African Journal of Business and Economic Research (AJBER)
(Online) ISSN 1750-4562 (Print) ISSN 1750-4554

Indexed by SCOPUS, UGC CARE List, IBSS, EBSCO, ProQuest, ABDC, SAJE, COPERNICUS, ERIH PLUS, CABELL, Sabinet and J-Gate

Vol. 20, (Issue 3), September 2025
pp 9- 36

Analysing the Impact of Trade Facilitation on Intra-exports in the Southern African Development Community (SADC)

DOI: https://doi.org/10.31920/1750-4562/2025/v20n3a1

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Abstract

This study examines the impact of trade facilitation, as measured by the World Bank's logistic performance index (LPI), on intra-Southern Africa Development Community (SADC) exports. It further performs counterfactual simulations to estimate expected intra-SADC export gains resulting from improvements in components of the LPI. Gravity results show that a 1% increase in LPI by the importer is associated with a 1.225% increase in intra-SADC exports on average. With regard to components of LPI, a 1% improvement in customs and border efficiency and timeliness is associated with a respective increase in intra-SADC exports by 1.333% and 2.072% on average, respectively. Counterfactual simulations show that if SADC member states whose LPI and components of LPI, particularly customs and border efficiency and timeliness, are below the SADC average are improved to reach the SADC average, intra-SADC exports would increase by US$7.8 billion, US$1.45 billion and US$1.53 billion, respectively. Furthermore, the biggest beneficiaries of these improvements would be Angola, the Democratic Republic of Congo and Zimbabwe. The

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study recommends that underperforming member states undertake trade facilitation reforms in components of LPI.

***Keywords**: Gravity Model; Logistic Performance Index; SADC; Trade Facilitation*
Acknowledgments

The author(s) would like to thank Mr Adam Willie for his valuable help on simulations.

Conflict of Interest Statement

The author discloses that there are no financial or non-financial interests that are directly or indirectly related to the work submitted for publication.

1. Introduction

Trade facilitation is a means for increasing trade competitiveness and economic growth, deepening regional integration, and an avenue for developing countries to participate in the regional and global value chains. It encompasses measures that simplify, harmonise and standardise customs and administrative procedures to minimise transaction and trading costs. Various literature has emphasised its importance on trade (Anderson & Van Wincoop, 2003; Hoekman & Nicita, 2008, 2011; Maskus et al., 2001; Shepherd & Wilson, 2009; Wilson et al., 2002; Wilson et al., 2003, 2005). The benefits of trade facilitation extend to revenue generation and foreign direct investment promotion (Duval & Utoktham, 2014; Engman, 2005). Trade facilitation is also an important channel through which trade stimulates economic growth (Sakyi et al., 2017). Trade facilitation promotes growth by first increasing trade, which then raises income and ultimately leads to economic growth (Wilson et al., 2003).

While some studies (Makochekanwa, 2013; Simwaka, 2011; Yabu, 2014) empirically examined trade facilitation in SADC, none have extensively integrated LPI scores and its components, particularly through the lens of intra-regional trade performance. This study fills this gap by not only using LPI and its components but also by performing simulation export gains associated with each component.

Trade cannot happen without logistics. If the logistics are poor, it also means that the trade will be poor. Efficient logistics is key to any

country because it connects firms to both domestic and international markets through reliable supply chain networks. Studies show that countries with low logistics performance often face high costs in the form of transportation costs and unreliable supply chains. Countries with low logistics performance find integrating and competing in the global markets and global value chains difficult. According to Arvis et al. (2016), the LPI is an index developed by the World Bank to analyse and compare countries' performance in six components, which are efficiency in customs and border management clearance, quality of trade and transport infrastructure, ease of arranging competitively priced shipments, competence and quality of logistics services, ability to track and trace consignments and frequency with which shipments reach consignees within scheduled or expected delivery times. When it was created in 2007, the LPI was initially designed to solely look at the border components of supply chains because trade and transport facilitation was the priority reform area. Because of its multi-dimensional assessment, the LPI helps countries to identify key areas that present barriers and require improvements. Understanding the logistics performance requires looking at the components and seeing how they interact with policy actions, competitive forces, and the economic and political environment.

Trade facilitation is important to SADC because, among the regional economic co-operations in Africa, SADC has the second largest number of landlocked countries after the Common Market for Eastern and Southern Africa (COMESA). These landlocked countries depend highly on their coastal neighbours for access to the sea and international markets. Furthermore, most SADC member states do not have good infrastructure, face high transportation costs and are far from Asian, American and European markets. To address regional challenges, SADC countries can improve their competitiveness and lower trade costs by making improvements to trade facilitation, particularly through a better LPI and its individual components.

Tariff reductions in SADC commenced in 2001, but the SADC FTA was achieved in 2008, and full tariff liberalisation was attained in 2012[2]. Intra-SADC exports have not been consistent and robust enough to benefit most of the members, favouring South Africa. Some member states, namely Mozambique, Tanzania and Zimbabwe, faced challenges with the implementation of the SADC-FTA despite full tariff liberalisation. These are among the reasons intra-SADC trade remains

[2]Free Trade Area | SADC

insignificant in SADC despite the fact that 13 of the 16 SADC members are signatories to the FTA and 10 have direct access to sea ports.

