always straightforward. While income is a necessary component of HD, it is not sufficient on its own. The impact of income on HD depends on how it is distributed and spent within a society. Resources can be directed towards investments in education and healthcare, fostering HD, or conversely, allocated towards unproductive or harmful expenditures (UNDP, 2013). Income may function as a potential transmission channel, whereby low income levels likely constrain significant improvements in HD. The HD Reports published by the UNDP since 1990 consistently demonstrate a positive association between per capita income and HD. This association is partially explained by the inclusion of income as one of the core dimensions within the HDI, a composite measure of HD.

Figure 1 depicts the hypothesized relationships between TF and HD. TF measures are expected to increase the volume of trade flows through cost reduction mechanisms. This expansion in trade is further theorized to impact HD through two primary channels mediated by economic growth: per capita income and government revenue. The first channel suggests that increased trade volume leads to higher per capita income, enabling individuals to satisfy a wider range of needs and desires for goods and services, consequently improving their standard of living. This includes greater capacity for individual spending on health (both personal and familial) and education, particularly for children. The second channel posits that increased trade activity leads to higher government revenue through increased tax and customs collections. These additional resources can then be allocated by governments towards improvements in social services, education, healthcare, environmental protection, and other areas, ultimately raising the overall standard of living of the population.

Figure 1: How does TF affect HD through the growth and income channel?



Source: Authors' design

Data and methodology

Data description

The HDI assesses average achievement in three key areas of HD: a healthier and longer life, knowledge, and a decent quality of life. Life expectancy at birth is used to examine the health aspects. The average years of schooling for adults aged 25 and above, as well as the predicted years of schooling for children of school age, are used to calculate the educational dimension. In addition, the standard of living is measured as the gross national income per capita. The HDI uses the logarithm of income to reflect the decreasing importance of income with the increase of GNI. Scores for the three dimensions of the HDI are combined into a composite index using the geometric mean.

The liner shipping connectivity index (LSCI) denotes a country's position within global liner shipping networks. The number of ship calls, their container carrying capacity, the number of services and companies, the size of the largest ship, and the number of other countries connected through direct liner shipping services are all factors in calculating this figure. The country value for each component is divided by the maximum value for that component in 2004, the average of five components is calculated for each country, and this average is then divided by the maximum average for 2004 and multiplied by 100 (UNCTAD, 2020).

The Quality of the Port Infrastructure Index (QPII) measures business managers' perceptions of their country's port facilities. Its data is taken from the Executive Opinion Survey of the World Economic Forum. Samples receive a double rating based on the company size and sector of activity. Its data is collected online or through in-person, interviews and the responses are collected using a weighted average by sector. The last year's data is combined with the previous year's data to create a two-year moving average. Scores range from 1 (port infrastructure is considered very ineffective) to 7 (port infrastructure is considered effective by international standards). In landlocked countries, respondents are asked about the ease of access to port utilities, and their answers are evaluated within the following range: (1): inaccessible; (7): very accessible (WEF, 2016).

The burden of customs procedures index (BCPI) measures executives' perceptions of the efficiency of customs procedures in their country. Its data is taken, classified, and collected in the same way that is explained in the quality of the QPII. The respondents rated the efficiency of the customs procedures in their own countries as follows: a score of 1 means the procedure is very inefficient, and a score of 7 means it is very efficient (WEF, 2016).

The container port traffic index (CPTI) measures the flow of containers from land to sea modes, and vice versa, in twenty-foot equivalent units (TEUs). When figuring out transit traffic, two elevators are used in the intermediate port—one

to unload the cargo and another to lift it out—and empty units are also counted (UNCTAD, 2020).

The Index of Economic Freedom (IEF) measures economic freedom based on 12 quantitative and qualitative factors, grouped into four broad categories, or "pillars," of economic freedom: Rule of Law (property rights, government integrity, judicial effectiveness); Government Size (government spending, tax burden, fiscal health); Regulatory Efficiency (business freedom, labour freedom, monetary freedom); and Open Markets (trade freedom, investment freedom, financial freedom). These twelve factors are rated on a scale from 0 to 100. The overall score for any country is derived by averaging these factors and giving equal weight to each. Government expenditure on education (GEE) is expressed as a percentage of GDP.

