Indo-African Agricultural Trade and its Weaponisation

Comprehensive Report

Devneel Daga (2022B3A70055G)

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Abstract

This paper quantitatively examines the asymmetric economic vulnerability embedded in the agricultural trade relationship between India and the African subcontinent. In a time where trade is increasingly weaponised and concentrated reliance on a single market exposes the exporting nation to a significant geopolitical risk and instability. The study pursues the core objectives of quantifying dependence of the between the exporter and the importer, analysing the trade vulnerability by employing a Differences-in-Differences model to assess the impact of a trade policy or a memorandum of understanding (MoU) on the country's trade value, relative to a country with comparable statistics. It also evaluates the domestic effects by applying the same structure to the domestic commodity price, testing whether political agreements have a direct impact on a trade policy shock.

Keywords: Trade Weaponization; Memorandum of Understanding (MoU); Agricultural Trade; Indo-African Trade; Differences-in-Differences (DiD)

1 Introduction

The global economic architecture, that was once defined by a push towards globalisation, liberalisation and increase in efficiency, is now fundamentally shaped by a complex framework of economic interdependence and geopolitical friction. In an era characterised by increase in trade policy uncertainty and the rise of bilateral trade disputes, the strategic use of commercial policy for political benefit is often termed the "weaponisation of trade", which has become a critical area of study. This phenomenon moves beyond the traditional economic sanctions that look to encompass the calculated exploitation of asymmetric trade relations to exert a geopolitical leverage. The agriculture and the food sector stand in the nexus of these trends, as a determinant of national security, food security and domestic stability, these agriculture trade flows are highly susceptible to sudden policy shifts and making the study of their vulnerabilities is not just an academic exercise, but a matter of urgent policy relevance.

While much of the literature on trade is focuses on conflicts among major economic powers or the impact of multilateral sanctions, there has been less attention paid to the vulnerabilities inherent in the concentrated exports in the Global South. A significant and growing example is the trade between India and African nations. A massive and price-sensitive consumer market is a pivotal destination for agricultural exports from a commodity-producing region. This market concentration creates a classic scenario of asymmetric interdependence. A single exporter from the commodity-producing region may rely on the dominant consumer market for a significant portion of its global sales of a specific commodity, while the same commodity constitutes a negligible fraction of the external market's overall import needs. This reliance exposes the exporting region to unilateral policy shocks from its dominant trading partner. The inherent risk is not just commercial but also political and developmental: a sudden imposition of a non-tariff barrier, a change in procurement policy (like a minimum support price), or even a quota restriction by the dominant consumer market could disproportionately destabilize the exporting region's entire agriculture sector and consequently impact farmers' incomes.

The existing academic work confirms that the success of trade weaponisation hinges on the exploiting the asymmetric interdependence. Furthermore, studies on trade-conflict dynamics also highlight that precisely defining and measuring this reliance, whether through trade share, trade dependence or trade openness, is a crucial step for generating accurate conclusions about conflict onset and economic vulnerability. By focusing on the Indo-African agriculture trade corridor, this paper shifts the analytical lens from the international conflict to the sub-geopolitical risk embedded within trade policy, specifically examining how a developing nation's concentrated market reliance translates into measurable domestic economic vulnerability. Moreover, a successful agricultural trade liberalisation has has been shown to require substantial supportive domestic policy, making the potential for external shocks to disrupt local system even more pronounced.

2 Literature Review

The modern global economy is characterized by a complex interplay of international trade, geopolitical tensions, and sophisticated domestic supply chain networks, particularly within the agri-food sector. This literature review synthesizes recent academic contributions across three principal domains: the multifaceted effects of trade and trade policy, the operational and structural challenges within agricultural supply chains, and the dynamics and policy implications of commodity price volatility. The reviewed studies employ a range of methodologies, from macro-level quantitative regression and general equilibrium models to micro-level firm and household surveys, to offer comprehensive insights into these areas, with a significant focus on emerging economies like India and the structural impact of trade conflicts and liberalization.

2.1 Trade Effects

Academic literature presents a nuanced view of the economic consequences of international trade, focusing on trade policy, economic interdependence, and the increasing use of trade for geopolitical leverage, often termed trade weaponization.