Intra-SADC trade grew from 15% to 18% in 2008 to around 20% in 2018. According to the Organisation for Economic Cooperation and Development (OECD, 2017, p. 32), intra-SADC trade was around 10% between 2000 and 2015, whereas that of the Association of Southeast Asian Nations (ASEAN) and European Union (EU) was 25% and 40%, respectively.

This paper's main objective is to analyse the impact of LPI and its components, together with other variables, on the value of intra-exports for selected SADC countries. Furthermore, it aims to analyse intra-SADC export gains that are associated with improving LPI and its components in the importing countries. Findings will inform and stimulate policy both at private and public levels so that correct decisions can be implemented both at national and regional levels on how LPI and its various components can be improved to enhance intra-exports and trade in SADC.

The study intends to answer the following questions;

- What is the impact of trade facilitation indicators (LPI and its components) on intra-exports value in selected SADC member states?
- What are the intra-SADC export gains if importing member states undertake to improve scores of LPI and its components?

This paper adds to existing literature on SADC in many important ways. First, it uses LPI and its six components, namely, customs efficiency, infrastructure, logistic competence, international shipments, tracking and tracing, and timeliness. The first three are areas for policy regulation (inputs), while the second three measure the performance of service delivery (outcomes). The LPI is a collaborative benchmarking tool that can be used to help countries in identifying challenges and opportunities they encounter in the performance of their trade logistics, so as to make improvements where necessary. The index provides an in-depth analysis of the logistics gap among countries, a comprehensive snapshot and a detailed comparison of countries' supply chain performance (Arvis et al., 2014; Hoekman & Nicita, 2008, 2011).

Second, trade facilitation data, especially LPI, has improved and the time span has increased; thus, new research can provide more accurate and relevant information than existing ones. Third, a lot of developing

countries are now appreciating the importance of trade facilitation more than before and, at the same time, are implementing various trade facilitation programmes. Thus, findings from the paper can offer relatively new and better insights into the relationship between trade facilitation and trade performance. The paper is organised as follows. Section two presents an overview of trade facilitation and initiatives in SADC. This is followed by a review of both theoretical and empirical literature. Section four presents the econometric model and methodology, while sections five and six present results and policy recommendations, respectively.

2. Trade Facilitation Initiatives in Sadc

Traditionally, trade facilitation focused on administrative and border issues, but it has recently been extended to include logistics, transport services, physical infrastructure, and competitiveness. Scholarly work on trade facilitation by international organisations e.g., the Asian-Pacific Economic Cooperation (APEC), International Chamber of Commerce, OECD, United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT), United Nations Conference on Trade and Development (UNCTAD), World Customs Organisation (WCO), and World Trade Organisation (WTO), and by prominent authors like Grainger (2011a, 2011b); Wilson et al. (2003) and Wilson et al. (2002) to mention a few, have varying definitions of trade facilitation. Wilson et al. (2002) stress that there is no standard definition of trade facilitation. Grainger (2011a, p. 67) further stresses that trade facilitation anchors on the four intertwined themes, namely, '*the simplification and harmonisation of rules and procedures; modernisation of trade systems, sharing and lodging of information between business and government stakeholders; administration and management of trade and customs procedures; and institutional mechanisms to safeguard effective implementation of trade facilitation principles*.' According to the Asian Development Bank and United Nations (2013, p. 6), trade facilitation encompasses *'policies and processes that reduce the cost, time, and uncertainty associated with engaging in international trade but excludes traditional trade instruments such as tariffs, import quotas, and other similar non-tariff barriers.'* Table 1 provides a summary of definitions of trade facilitation by various organisations. These definitions are within the context of WTO negotiations on trade facilitation. Nevertheless, despite their differences, all definitions of trade facilitation share a common goal: to improve the

trading environment and reduce or eliminate transaction costs (Grainger, 2008).

Table 1: The Evolving Definition of Trade Facilitation

WTO and UNCTAD	Simplification and harmonisation of international trade procedures, including activities, practices, and formalities involved in collecting, presenting, communicating, and processing data required for the movement of goods in international trade.
OECD	Simplification and standardisation of procedures and associated information flows are required to move goods internationally from seller to buyer and to pass payments in the other direction.
UN/ECE	A comprehensive and integrated approach to reducing the complexity and cost of the trade transactions process and ensuring that all these activities can take place in an efficient, transparent, and predictable manner, based on internationally accepted norms, standards, and best practices.
APEC	The simplification, harmonisation, use of new technologies and other measures to address procedural and administrative impediments to trade.
APEC	The use of technologies and techniques which will help members to build up expertise, reduce costs and lead to better movement of goods and services.

Source: Wilson et al. (2002, p. 14)