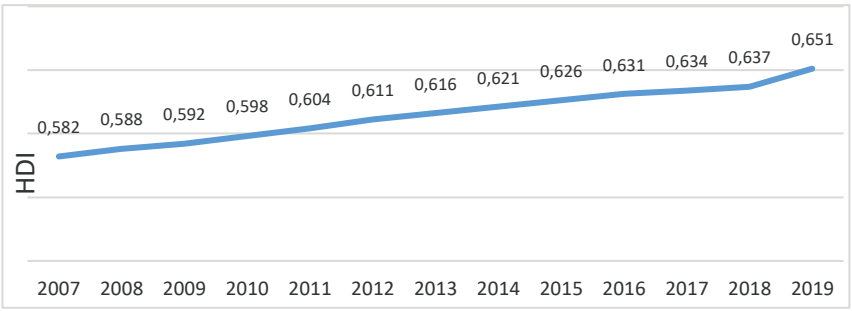
Table 1: Description of variables

Variable	**Unit**	**Source**
Human Development Index (HDI)	Scale (0-1)	UNDP
Liner shipping connectivity index (LSCI)	percent	WDI
Container port traffic index (CPTI)	number	
Quality of port infrastructure Index (QPII)	Scale (1-7)	
Burden of customs procedure Index (BCPI)		
Government expenditure on education (GEE)	percent	
Index of Economic Freedom (IEF)	Scale (0-100)	Heritage Foundation

Source: Authors' preparation

LMICs have poor HD compared to other upper-middle-income or high-income countries. Certainly, the governments of LMICs like other governments have implemented several policies in order to improve their levels of HD. The UNDP has assisted the governments of these countries in formulating policies and action plans to address the structural barriers and gaps that limit access to poor, marginalized, and vulnerable groups. In addition, the UNDP has requested attention to the root causes of poverty, inequality, and exclusion when developing country programs (UNDP, 2020). These efforts seem to have been relatively successful, as the average value of the HDI has increased from 0.582 in 2007 to 0.651 in 2019, an increase of 11.8 percent (see Figure 2).

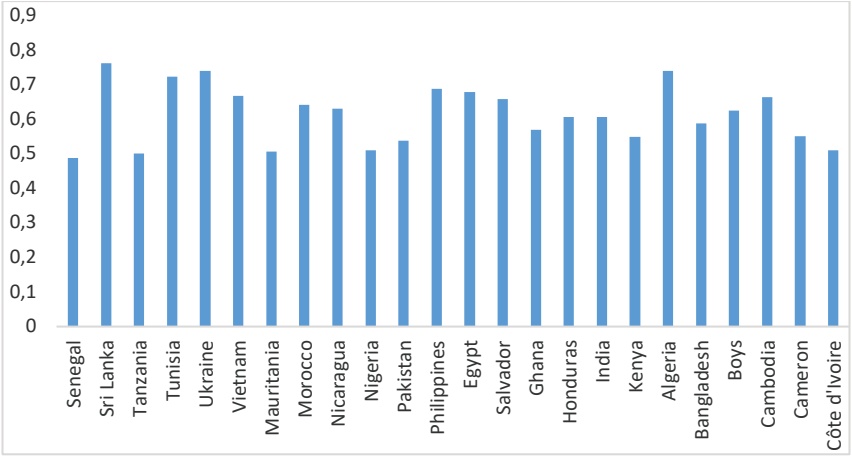
Figure 2: The HDI _ average sample countries



Source: Authors' preparation

Although the average value of the index for the sample during the study period was 0.614, which puts it in the category of medium HD countries, the country-specific analysis shows disproportionate numbers. Its value has ranged between 0.435 (in Côte d'Ivoire in 2007) and 0.78 (in Sri Lanka in 2019). Figure 3 shows the data in the form of columns for the sample countries that enable the authors to make a comparison between them from 2007 to 2019.

Figure 3: The HDI _ average study period

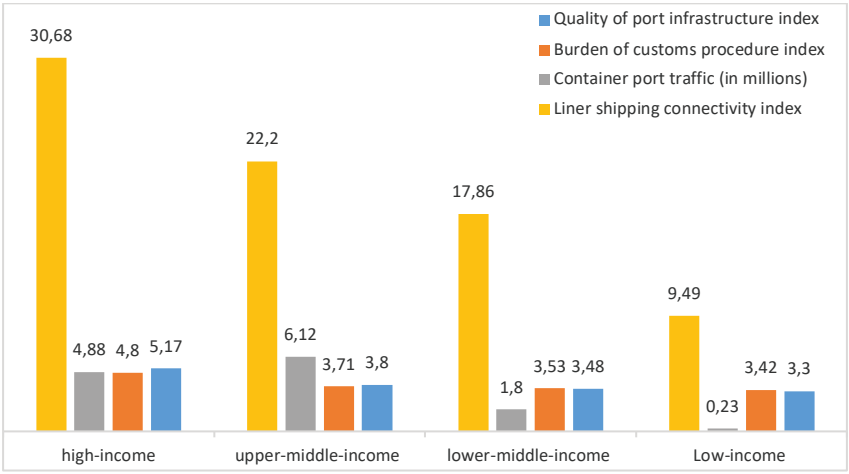


Source: Authors' preparation

Senegal (East Africa) is the only one of the 24 countries on the list to be classified as having low HD. Tunisia, Algeria (North Africa), Ukraine (Eastern Europe), and Sri Lanka (South Asia) were ranked in the high HD category. While the list did not