2.1.1 Trade Policy and Economic Outcomes

The relationship between trade policy and economic performance is a central theme. Studies on trade liberalization, such as De Silva, Malaga et. al. (2013)'s "Trade Liberalisation Effects On Agriculture Production Growth: The Case of Sri Lanka," confirm that trade liberalization policies significantly boost economic growth by promoting Trade Openness and Total Investment, leading to a direct increase in the real GDP of the agricultural sector. However, this positive effect is not universal, as the same study found that regional Free Trade Agreements (FTAs) showed a negative and significant relationship with agricultural production growth. This suggests that the impact of trade policy reform is highly dependent on its specific design and scope.

A quantitative assessment for India's agricultural sector, provided by Storm (1997)'s "Agriculture Under Trade Policy Reform: A Quantitative Assessment for India," further complicates the picture, suggesting that the gains from agricultural trade liberalization alone are often not large or unambiguous. This study, using a Computable General Equilibrium (CGE) model that accounts for structural asymmetries between agricultural (price-clearing) and non-agricultural (output-adjusting) markets, concludes that successful reform requires substantial supportive agricultural policy, such as increased public agricultural investment and fertilizer subsidies. This finding highlights a potential conflict with international trade agreements like the GATT requirement to reduce subsidies.

2.1.2 Trade Weaponization and Sanctions

In the contemporary geopolitical landscape, the weaponization of trade has become a critical area of study. Feldhaus, Huang et. al. (2020)'s "The Weaponization of Trade: A study of modern trade conflicts from the mid-1900s to present," tracing its evolution, concludes that trade weaponization succeeds when asymmetric interdependence is exploited. Furthermore, the escalation of these conflicts is more likely when they are motivated by geopolitical goals or occur across alliances. Key variables for understanding this phenomenon includes the objectives of the aggressor (geopolitical vs. economic), relative vulnerability, diplomatic relations (alliance structure), and the role of international institutions.

Sanctions represent a direct form of trade weaponization, and their effects on firms are significant. Crozet, Hinz et. al. (2021)'s "Worth the pain? Firms' exporting behaviour to countries under sanctions" investigated French exporting firms and found that imposing sanctions (e.g., on Iran and Russia) significantly lowers the firm-level probability of exporting, particularly for firms that are highly reliant on trade finance. Conversely, the study found that lifting sanctions (e.g., on Cuba and Myanmar) had no or only small trade-inducing effects, and provided evidence of firms actively engaging in sanctions avoidance by exporting indirectly. Separately, Jäkel, Østervig et. al. (2024)'s "The effects of heterogeneous sanctions on exporting firms: Evidence from Denmark," using a firm-level gravity equation and the Global Sanctions Database, found that sanctions, on average, lead to a significant reduction in exports and an increase in the probability of market exit. The effects are heterogeneous, with different sanction types and objectives, such as "prevent war," having the largest negative impact.

2.1.3 Trade Interdependence and Conflict

The contentious debate regarding the relationship between economic interdependence and militarized interstate disputes (MIDs) is addressed by Gartzke & Li (2003)'s "Measure for Measure: Concept Operationalization and the Trade Interdependence-Conflict Debate," demonstrating that variable construction alone can explain conflicting findings in the literature. The study establishes a simple formal equivalence uniting the competing dyadic measures (trade dependence and trade share) with the consensus monadic measure (trade openness). Using large-sample quantitative regression analyses, Gartzke & Li (2003) conclude that trade share (bilateral trade/total trade, which correlates negatively with openness) is positively correlated with MID onset, while trade dependence (bilateral trade/GDP) and trade openness (total trade/GDP) are negatively correlated with MID onset. This highlights the necessity of precise conceptual operationalization in trade-conflict research.

2.1.4 Trade Policy Uncertainty (TPU)

The economic effects of Trade Policy Uncertainty (TPU) are also quantitatively significant. Caldara, Iacoviello et. al. (2020)'s "The economic effects of trade policy uncertainty," using three measures of TPU (news coverage, firms' earnings calls, and tariff rates) applied to a Vector Autoregressive (VAR) model and a General Equilibrium Model for the U.S. economy, concludes

that increases in TPU significantly reduce investment and aggregate economic activity. Higher expected tariffs and uncertainty specifically deter investment, particularly for exporters.