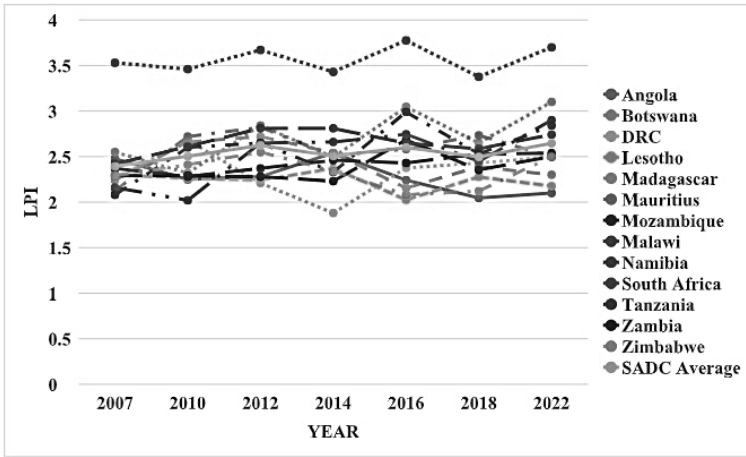
SADC has facilitated trade in various ways. First, the SADC Protocol on Trade (Article 13) provides for member states to take appropriate measures through cooperation on customs administration. Second, Article 14 of the same Protocol allows member states to promote intra-trade through coordination, rationalisation, simplification and harmonisation of trade documentation and procedures. Also, the bloc established a Sub-Committee on Customs Cooperation to oversee the implementation of these articles. Furthermore, 11 SADC members [3] acceded to the Revised Kyoto Convention, which provides for a uniform set of modern, simple and efficient customs administrations. Through WCO, the bloc also has a Customs Reform Programme, which gathers information with regard to customs administrations, helping stakeholders in understanding the operating environment and implementing comprehensive programmes.

[3]Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Zambia and Zimbabwe.

Since 2019, SADC initiated a Trade Facilitation Programme (TFP) to further deepen regional economic integration by focusing on non-tariff barriers, technical barriers to trade and sanitary and phytosanitary measures, as well as customs technical assistance support. The overall aim of TFP is to increase SADC's trade with other blocs, particularly the EU, by supporting trade facilitation and implementation. The programme gives priority to activities and actions that reduce border-related trading costs through effective coordination, rationalisation and simplification of trade procedures and documentation, enhanced efficiency in border operations, including business-friendly operating hours, and improved co-operation in border management by SADC countries. Also from 2021, the bloc has been conducting time-release studies along its corridors to assess bottlenecks and efficiency in the clearance of goods crossing border posts.

Despite all these initiatives undertaken by SADC, LPI scores, as shown by Figure 1, suggest otherwise. Most member states' LPI has been below the SADC average. Namibia and Tanzania had the lowest scores between 2007 and 2010; however, since 2012, they have made great improvements. Botswana and Malawi also performed well. On the contrary. Angola, DRC and Zimbabwe performed poorly during the period under review. South Africa has always been the best performer in the region. Nevertheless, its score in recent years has been falling. Generally speaking, out of the 13 member states, only four member states (Botswana, Malawi, Tanzania and South Africa) had an average above the SADC average for the years 2007, 2010, 2014, 2016, 2018, and 2022. Regarding the performance of individual components, only South Africa scored above average, while Botswana and Malawi also managed to do so in two components each. The statistics is a confirmation that trading costs are still high in the region.

Figure 1:Selected SADC members' LPI (2007 – 2022)



Source: World Bank Data.

The low intra-trade in SADC could be a result of low scores on LPI attained by member states. The low score also demonstrates the necessity of member states to improve competitiveness and facilitate trade by addressing supply-side bottlenecks, including strengthening cooperation in cross-border infrastructure and dealing with non-tariff barriers that hinder the smooth flow of goods. This calls for the need for greater improvements in trade facilitation indicators. Hence, identifying critical factors that hinder intra-trade in SADC can help enhance competitiveness, build supply capacity and achieve greater economies of scale among SADC member states by enhancing trade facilitation through targeting components of the LPI.

3. Literature Review

While studies on trade facilitation and intra-SADC trade are not new, previous studies find mixed results. Simwaka (2011) includes the quality of infrastructure to proxy transportation or transaction costs between corresponding partners and evaluates trade potentials in SADC. The study finds transportation costs as a major inhibiting factor to trade flows among the countries in the sample. Simulation results show that the effect of FTA increases intra-SADC flow from US$8 billion to US$13.9 billion between 2003 and 2007. Makochekanwa (2013) includes 3 indicators of trade facilitation, namely port efficiency, customs

environment, and e-business usage, to analyse the impact of trade facilitation on intra-SADC exports. Furthermore, the paper performs simulations on intra-trade potentials between one country and another country. Mainza (2019) uses LPI to estimate its impact on intra-SADC trade. Nevertheless, the paper did not include components of LPI. What is more, the author did not perform simulations to find potential trade gains.

The importance of trade facilitation stimulated governments and various organisations to ensure compliance with procedures, documentation and regulations related to international trade. Trade facilitation results in a substantial reduction in trading costs and gains in trade. GDP and export gains estimated from trade facilitation by 2020 were 1.78% and 8.23%, respectively (Zaki, 2014). Also, the World Economic Forum in Hanouz et al. (2014) estimated that improvements in trade facilitation would increase world GDP and world exports to 2.6% and 9.4%, respectively. Furthermore, African countries would benefit the most, approximately 16.5% on average, from trade cost reduction (WTO, 2015). Hertel et al. (2001) and UNCTAD (2001) use computable general equilibrium (CGE) to quantify trade gains associated with trade facilitation improvements. Results point to the importance of trade facilitation to trade.

Wilson et al. (2002) and Wilson et al. (2003)find that improvements in four dimensions of trade facilitation and e-business, customs environment, port efficiency and regulatory environment, respectively, could increase intra-APEC trade by 10% (US$280 billion) and 21% (US$254 billion). Results by Shepherd and Wilson (2009) reveal that improving port facilities by ASEAN countries could expand trade by up to 7.5% (US$22 billion).