include any country within the very high HD category, the rest of the countries were among the medium HD countries. The gap between these countries is estimated at 0.273. Although the general picture reveals that these countries are still below the required level, it is more evident in Africa (Tanzania, Mauritania, Nigeria, Ghana, Kenya, Cote d'Ivoire, and Cameroon) and Asia (Pakistan and Bangladesh). However, the index is constantly rising. Its value has risen in Senegal (the worst country in the sample) between 2007 and 2019, from 0.448 to 0.512, an increase of 13.1 percent. In the same period, its value in Sri Lanka (the best country in the sample) has increased from 0.734 to 0.782, an increase of 6.5 percent.

Figure 4: The Trade Facilitation Indicators (TFIs)



Source: Authors' preparation

Figure 4 compares the TFIs for the lower-middle-income group with those for other income groups. It appears that the lower-middle-income group is often lagging behind the high-income group and the upper-middle-income group but ahead of the low-income group. In terms of the LSCI, the sample countries lag behind the high-income countries by approximately 72 percent, indicating that the sample countries still have a long way to go to achieve what the high-income countries have achieved. The QPII reduces the impact of distance between regions. It integrates the national market and links it at a low cost to markets in other countries and regions. Its lag is estimated to be 5.48 percent behind the high-income countries. As for the BCPI, the sample countries are ahead of the low-income group by only 3 percent, and they lag behind the upper-middle-income countries and the high-income countries by 5 percent and 36 percent, respectively. This shows that the sample countries, although they do not lag far behind the upper-middle-income countries, are still rel-

atively far from the high-income countries. There is a small exception for container port traffic: the upper-middle-income countries top the rankings; this is due to the presence of China in this group. It is well known that the Chinese economy is the second largest in the world and is highly dependent on maritime trade. The LMICs lag behind the upper middle-income countries by 240 percent. They also lag behind the high-income countries by 170 percent, a delay that indicates a large gap in this regard.

Two key factors motivated the focus on LMICs for this study. First, LMICs may prioritize other development objectives, potentially neglecting the implementation of TF measures. However, research suggests that such measures can generate significant economic benefits for developing countries. An OECD (2015) report underscores this point, highlighting the potential for full implementation of the TFA to reduce global trade costs by 16.5%, 17.4%, and 14.6% for low-income countries, LMICs, and upper-middle-income countries, respectively. Partial implementation would still yield reductions of 12.6%, 13.7%, and 12.8%, respectively. Second, data availability limited the sample size to 24 LMICs with complete datasets.

Methodology

To estimate the model, the study used the panel data approach. They are binary data with a cross-section of 24 LMICs as the first dimension. The second dimension is the time series (2007–2019). Since both the number of cross-sections and the length of the time series are short, the study will rely on the choice of differentiation between the three main forms of the panel data models: the pooled regression model, the fixed-effects model, and the random-effects model (Baltagi, 2013).

The regression model will be estimated according to the following equation:

$$HDI = \int (LSCI, QPII, BCPI, CPTI, GEE, IEF)$$

where:

HDI: Human Development Index, which is the dependent variable.
As for the variables that represent TF, they are:
LSCI: Liner Shipping Connectivity Index;
QPII: Quality of Port Infrastructure Index;
BCPI: Burden of Customs Procedure Index;
CPTI: Container Port Traffic Index.
As for the control variables, they are:
GEE: Government expenditure on education;
IEF: Index of Economic Freedom.

The estimation process goes through three steps:

- ✓ The causality test: The causal relationship between the independent variables and the dependent variable of the model was tested using (Dumitrescu and Hurlin, 2012) test.
- ✓ Determining the most appropriate model: two tests will be used: Restricted F-test to choose between the pooled regression model and the fixed effects model. If Restricted F- test indicates the suitability of the pooled regression model, we will stop at this stage, the pooled regression model is considered to be the most appropriate. Whereas, if it indicates the suitability of the fixed-effects model, the Haussmann test will be performed to prefer between the fixed-effects model and the random-effects model (Haussmann, 1978).
- ✓ Check the model quality: model diagnostic tests have been performed, using a cross-sectional dependence test to check whether residuals are linked across entities (Pesaran, 2004). Then, the Wald test, the Lagrange multipliers test, and the Likelihood Ratio test were used to test the heteroscedasticity in the residuals of the random-effects regression model. Finally, the HR-test is used to test the first-order autocorrelation in fixed-effects panel data models without gaps (Born and Breitung, 2016) and (Wursten, 2018).

In order to handle the various econometric concerns, the research employs four distinct models.