2.2 Supply Chains

The literature on supply chains, especially in the agricultural sector, emphasizes their structure, efficiency, financing, and the role of contract farming as an organizational model.

2.2.1 Agricultural Value Chains and Finance

Agricultural and food Global Value Chains (GVCs) have undergone significant structural changes. Dellink, Dervisholli et. al. (2020)'s "A quantitative analysis of trends in agricultural and food global value chains (GVCs)," using EORA Multi-Regional Input-Output (MRIO) tables and the Koopman, Wang, and Wei (2014) decomposition framework, reveals that GVC participation in agri-food increased significantly until 2008 and then stalled. This participation is driven more by scale effects than by changes in positioning, with high-income countries typically more downstream and low-income countries more upstream in the value chain.

In the context of emerging economies like India, Ashok, Mani et. al. (2015)'s "Financing Agricultural Value Chains: Challenges and Opportunities" finds the primary constraint is the inefficient, fragmented, and long supply chain. The proposed solution is an integrated Value Chain Financing (VCF) approach that strategically shifts the focus from 'farm-to-fork' to 'plate-to-plough' to meet demand, supported by institutional aggregation and massive infrastructure investment (e.g., cold-chains, warehousing, technology). Soundarrajan & Vivek (2015)'s "A study on the agricultural value chain financing in India" further concludes that VCF offers an opportunity to expand agricultural financing, improve efficiency, strengthen linkages, and replace adversarial relations with a win-win situation among participants. This approach involves financial institutions actively identifying, evaluating, and tailoring loans, often with technical assistance programs.

Operational studies, such as the Linear Programming model developed by Bhatia & Janardhana (2020) in "Agriculture supply chain management - an operational perspective," which focused on a hypothetical farm, conclude that coordinating the parameters of the supply chain (e.g., land allocation, labour planning, and a decay function for storage time) can enable a 25% rise in farm revenues if growers sell their product directly to consumers, thereby maximizing farm revenue and minimizing losses for perishable crops.

2.2.2 Domestic Trade Networks and Constraints

Analysing domestic trade flows within India reveals crucial structural dynamics. Kulkarni, Bhatia et. al. (2022)'s "Evolution Of Agricultural And Non-agricultural Produce Flow Network in India" used interstate movement data to show that while total trade volume has increased, the lack of a significant increase in connectivity reveals an over-reliance on particular export hubs. However,

the agricultural network is noted for showing a greater trend towards self-reliance through diversification compared to the non-agricultural network, which is becoming more dependent on hot-spot states.

A detailed study of the capsicum supply chain in the northwestern Himalayan region of India by Thakur et al. (2024) in "Agricultural Produce Supply Chain Network of Capsicum: Empirical Evidence from India" highlights critical constraints. The dominant marketing channel (47.25% dominance) involves a Commission Agent (Producer-Commission Agent-Retailer-Consumer), but the research concludes that the Producer-Consumer channel (Channel-A) is the most efficient, despite not being the most preferred. Key constraints for farmers, prioritized using the Garrett ranking method, include the absence of market consultation services, inadequate road infrastructure, and high commission charges, all urgently requiring targeted interventions to create a more robust marketing environment.

2.2.3 Contract Farming

Contract farming is an increasingly important organizational model within agricultural value chains. A study contrasting gherkin and paddy seed farmers in Andhra Pradesh, India, by Swain (2012)'s "Determinants of Farmers' Participation in Contract Farming: The Cases of Gherkin and Paddy Seed in Andhra Pradesh, India," found that large farmers with better irrigation facilities and bigger family sizes are more likely to participate. This finding suggests that the current practice may inadvertently lead to higher inequality and necessitates the introduction of inclusive institutional mechanisms. Broader, generalizable evidence from nationally representative surveys across six developing countries, provided by Meemken & Bellemare (2020)'s "Smallholder farmers and contract farming in developing countries," supports the view that contract farmers obtain an average of 10% higher incomes, but this benefit is not unambiguous and is observed only in some countries. Crucially, the analysis emphasizes that contract farming significantly increases the demand for hired labour among participating households.