Moïsé et al. (2011) find that improving all trade facilitation indicators could reduce trade costs by around 10%. Moïsé and Sorescu (2013) further reveal that improving all trade facilitation indicators results in more gains than improving some of the indicators. Reductions in total trade costs for low, lower middle and upper middle-income countries could increase trade by 14.5%, 15.5% and 13.2%, respectively.

Hoekman and Nicita (2008, 2011) found that improvements to LPI components in low and middle-income countries could increase imports by 15.2% and 13.5%, and exports by 14.6% and 17%, respectively. The largest gains are realised from infrastructure, logistics and efficiency of customs and border agencies. Mainza (2019) finds that LPI improvements by both exporter and importer substantially increase trade.

Makochekanwa (2013) assesses the impact of trade facilitation on intra-SADC trade. Results reveal that implementations in port efficiency and e-business could increase untapped trade potential among SADC countries. Willie (2020) suggests that implementing digital trade facilitation reforms by COMESA member states could lead to intra-COMESA export gains from US$5.9 billion to US$12.3 billion. All these results are in support of the paper's hypothesis that improvements in LPI components result in more trade gains for SADC countries.

4. Materials and Methods

4.1 Estimation issues and econometric strategy

The gravity model is widely used to estimate factors that determine trade, immigration and foreign direct investment flow between countries. Following the work of Pöyhönen (1963) and Tinbergen (1962), other authors(Anderson, 1979; Anderson & Van Wincoop, 2003; Baier & Standaert, 2020; Deardorff, 1998; Head & Mayer, 2014) have used the gravity model to conduct empirical work on trade flow. Specifically, the gravity model shows that bilateral trade flows are connected to market size (GDP) and distance between countries. The model assumes that larger economies and shorter distances between countries lead to higher bilateral exports. Countries with large economic size generally trade more with each other, while those further apart trade less. Other elements of trade costs or trade policy measures are then added to the basic formula of the gravity model. The gravity model is generally expressed as follows:

$$\boldsymbol{X_{ijt} = \alpha \frac{GDP_{it}^{\beta_1} GDP_{jt}^{\beta_2}}{D_{ij}^{\beta_3}}} \qquad \textbf{(1)}$$

Taking the natural logarithm of equation (1) gives the following equation.

$$\boldsymbol{lnX_{ijt} = \alpha + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \varepsilon_{ij}} \qquad \textbf{(2)}$$

where $\boldsymbol{X_{ijt}}$ is the bilateral exports value of all goods in thousand United States dollars from country $\boldsymbol{i}$ (exporter) to country $\boldsymbol{j}$ (importer) at period $\boldsymbol{t}$, while $\boldsymbol{GDP_{it}}$ and $\boldsymbol{GDP_{jt}}$ represent gross domestic products of the exporter and importer, respectively. $\boldsymbol{D_{ij}}$ measures the geographical distance in kilometres between the capital cities of the exporter and

importer. ε_{ij} is a random error while α and β's are parameters to be estimated. β_1 and β_2 are expected to have positive signs, while that of β_3 should have a negative sign.

We examine the intuition behind coefficients in the gravity model by finding the correlation among basic variables. Table 2 below shows the correlation matrix of the variables, and of interest are the numbers in bold. It is evident that the economic size of both exporting and importing countries and bilateral exports are positively correlated, while distance and bilateral exports are negatively correlated. The results support the intuition that economic size is positively related to bilateral trade flows and distance is inversely related to bilateral trade flows.

Table 2: Correlation Matrix of Selected Variables

	lnXijt	*lnGDPit*	*lnGDPjt*	*lnDij*
lnXijt	**1.0000**			
lnGDPit	**0.4288**	1.0000		
lnGDPjt	**0.3361**	-0.0249	1.0000	
lnDij	**-0.4286**	-0.0325	0.0187	1.0000

Source: Author's Calculation

Nevertheless, recent literature stresses that the intuition of the gravity model should also follow theoretical foundations, which are the Armington model, monopolistic competition with homogenous firms, the multi-country Ricardian model, perfect competition and heterogeneous firms (Baier & Standaert, 2020; Head & Mayer, 2014; Shepherd, 2022). Unlike the standard monopolist competitive model, which assumes that all firms are identical, the heterogeneous firm model assumes that firms possess different characteristics such as size and productivity. The authors influenced the current gravity model by including country or firm characteristics in the standard gravity model.

Melitz (2003) develops a model that captures different characteristics of a firm. Other authors like Chaney (2008); Helpman et al. (2008) and Melitz and Ottaviano (2008) use the heterogeneous firm model. Different elements of trade costs are included in the standard formation of the gravity model to address country heterogeneous factors. These costs can take various forms, including colonial heritage, contiguity, currency union, landlockedness, language or ethnic similarities and many other attributes.

In addition to these trade costs, this paper includes trade facilitation measures to further capture country differences. Equation 2 does not

capture countries 'different characteristics. As a result, a heterogeneous firm model is adopted. The model considers certain important issues in the gravity model to ensure that policy advice is based on robust evidence. According to Chaney (2008); Helpman et al. (2008); Melitz (2003) and Melitz and Ottaviano (2008), the decomposition of the heterogeneous firm model is theoretically as follows:

$$\boldsymbol{X_{ij} = S_i M_j d_{ij}^{e}} \qquad \textbf{(3)}$$

where $\boldsymbol{X_{ij}}$ is the bilateral exports from the country $\boldsymbol{i}$ to country $\boldsymbol{j}$ and $\boldsymbol{S_i}$, $\boldsymbol{M_j}$, $\boldsymbol{d_{ij}}$ and $\boldsymbol{e}$ are exporter-specific push factors, importer-specific pull factors, bilateral drag factors and trade elasticity, respectively. When other costs, such as tariffs, are included, the equation becomes:

$$\boldsymbol{X_{ij} = S_i M_j d_{ij}^{e}(1 + \tau_{ij})^{e}} \qquad \textbf{(4)}$$

where $\boldsymbol{\tau_{ij}}$ is the tariff between the exporter and the importer and $\boldsymbol{e}$ is the trade elasticity. Data for the value of the elasticity can be found in Egger et al. (2018).