- ✓ Feasible Generalized Least Squares (FGLS): The purpose is to fix the regression coefficients based on the estimated variance-covariance matrix, which takes heteroscedasticity into account. In cases of heteroscedasticity, we prefer the FGLS model over OLS due to its superior efficiency. Another plus is how simple it is to put into action Beck and Katz, 1995). This research makes use of the FGLS method through the FGLS-igls technique, which estimates the variance-covariance matrix iteratively up to convergence.
- ✓ Panel-Corrected Standard Errors (PCSEs): This method aims to account for both heteroscedasticity and cross-sectional dependence by modifying the regression coefficients' standard errors. Panel data analysis frequently employs this approach when heteroscedasticity and cross-sectional dependence are present. PCSEs provide dependable estimates of standard errors, enabling the assessment of hypotheses related to the regression coefficients(Greene, 2018).
- ✓ Driscoll and Kraay Estimation: The goal of this method is to deal with both heteroscedasticity and cross-sectional dependence. It does this by creating a reliable covariance matrix that takes into account the errors' possible serial correlation. This approach is especially beneficial for datasets that have a substantial number of cross-sectional units and a limited time series. Even when the error terms exhibit correlation across both time and cross-sections, it provides dependable estimates of standard errors. When the cross-sectional size is high and the time series is short, this approach is favored (Driscoll and Kraay, 1998).

Results and discussion

Trend Analysis

Table 2 shows the descriptive statistics of the variables.

Table 2: Descriptive statistics

	HDI	LSCI	QPII	CPTI	BCPI	GEE	IEF
Mean	0.61282	22.4357	3.75881	2295963	3.52123	5.0708	56.3916
Median	0.617	16.7842	3.7	839389.8	3.5	4.6541	56.3
Maximum	0.78	66.7210	5.33409	16382600	4.8	8.9430	69.9
Minimum	0.435	3.61553	2.21232	57478	2.2	2.2742	44.2
Std. Dev.	0.08700	15.6838	0.67727	3247029	0.52267	1.6310	4.20115
Skewness	0.00514	1.23122	1.87E-01	2.159853	0.11453	0.4657	0.15876
Kurtosis	1.96101	3.43120	2.34E+0	7.62402	2.72262	2.3509	4.33377
Jarque-Bera	13.9896	80.9838	7.4007	518.8701	1.67690	16.701	24.3589
Probability	0.00091	0	0.02471	0	0.43237	0.0002	0.000005
Sum	190.587	6977.51	1168.99	7.14E+08	1095.10	1577	17537.8
Sum Sq. Dev.	2.34650	76255.0	142.198	3.27E+15	84.689	824.66	5471.398
Observations	311	311	311	311	311	311	311

Source: authors' calculations

In order to comprehend the changes that occurred in our study variables between 2007 and 2019, we examined their temporal trends.

- ✓ Human Development Index (HDI): The Human Development Index (HDI) in our sample of low- and middle-income countries (LMICs) has a consistently favorable pattern, indicating progress in human development. According to Figure 2, the mean HDI value rose from 0.582 in 2007 to 0.651 in 2019, indicating a significant 11.8% rise within this time frame. Nevertheless, as seen in Figure 3, the pattern is not consistent across all countries.
- ✓ Liner Shipping Connectivity Index (LSCI): The LSCI, which illustrates a nation's incorporation into worldwide shipping networks, indicates a favorable trajectory for the LMICs in our study. Nevertheless, Figure 4 clearly demonstrates that low- and middle-income nations (LMICs) have a much lower Level of Service Connection Index (LSCI) compared to high-income nations. This emphasizes a major disparity in connection between the two groups. This indicates that while low- and middle-income countries (LMICs) are making progress in improving their marine transportation industry, significant efforts are still required to reach the level of developed countries with higher incomes.
- ✓ Quality of Port Infrastructure Index (QPII): Though at a slower rate than other income categories, the QPII shows a positive trend for the LMICs (see Figure 4). This implies that LMICs must accelerate investments to keep up

with high-income and upper-middle-income nations, even while their port infrastructure is improving.

- ✓ Burden of Customs Procedure Index (BCPI): For the LMICs, the BCPI has a mixed trend. Customs efficiency has improved in some countries, but it has dropped in others. This implies that there is a need for greater consistency in applying reforms and handling issues with a balance between regulatory control and efficiency.
- ✓ Container Port Traffic Index (CPTI): Reflecting increased containerization and a move toward efficient marine commerce, the CPTI shows a positive trend in the LMICs. However, the LMICs still lag behind the upper-middle-income and high-income nations, highlighting the need for ongoing port infrastructure and supporting technology to enable containerized commerce (see Figure 4).
- ✓ Government Expenditure on Education (GEE): The GEE in our sample of LMICs shows a typical upward trend, reflecting growing awareness of education. This tendency is positive, given that education is the main engine of human progress.
- ✓ Index of Economic Freedom (IEF): In our sample of LMICs, the IEF shows a mixed tendency, pointing to opportunities and difficulties for advancing economic freedom.

Econometric Analysis

Dumitrescu and Hurlin's (2012) test result is displayed in Table 3. At the 1% level of significance, it demonstrates that all of the independent variables cause the dependent variable.

Table 3: Dumitrescu-Hurlin panel Granger causality test

Independent Variables	W-bar	Z-bar	Independent variables	W-bar	Z-bar
GEE	4.0478	5.0160	**BCPI**	3.1635	2.8500
		(p-value = 0.0000)			(p-value = 0.0044)
LSCI	3.1890	7.5830	**CPTI**	4.4539	6.0108
		(p-value = 0.0000)			(p-value = 0.0000)
QPII	3.5835	3.8789	**IEF**	5.6553	8.9535
		(p-value = 0.0001)			(p-value = 0.0000)

Source: authors' calculations

The results of Table 4 indicate that the Null hypothesis was rejected and the Alternative hypothesis was accepted; thus, the fixed-effects model is preferable.

Table 4: Fixed-effects regression results

corr (u_i, Xb) = -0.0634		F(6,282) = 19.76		Prob > F = 0.0000		
HDI	**Coef**	**Std. Err**	**t**	**P>|t|**	**[95% Conf. Interval]**	
GEE	0000845.	.0020531	0.04	0.967	-.0039569	.0041259
LSCI	001009.	.0002911	3.87	0.001	.000436	.0015819
QPII	0010244 .	.0006748	1.52	0.130	-.0003039	.0023527
BCPI	.002486	.0028053	0.89	0.376	-.0030359	.0080079
CPTI	4.99e-09	1.22e-09	4.10	0.000	2.59e-09	7.38e-09
IEF	0008006 .	.0005399	1.48	0.139	-.0002621	.0018634
_Cons	5207199.	.034652	15.03	0.000	.4525105	.5889294
sigma_u	.08286792					
sigma_e	.01868834	(fraction of variance due to u_i)				
rho	.95160237					
F test that all u_i =0: F(23, 282) = 191.65 Prob > F = 0.0000						

Source: authors' calculations

Next, we estimate the random-effects model, and the results are presented in Table 5.

Table 5: Random-effects regression results

Corr (u_i, X) =0 (Assumed)		Wald chi2 (6) = 119.44		Prob> chi2 =0.000		
HDI	**Coef**	**Std. Err**	**Z**	**P>| Z**	**[95% Conf. Interval]**	
GEE	.001045	.002022			-.002918	.0050079
LSCI	.0009799	.0002886	0.52 3.40	0.605 0.001	-.0004143	.0015455
QPII	.0010502	.0006787	1.55 0.86	0.122	-.0002801	.0023804
BCPI	.0024105	.0028168	4.16	0.392 0.000	-.0031103	.0079313
CPTI	5.05e-09	1.21e-09	1.57 13.64	0.117	2.67e-09	7.43e-09
IEF	.0008417	.0005372		0.000	-.0002112	.0018946
_Cons	.5142311	.0377069			.4403269	.5881352
sigma_u	.07598228					
sigma_e	.01868834	(fraction of variance due to u_i)				
rho	.94295621					

Source: authors' calculations

A Haussmann test is now required to preference between the fixed-effects model and the random-effects model.

Table 6: Haussman test

	Coefficients			
	(B) fe	**(B) re**	**(b-B) Difference**	**sqrt(diag(V_b-V_B)) S.E.**
GEE	.0000845	.001045	-.0009604	.0004266
LSCI	.001009	.0009799	.0000291	.0000505
QPII	.0010244	.0010502	-.0000258	.0000261
BCPI	.002486	.0024105	.0000755	.0001944
CPTI	4.99e-09	5.05e-09	-6.10e-11	1.77e-10
IEF	.0008006	.0008417	-.0000411	.0000819
b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg Test: Ho: difference in coefficients not systematic chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 9.76 Prob>chi2 = 0.0823				

Source: authors' calculations

Based on the results of Table 6, we accept the null hypothesis at the 5% level of significance, meaning that the random-effects model is the best.

The cross-sectional dependence test result indicates acceptance of the null hypothesis and rejection of the alternative hypothesis (see Table 7), which means that the model includes the problem of residual cross-sectional dependence.

Table 7: Pesaran's CD test

Pesaran's test of cross sectional independence 33.523= , Pr = 0.0000 Average absolute value of the off-diagonal elements = 0.693

Source: authors' calculations

According to the results of three tests in Table 8, we reject the null hypothesis and accept the alternative hypothesis. We deduce that there is a heteroscedasticity problem.