Nevertheless, the empirical form of the gravity model includes the error term is

$$\boldsymbol{X_{ij} = S_i M_j d_{ij}^{e} n_{ij}} \qquad \textbf{(5)}$$

The trade costs are specified and included in the term bilateral drag factors $\boldsymbol{d_{ij}}$, such that

$$\boldsymbol{d_{ij} = dist_{ij}^{b_1} exp(T_{ij}^{b_2})} \qquad \textbf{(6)}$$

where $\boldsymbol{dist}$ represents all continuous drag factors like distance and $\boldsymbol{T}$ represent all dummy drag factors like contiguity. This means that trade costs are a function of distance, geographical factors and trade facilitation variables (see (Duval & Utoktham, 2014, p. 7)).

Fitting these into equation **(5)**, we get

$$\boldsymbol{X_{ij} = S_i M_j dist_{ij}^{b_1} exp(T_{ij}^{b_2}) n_{ij}} \qquad \textbf{(7)}$$

Generally, the usual approach was to log-linearise equation (7) and estimate its coefficients using ordinary least squares (OLS). Nevertheless, the OLS assumption, which states that the expected value of the error term conditional on independent variables should be equal to zero, is sometimes violated. Also, the log of the error term depends on high values of the error term, thus making it heteroscedastic. So, using OLS in the presence of heteroscedasticity produces inconsistent estimates. Another problem is that there could be zero values for bilateral exports; hence, taking logs could drop potentially informative data. However, another alternative is to add a small number to the zero and then use OLS. Nevertheless, the approach does not reveal information on the reasons behind these zero values. Also, discarding or replacing zeros can result in sample bias selection (Westerlund & Wilhelmsson, 2011). One popular approach to deal with heteroscedasticity and generally used in the face of zero bilateral trade values in log-linearised models is the Poisson pseudo maximum likelihood (PPML) proposed by Santos Silva and Tenreyro (2006, 2011). PPML can be appropriate in cases where there is a presence of zero trade values and heteroscedasticity (Piermartini & Yotov, 2016; Yotov et al., 2016). As suggested by Santos Silva and Tenreyro (2006), performing specification tests like heteroscedasticity is of little relevance when estimating gravity equations. Rewriting equation **(7)** using a generalised linear model, we get the following equation:

$$\boldsymbol{X_{ij} = exp\left(logS_i + logM_j + b_1 logdist_{ij} + b_2 T_{ij}\right) n_{ij}} \qquad \textbf{(8)}$$

Using PPML on equation **(8)** results in efficient estimates. However, the variance of the dependent variable and its conditional mean should be equal. If not equal, variations of the PPML are suggested, e.g., the negative binomial pseudo maximum likelihood (NBPML). Nevertheless, over-dispersion is not a problem because PPML results are consistent regardless of the distribution of the data (Shepherd, 2013). Furthermore, the PPML estimation is the only pseudo maximum likelihood estimation that results in valid parameter estimates for a gravity equation because it requires very mild assumptions (Santos Silva & Tenreyro, 2022). Sukanuntathum (2012) finds that NBPML produces robust results for data with heteroscedasticity and zero flows. Negative binomial estimation's data properties in the context of trade are not scale invariant (Shepherd, 2013). Despite the above, this paper uses NBPML because of over-dispersion (variance of the dependent variable greater than its

conditional mean) and the small percentage of missing data of the dependent variable, that is, 13.5% of 1092 observations from 13 countries. Also, our results from NBPML compared to those from PPML are meaningful and statistically significant.

4.2 Counterfactual analysis

The counterfactual simulations use elasticities from gravity results to examine changes in intra-SADC exports resulting from two scenarios of improving overall LPI and its components. Counterfactual results from simulations can give more concrete policy content and can inform policymakers on which areas of LPI require attention. The simulation process follows the strategy presented in Shepherd and Wilson (2009); Willie (2020) and Wilson et al. (2003). It involves considering two scenarios, which are then used to calculate the potential export gains associated with each scenario. The first scenario analyses the change in total intra-exports if SADC countries with a below-average LPI improve their score to the regional average. The second scenario analyses the change in total intra-exports if SADC countries whose average of the components of the LPI score is below that of SADC are improved to the average of SADC.

The second step is to calculate the total intra-SADC exports for each country for each period. This amount is subtracted from the new intra-SADC exports arising from each scenario. It is then expressed as a change for each country for both LPI and its components. These changes are then multiplied by the coefficient of elasticity of each component of LPI obtained from the gravity model and the initial intra-SADC exports from each member to SADC. The result is used to explain gains from improving each component of LPI.