Table 8: Panel Groupwise Heteroscedasticity Tests

Panel Groupwise Heteroscedasticity Tests		
Ho: Panel Homoscedasticity - Ha: Panel Groupwise Heteroscedasticity		
Lagrange Multiplier LM Test Likelihood	2.70e+04 182.1098	P-Value<Chi2(27) =0.0000
Ratio LR Test	1.002+06	P-Value<Chi2(27) =0.0000
Wald Test		P-Value<Chi2 (28) = 0.0000

Source: authors' calculations

The results in Table 9 show that the null hypothesis is accepted and the alternative hypothesis is rejected. This means that the model does not include a first-order autocorrelation.

Table 9: HR-test for panel serial correlation

Heteroskedasticity-robust Born and Breitung (2016) HR-test as postestimation Panel var: country Time var: year					
Variable	HR-stat	p-value	N	MaxT	balance?
Post Estimation	-1.55	0.120	24	13	balanced
Notes: Under HO, HR ~ N(0,1) HO: No first-order serial correlation. Ha: Some first order serial correlation					

Source: authors' calculations

We note that the model does not include the problem of autocorrelation, according to the results of the HR test. However, it includes the problem of heteroskedasticity according to the results of the three tests (Wald test, LM Test, LR Test). It also includes the problem of residual cross-sectional dependence, as shown by the results of the Pesaran test.

To deal with heteroskedasticity and cross-sectional dependency problems, we use the following econometric approaches: (Driscoll and Kraay, 1998), feasible generalized least squares estimation (FGLS) (Beck and Katz, 1995), and panel-corrected standard error estimation (PCSEs) (Greene, 2018).

Table 10: Controlling for heteroskedasticity and cross- sectional dependence

	FGLS	FGLS_igls	PCSES	Driscoll_Koy
GEE	***0.0231 (0.000409)	**0.000303 (0.000103)		0.00104 (0.00164)
LSCI	***0.00106 (0.0000625)	0.0000142 (0.00000735)	***0.0235 (0.00258) ***0.00113 (0.000332)	**0.000980 (0.000239)
QPII	***0.00358 (0.000684)	-***0.00193 (0.0000453)	0.00359 (0.00372) -*0.0219	**0.00105 (0.000301)
BCPI	-0.0202*** (0.00105)	-***0.000634 (0.000121)	(0.0105) 7.35e-09*** (1.05e-09)	0.00241 (0.00638)
CPTI	7.66 e-09*** e-10)2.81 (	6.01e-10*** (9.31e-11)	0.000786- (0.000556)	5.05e-09** (1.44e-09)
IEF	-0.000920*** (0.000110)	***0.000252 (0.0000378)	*** 0.560 (0.0354)	*0.000842 (0.000359)
Constant	***0.564 (0.00718)	***0.848 (0.00167)	312	***0.514 (0.0738)
Observations	312	312		312

Note: ***, ** and * refer to statistical significance at 1%, 5%, and 10%, respectively.

Source: authors' a calculations

Based on the results in Table 10, the FGLS model (FGLS-igls) is the most effective in fitting the data; it generates statistically significant coefficients with lower standard errors than the other models. This provides additional evidence that the FGLS method successfully addresses the problems of cross-sectional dependence and heteroscedasticity that were present in the study's data.

The shaded column in Table 10 displays the regression results. It shows the impact of each 1 percent increase in each TF measure on HD. It shows all the TF measures that have statistical significance at the 1% level of significance.

The estimated coefficients vary for different trade facilitation indexes (TFIs). Before going into the presentation of these results, we would like to point out that the main entrance to their explanation is the cost. With the reduction of trade costs through these measures; trade expands; growth is stimulated, and individual income and government revenues increase, which will provide each of them with additional resources to improve the standard of living in terms of increased consumption, health care, or education quality (see Figure 1).

The QPII has the highest estimated coefficient (0.0035). This indicates that the greatest gains that will be achieved in the HD of these countries will be from this measure. It is known that the QPII plays a significant role in preparing the quays and reducing congestion. There is no doubt that congestion will increase the length of time goods remain in ports. This will constitute a heavy burden on companies that work in import and export. Because delaying the delivery of goods to their beneficiaries beyond the specified time often leads to a delay in receiving their prices, it is not limited to this point, but it entails additional taxes and royalties and a deterioration in the quality of goods, especially if they are sensitive to delay.

On the other hand, it could be damaged or stolen. These are all huge costs that companies will incur, so profits will be reduced. The companies that have just been damaged—and in an attempt to reduce their losses—will burden a share of these costs on the consumer, which will negatively affect his well-being. This result is consistent with the findings of Clark et al. (2004), which show that increasing port efficiency from 25 percent to 75 percent leads to a 12 percent reduction in shipping costs. Moreover, inefficient ports reduce trade and negatively affect economic growth. The study by Bottasso et al. (2014) revealed that ports increase the GDP of the regions in which they are located. It also affects the GDP of neighbouring regions. Limao and Venable (2001) found that infrastructure quality and transportation costs are important for export-driven economic growth. Gordon et al.'s (2005) study has concluded that investment in port facilities, along with other supportive policies, can help the port achieve sustainable competitiveness.

The LSCI is positively related to HD, but the value of its estimated coefficient (0.0016) is approximately half the value of the port infrastructure quality estimated coefficient. It indicates how well countries are connected to global shipping networks based on the state of their maritime transport sector. It reflects the country's level of integration into global shipping networks. Every country's access to world markets depends largely on its transport connections, particularly with regard to shipping services for the import and export of manufactured goods. Access to shipping networks affects a country's logistical performance. The objective behind improving logistics performance is to reduce trade costs. This is to ensure that products are transferred

from producers to consumers at the required speed and that they reach their destination in the best condition possible without being damaged. This result is consistent with the results of the Wilmsmeier and Hoffmann (2008) study, which found that a one-standard-deviation increase in LSCI means an expected reduction of US$287 in the shipping rate. In addition, an increase of one standard deviation in port infrastructure for an importing country implies an expected reduction of US$225 in the shipping rate. Furthermore, Fugazza and Hoffmann (2017) discovered that LSCI is a critical determinant of exports.

The CPTI has the smallest estimated coefficient (0.0007), which is approximately one-fifth of the value of the port infrastructure quality estimated coefficient. It is well understood that the use of containers in sea shipping had a significant impact on global trade. As a result of that, shipping became fast and inexpensive. It also provides the best protection for goods from damage, loss, and theft. It is very flexible and versatile. It enables local factories to send their production to different continents at competitive prices. Importers will also benefit from these advantages, thus reducing the cost of imports.

These results mean that the efforts of the sample countries should focus on improving the maritime trade environment by improving TF for the ports and maritime transport sectors. The results confirmed that it would have a positive impact on HD. However, this depends on the number of expenditures that governments will make on each measure and the extent of their capabilities.

The BCPI has a negative impact. Although we do not have ready-made evidence based on statistical data, we can say that these countries have not succeeded in achieving the desired balance between reducing customs burdens and ensuring commitment to performing the customs control mission. That is, this reduction could have impaired the performance of this mission, which has encouraged smuggling, customs fraud, and other customs crimes. On the other hand, this measure favours the imports of some countries at the expense of their exports. That is, the imports of these countries rose more quickly than their exports, taking advantage of the easing of these measures, which had a negative impact on their balance of payments (Hoekman B and Shepherd B, 2013).

The COVID-19 Pandemic and its Impact on Trade Facilitation and Human Development

The COVID-19 pandemic has significantly impacted global trade, impacting human progress in both positive and negative ways. At first, the pandemic caused extensive interruptions in international supply chains, port operations, and border inspections, which in turn slowed commerce flows, raised trade costs, and created red tape. Nev-

ertheless, nations have taken steps to lessen the blow to commerce, including digitizing trade procedures, making it easier for commodities to travel across borders, and fostering cooperation and data exchange between international organizations and national governments.

The pandemic brought about many negative effects on human development, including strain on health systems, interruptions to schooling, and worsened poverty and inequality. A few good outcomes include more funding for healthcare research and infrastructure, which in turn leads to better vaccinations and other medical innovations. The growing trend of working remotely and taking classes online has emphasized the need for universal access to and use of digital infrastructure.

It would be instructive to do a comprehensive trend study of critical variables during the time after the epidemic (beginning in 2020). We could investigate the impact of the pandemic on public spending on education and economic freedom by focusing on the Human Development Index (HDI), Total Factor Indexes (TFIs), and control factors.

Finally, the COVID-19 epidemic has shown how important trade facilitation is for our collective progress. Despite the early upheaval, it ultimately encouraged new ideas and brought attention to the necessity for a stronger and more adaptable international commerce system. Since pre-existing vulnerabilities and inadequate healthcare resources disproportionately affect LMICs, understanding their reaction and trade facilitation measures is essential for fostering a more sustainable and equitable future. Once a pandemic has passed, digitalization will play an essential role in easing commerce and fostering human progress.

Conclusion

This study has empirically examined the impact of trade facilitation measures on human development in a sample of 24 lower-middle-income countries. The analysis specifically focused on three key trade facilitation sectors: ports (measured by the Quality of Port Infrastructure Index), customs (measured by the Burden of Customs Procedure Index), and maritime transport (measured by the Liner Shipping Connectivity Index and Container Port Traffic). Employing a panel data approach for the period 2007-2019, we estimated the relationships using four models: feasible generalized least squares (FGLS), incorrect generalized least squares (FGLS-igls), panel-corrected standard errors (PCSEs), and the Driscoll-Kraay method. The findings reveal that trade facilitation measures, particularly those enhancing port infrastructure and maritime transport efficiency, significantly contribute to human development. Notably, improvements in port infrastructure quality demonstrated the largest positive impact.