4.3 Econometric model and data

We include distance, LPI and institutional quality as part of continuous drag factors and landlockedness, contiguity and common language as part of dummy drag factors to derive the following equation.

$$\boldsymbol{X_{ijt} = \alpha + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 lnLPI_{jt} + \beta_5 lnLL_{ij} + \beta_6 lnCB_{it} + \beta_7 lnCL_{jt} + \beta_8 lnINST_{jt} + \varepsilon_{ij}} \quad \textbf{(9)}$$

where the dependent variable and the first three independent variables are as explained in equation **(2)**. $\boldsymbol{LPI}$, $\boldsymbol{INST}$, $\boldsymbol{LL}$, $\boldsymbol{CB}$ and $\boldsymbol{CL}$are logistic

performance index, institutional quality, landlockedness, common border and common official language, respectively. The LPI and its components offer the most comprehensive and comparable data on country logistics and trade facilitation environments (Arvis et al., 2014, p. 14). The dummy variable 'landlocked' takes the value 1 if one of the two trading partners is landlocked, and the dummy variables 'common border' and 'common official language' take the value 1 if the two trading partners share a border and official language. Since the analysis is focusing on exports, the paper follows Wilson et al. (2003) and includes only the logistic performance of importing countries because, from the exporter's view, export gains depend on the importing countries the exporting country trades with and how much improvement in trade facilitation measures the importing countries achieve under a given scenario. Similarly, from an importer's view, import gains depend only on their own country's improvements in trade facilitation indicators. That is to say, improvements in trade facilitation by an importing country are more important to exports than improvements by the exporting country.

The paper further disintegrates the LPI to include its components in the equation. However, because of the high multicollinearity among the components (see Table 3), only a single component of the importer is included in the model at any given time. $\boldsymbol{CBE}$, $\boldsymbol{TTI}$, $\boldsymbol{QLS}$, $\boldsymbol{EIS}$, $\boldsymbol{TT}$, and $\boldsymbol{T}$ are customs and border efficiency, trade and transport infrastructure, quality of logistic services, ease arrangements of international shipments, ability to track and trace consignments and frequency with which shipments reach consignee within expected delivery time respectively.

Table 3: Correlationmatrix of LPI components of importer

	lnCBEjt	***lnTTIjt***	***lnQLSjt***	***lnEISjt***	***lnTTjt***	***lnTjt***
lnCBEjt	1.0000					
lnTTIjt	0.8551	1.0000				
lnQLSjt	0.7959	0.8607	1.0000			
lnEISjt	0.6660	0.6849	0.7416	1.0000		
lnTTjt	0.7493	0.7711	0.8017	0.6262	1.0000	
lnTjt	0.7725	0.7261	0.7815	0.6965	0.7036	1.0000

Source: Author'sCalculation

The paper uses annual secondary data for 2007, 2010, 2012, 2014, 2016, 2018, and 2022 on 13 SADC countries, namely Angola, Botswana, DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe. The export data is intra-exports among the listed countries. The choice of these countries is

based on data availability of LPI. Data for variables were retrieved from the following various sources. Bilateral exports data is from the International Monetary Fund's Direction of Trade (IMF-DOT) database, LPI and its components data is from the World Bank (WB), while data for distance, landlockedness, common official language and contiguity was from the Centre D'etudes Prospectives Et D'informations Internationales (CEPII) website. Data for GDP is from the UNCTAD database and is in United States dollars. The dataset is strongly balanced without gaps. A summary of variables, explanations and their data sources are in Table 4.

Table 4: Variable Description and Data Sources

Variable	Description	Expected Sign	Data Sources
X	Bilateral exports in thousand US$.	Dependent variable	IMF-DOT.
GDP	GDP in million US$.	+	UNCTAD.
D	Distance between cities in kilometres.	-	CEPII.
LPI	Logistic performance index, rated from 1(worst) to 5(best).	+	WB.
$INST$	Institutional quality	+	The Heritage Foundation.
LL	Landlocked.	-	CEPII.
CB	Common border/ contiguity.	+	CEPII.
TA	Common trading agreement.	-	WTO.
CBE	Customs and border efficiency.	+	WB.
TTI	Trade and transport infrastructure.	+	WB.
QLS	Logistic quality and competence.	+	WB.
EIS	International shipments.	+	WB.
TT	Tracking and tracing.	+	WB.
T	timeliness.	+	WB.
ln	Natural logarithm.		
i	Exporting country.		
j	Importing country.		
t	Time in years.		
α, β	Parameters.		
ε	Error term.		

Source: Computed by Author

4.4 Results and discussion

4.4.1 Gravity model results

The impact of LPI was estimated using STATA software. Results showing the impact of LPI are shown in table 5. The first column after the column with variables shows PPML results, while the second column shows results of NBPML. The results from NBPML are consistent and efficient, whereas those of PPML are not. As such, the focus is on NBPML results. Generally, all the independent variables have expected signs, and their coefficients are statistically significant except for institutional quality, which is negative and insignificant. Distance and landlockedness negatively affect bilateral exports, while the GDP of both the exporter and importer, improvements in trade facilitation by the importer, contiguity and having trade agreements between trading partners positively impact intra-SADC exports. The greatest benefits to intra-SADC exports arise when trading partners share a common border, followed by trade facilitation, GDP and having trade agreements. It is clear that distance has the most significant negative effect on intra-SADC trade, followed by landlockedness. An improvement of LPI by the importing country increases intra-SADC exports on average. Specifically, a percentage increase in the state of LPI of the importing country increases intra-SADC exports by 1.23% on average, ceteris paribus.