The study confirms two important recommendations:

- ✓ Governments of low- middle-income countries should prioritize Implementing trade facilitation measures that are driven by improving the port and maritime transport sector as a promising strategy to achieve human development.
- ✓ Optimizing the balance between the flexibility of customs procedures and the strictness of their supervisory role is crucial to maximize the opportunities arising from their implementation and ensure the positive effects outweigh the negative effects.

Contributions and limitations

This research provides new insights and enhances the current literature by examining the relationship between trade facilitation and human development.

- ✓ Concentrate on lower-middle-income nations (LMICs): The majority of current research either examines larger global datasets or explores specific areas, such as Africa or the OIC nations. This study notably concentrates on low- and middle-income countries (LMICs), a category that has distinct development obstacles and where the consequences of trade facilitation measures may be particularly significant. This focused approach benefits this specific income group by providing a more in-depth understanding of the connection between trade facilitation and human development.
- ✓ In-depth Examination of Crucial Trade Facilitation Sectors: This study surpasses a mere assessment of the general influence of trade facilitation and explores the distinct functions of ports, customs, and marine transport. The study provides useful insights into the relative efficiency of various trade facilitation measures within a larger framework by examining the specific impacts of these sectors.
- ✓ The study's findings underscore the substantial influence of port infrastructure quality and marine transport efficiency on human development. This focus on the marine industry complements prior studies that frequently concentrate on customs protocols and trade expenses. The report offers essential policy suggestions for low- and middle-income countries (LMICs) that aim to utilize their marine sectors for development by highlighting the significance of ports and maritime transport.
- ✓ Tackling Econometric Challenges: The study utilizes a rigorous empirical approach, employing numerous econometric models to address possible issues of heteroscedasticity and cross-sectional dependency in the data. This strategy improves the strength and dependability of the results compared to research that may not sufficiently address these econometric concerns.
- ✓ Policy Recommendations for LMICs: The study's results provide explicit and pragmatic policy suggestions for LMICs, emphasizing the need to prioritize

investments in port infrastructure and enhance marine transport efficiency as a fundamental approach to attaining human development. These suggestions are particularly relevant at this time, given the growing importance of global value chains and the impact of marine commerce on global economic expansion.

However, the study identifies limitations that warrant consideration in future research:

- ✓ A limitation of this study is that it does not factor in the implementation costs of trade facilitation measures. This omission could lead to an overestimation of the net benefits. Therefore, future research should comprehensively assess both the gains and costs associated with trade facilitation initiatives.
- ✓ Although we prove the existence of a relationship between trade facilitation and human development, the model used in the study does not accurately specify transmission mechanisms, and therefore relying on explaining this transmission through the income channel only is tinged with caution.

Looking ahead, future research should explore how trade facilitation initiatives directly impact other dimensions of human development, such as health, education, and environmental sustainability, independent of income effects. By addressing these considerations, policymakers can better leverage trade facilitation strategies to enhance overall well-being.

Declarations

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Conflicts of interest/Competing interests

There is no conflict of interest.

Availability of data and material

The data that support the findings of this study are openly available in the website of United Nations Development Programme (https://www.undp.org/), the website of World Development Indicators ,Data Bank (https://databank.worldbank.org/source/world-development-indicators) and the website of Heritage Foundation (https://www.heritage.org/).

Code Availability

The computer program results are shared through the tables in the manuscript.

Authors' Contributions

Khalifa Khaldi

o Conceptualization: Developed the idea for the study and formulated overarching research goals.
o Writing - Original Draft: Authored the initial version of the manuscript.
o Writing - Review & Editing: Edited the initial draft and critically reviewed subsequent versions.
o Literature Review: Contributed to reviewing the relevant literature.

Okba Abdelaoui

o Methodology: Designed economic models and identified relevant economic variables.
o Formal Analysis: Analyzed the results using economic methods.
o Validation: Verified the consistency and applicability of models to the research context.
o Visualization: Assisted in preparing graphical representations of data and results.
o Supervision: Oversaw the research process and provided leadership.

Lotfi Mekhzoumi

o Methodology: Managed the statistical modeling and ensured robust econometric analysis.
o Formal Analysis: Conducted statistical analysis of the data.
o Software: Programmed and implemented econometric tools for analysis.
o Validation: Ensured accuracy and reproducibility of statistical findings.
o Data Curation: Organized, cleaned, and managed the dataset used for the study.
o Project Administration: Coordinated the research and managed execution.

NOTES

[1] For brevity, we will use the abbreviation TF for trade facilitation throughout the paper.

[2] For brevity, we will use the abbreviation LMICs for lower-middle-income countries throughout the paper.

[3] For brevity, we will use the abbreviation HD for human development throughout the paper.

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