The impact of the components of LPI on intra-SADC exports is also examined, and the results are presented in Table 6. Specifications 1 to 6 present NBPML results of the impact of customs and border efficiency, infrastructure, international shipments, logistic competence, tracking and tracing and timeliness in that order. Again, the signs of all the coefficients of the independent variables are as expected and are statistically significant except for institutional quality and four components of LPI. Although improvements in LPI generally stimulate intra-SADC exports, not all the components of LPI significantly stimulate intra-exports in SADC. Results reveal that only improvements in customs and border efficiency and timeliness positively contribute to more intra-exports in SADC, while there is no statistical evidence in other components.

Table 5: Results of LPI of Importer

Variables	PPML	NBPML

lnGDPit	1.109***	1.030***
	(0.0419)	(0.0614)
lnGDPjt	0.622***	0.699***
	(0.0503)	(0.0866)
lnDij	-0.0469	-1.673***
	(0.104)	(0.182)
LLij	0.172	-1.491***
	(0.132)	(0.189)
CBij	1.394***	1.941***
	(0.162)	(0.184)
TAij	0.362***	0.315*
	(0.138)	(0.177)
lnINSTjt	0.167	-0.0787
	(0.205)	(0.347)
lnLPIjt	1.903***	1.225*
	(0.417)	(0.713)
lnalpha		1.759***
		(0.0356)
Constant	-2.320	11.91***
	(1.674)	(1.872)
Obs	1,076	1,076
R-squared	0.676	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Results for impact of LPI components

Variables	1	2	3	4	5	6
lnGDPit	1.047***	1.028***	1.026***	1.028***	1.027***	1.048***
	(0.0620)	(0.0614)	(0.0617)	(0.0615)	(0.0617)	(0.0609)
lnGDPjt	0.709***	0.738***	0.790***	0.761***	0.815***	0.695***
	(0.0755)	(0.0846)	(0.0836)	(0.0757)	(0.0910)	(0.0679)
lnDij	-1.683***	-1.686***	-1.697***	-1.683***	-1.700***	-1.612***
	(0.181)	(0.182)	(0.182)	(0.182)	(0.181)	(0.182)
LLij	-1.450***	-1.465***	-1.424***	-1.441***	-1.396***	-1.462***
	(0.182)	(0.190)	(0.198)	(0.187)	(0.190)	(0.180)
CBij	1.950***	1.926***	1.886***	1.903***	1.874***	1.995***
	(0.183)	(0.186)	(0.184)	(0.184)	(0.184)	(0.182)
TAij	0.325*	0.316*	0.314*	0.327*	0.318*	0.368**
	(0.177)	(0.178)	(0.178)	(0.178)	(0.180)	(0.177)
lnINSTjt	-0.187	-0.0607	0.105	0.0410	0.132	-0.238
	(0.358)	(0.362)	(0.328)	(0.333)	(0.320)	(0.357)
lnCBEjt	1.333**					
	(0.614)					
lnTTIjt		0.702				
		(0.604)				
lnQLSjt			0.185			
			(0.557)			
lnEISjt				0.579		
				(0.572)		
lnTTjt					-0.0436	
					(0.569)	
lnTjt						2.072***
						(0.588)
Constant	12.12***	12.08***	11.43***	11.47***	11.27***	10.80***
	(1.859)	(1.938)	(1.863)	(1.835)	(1.841)	(1.873)
lnalpha	1.761***	1.763***	1.764***	1.763***	1.764***	1.756***
	(0.0356)	(0.0356)	(0.0356)	(0.0356)	(0.0356)	(0.0356)
Obs	1,077	1,076	1,077	1,077	1,077	1,077

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.4.2 Counterfactual simulations results

The goal of the first scenario is to increase the LPI of countries below the SADC average to the level of the SADC average of LPI while that of the second scenario is to increase the LPI, components of countries below the SADC average of each component to the level of the SADC average of each component. Only components of LPI whose coefficients are statistically significant are considered for simulation. The

counterfactual results from scenario one show that if SADC countries whose LPI average for the period 2007 to 2022 is below the average of the average during the same period rise to the average of SADC, total intra-SADC exports could increase by US$7.8 billion. The increase is equivalent to a 3.04% increase (see table 7). The countries that would realise the most in intra-export gains from improvement of LPI are DRC (37%), Zimbabwe (23%) and Angola (17%).

The second scenario's results show that improving customs and border efficiency and timeliness in countries below the SADC average could increase total intra-SADC exports by 0.56% and 0.6%, respectively (see table 8). These increments in intra exports translate to US$1.45 billion and US$1.53 billion respectively. The total contribution of the two components is US$2.98 billion or 1.16% to overall improvement in LPI. This means that if all countries whose customs and border efficiency and timeliness are below the average of SADC improve on these components to the level of the average of SADC, total intra-SADC exports could rise to around US$2.98 billion or increase by 1.16%. The countries that would benefit the most due to improvements in customs and border efficiency are Zimbabwe (40%), DRC (31%) and Zambia (12%), while those that would benefit the most from improvements in timeliness are Angola (41%), DRC (37%) and Zimbabwe (10%).

The counterfactual simulation results align with existing literature, which suggests that the gains from improvements in trade facilitation are significant. Simulation results corroborate with Hoekman and Nicita (2008, 2011), who state improvements in the efficiency of customs and border agencies are among the components of LPI with the largest increase in trade flow. Shepherd and Wilson (2009) reveal that improvements in air transport by ASEAN countries could lead to a 42% increase in trade (close to US$125 billion). Wilson et al. (2005) also find that improvements in trade facilitation indicators could increase trade by 10% or US$377 billion. Wilson et al. (2002) and Wilson et al. (2003) also estimate that improvements in four dimensions of trade facilitation measures could increase intra-APEC trade by close to US$280 billion (10%) and US$254 billion (21%), respectively. Simwaka (2011) finds that the effect of FTA increases intra-SADC flow from US$8 billion to US$13.9 billion. Simulations by Willie (2020) reveals that a 50% and 100% implementation of digital trade facilitation by COMESA member states would increase intra-COMESA exports to between US$5.9 billion and US$12.3 billion, respectively.

Table 7: Simulation Overview: Improvements to SADC Best Average

Country	Goal	% Δ in intra-exports		
		Δ in US$ billion	% Share of Δ inTotal Intra-SADC exports	% contribution to Δ in LPI
Angola	To increase the average LPI to the average of SADC.	1.33	17.03	0.52
DRC	To increase the average LPI to the average of SADC.	2.85	36.55	1.11
Lesotho	To increase the average LPI to the average of SADC.	0.36	4.63	0.14
Madagascar	To increase the average LPI to the average of SADC.	0.05	0.60	0.02
Mozambique	To increase the average LPI to the average of SADC.	0.52	6.69	0.20
Namibia	To increase the average LPI to the average of SADC.	0.19	2.46	0.07
Zambia	To increase the average LPI to the	0.70	8.97	0.27
Zimbabwe	average of SADC. To increase the average LPI to the average of SADC.	1.80	23.07	0.70
Total		**7.81**	**100**	**3.04**

Source: Calculation by Author

Table 8: Simulation Overview: Improvements in LPI components

LPI component	Goal	% Δ in intra-Exports	
		Amount (US$ billion)	% Share to LPI improvement
CBE	To increase the average CBE to the average of SADC.	1.45	0.56
Timeliness	To increase the average timeliness to the average of SADC.	1.53	0.60
Total		**2.98**	**1.16**

Source: Calculation by Author

4.5 Discussion of results

The paper finds that improvements in trade facilitation indicators (LPI) generally stimulate intra-SADC exports. Specifically, a 1% increase in LPI by the importer would result in a 1.225% increase in intra-SADC exports on average. The results are consistent with Mainza (2019), who found that improvements in the LPI by exporter and importer increased trade flows between SADC members by 1.3% and 0.8% respectively. Furthermore, the results show that improvements in customs and border efficiency and timeliness could increase intra-SADC exports by 1.333% and 2.072%, respectively. There is no evidence that other components of LPI could lead to an increase in intra-SADC exports. This could be due to the infrastructure deficit that the African continent faces, thus limiting the impact of the other components of LPI. According to the African Development Bank (2018), Africa has an infrastructure financing gap amounting to US$108 billion. Siyakiya et al. (2023, p. 25) also posit that African countries lack world-class infrastructure such as dams, electricity, energy, roads and railway networks, development-oriented leadership and a well-educated and trained workforce and population in scientific and technical fields. Addressing infrastructure rigidities, poor transportation, linkages and logistics, high corruption and rent-seeking behaviours, as well as ineffective government policies could enhance the continent's development.

Counterfactual simulations reveal that if SADC member states whose LPI are below the SADC average are improved, total intra-SADC exports would increase by 3.04% on average. This is equivalent to a US$7.8 billion increase in exports in the region. Summarily, the greatest gains in total intra-SADC exports would be realised if member states make improvements in customs and border efficiency and timelines. Furthermore, Angola, DRC and Zimbabwe would realise the largest change in intra-SADC export gains as a result of improvements in both their LPI and customs and border efficiency and timelines. Given the current economic and political conditions in the three countries, improvements in LPI and its components may not be as fast as expected. Nevertheless, in the case of Zimbabwe, despite the economic and political challenges and lack of support from international banks due to economic sanctions, the country has managed to use local resources to modernise and rehabilitate infrastructure and main road networks, particularly at its trunk roads and its main border post with South Africa (Government of Zimbabwe, 2024). Angola and DRC can equally do the

same since they are endowed with natural resources. However, to realise that requires implementation of proper institutions and combatting corruption and rent-seeking behaviours.

5. Conclusions and Policy Implications

This paper analyses the impact of trade facilitation using LPI and its components on intra-SADC exports. It further performs counterfactual simulations based on two scenarios. The key findings are that improvements in LPI and its components increase intra-SADC exports. However, the impact of various components of logistic performance, which are classified into areas of policy regulation and service delivery performance, is not uniform. Both regression and counterfactual simulation results show that changes in intra-SADC export gains come from focusing on improvements in customs and border efficiency and timeliness. Thus, the results point to the need for more policy direction towards these components of logistic performance. The results clearly show components of LPI that SADC countries should prioritise to realise huge intra-exports gains. What is more, the exporters are also the importers, which makes the results applicable to all SADC countries regardless of the direction of trade; thus, they tend to benefit from improving all the components of LPI. The findings contribute to broader goals of regional and continental economic integration and development through harnessing trade facilitation. The paper recommends that future studies use disaggregated export flow to identify which products benefit most from trade facilitation.

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