2.3 Volatility in Prices and Prediction

The issue of price volatility in agricultural commodities is a major challenge, addressed by studies focusing on policy responses and advanced prediction techniques.

2.3.1 Price Volatility and Policy Responses

An evaluation of volatility in Indian agricultural commodity prices (specifically wheat) by Bathla (2013)'s "Volatility in Agriculture Commodity Prices in India: Impact and Macroeconomic and Sector-Specific Policy Responses," concludes that trade and sector-specific policies make domestic price and output resilient to external shocks like global price volatility, exchange rate fluctuations, and import surges. However, the study, which uses a structural econometric model, also notes that mechanisms like Minimum Support Price (MSP) and procurement can dissuade full price transmission.

2.3.2 Commodity Price and Arrival Prediction

Forecasting is critical for managing supply chain risk and market volatility. Prasad, Vuyyuru et. al. (2019)'s "Agriculture Commodity Arrival Prediction using Remote Sensing Data: Insights and Beyond," focusing on the "Tur" (red gram) crop in Karnataka, India, proposes a framework utilizing remote sensing data (NDVI) and historical log arrivals to predict future commodity arrivals. By employing cascaded dimensionality reduction techniques (Elastic-net and Principal Component Analysis) and regularized regression models, the proposed model, RegPCR, consistently outperforms traditional methods like Random Forest, Boosting, and ARIMA for predicting market arrivals and successfully forecasts a state-wide average price outlook for up to three months.

Another study focusing on crop price forecasting in emerging economies, Jain, Marvaniya et. al. (2020)'s "A Framework for Crop Price Forecasting in Emerging Economies by Analysing the Quality of Time-series Data," addresses the issues of human-induced data errors and price fluctuations. The core methodology involves using multivariate regression models and proposing a framework for context-based model selection and retraining. The analysis incorporates features suchs as historical prices, market arrival quantity, weather data, and data quality features (missing value flag, outlier flag, etc.). This work concludes that a trend-based model selection strategy performs best, significantly improving accuracy over standard forecasting techniques by effectively managing data quality challenges and high price volatility.

3 Research Gaps

Despite providing new evidence on asymmetric agricultural trade dynamics, several important gaps remain that future research should address. These gaps highlight areas where additional data, methodological refinement, or broader comparative analysis is needed.

1. Micro-level evidence: Limited firm- and farm-level data constrain understanding of how MoUs and market dependence affect bargaining, contract terms and distributional outcomes at the producer and trader level.
2. Regional integration and alternative markets: The role of African regional trade blocs and alternative export destinations in mitigating (or amplifying) dependence is under-studied, reducing insight into feasible diversification strategies.
3. Non-tariff measures and implementation heterogeneity: Existing research often treats protocols and sanitary measures as uniform; more work is needed on how compliance costs, enforcement capacity, and certification bottlenecks alter the economic effects of regulatory MoUs.
4. Seasonality, climate and longer-run dynamics: The interaction between seasonal production cycles, climate risk, and policy shocks (including persistence and adaptation over time) is insufficiently explored, limiting policy prescriptions for resilience.

4 Objectives

This study outlines three core objectives that guide the empirical analysis of asymmetric agricultural trade between India and its African partners. These objectives reflect the central research focus of understanding how geopolitical uncertainty, structural dependence, and policy shocks shape both bilateral trade flows and domestic agricultural outcomes in exporting countries.

1. To assess the effect of the importer's Geopolitical Risk (GPR) on the bilateral trade flow and the price of production of commodities in the exporter nation.
2. To assess the effect of the Import Share, i.e., the ratio between the exporter's exports to the importer and the importer's total imports, on the bilateral trade flow and the price of production of commodities in the exporter nation.
3. To assess the effect of the MoU on the bilateral trade flow and the price of production in the exporter nation.

5 Hypotheses

5.1 Objective 1: Determinants of Bilateral Trade Flows (Equ. 1)

This objective evaluates whether bilateral trade flows between India and its African partners are shaped by (i) geopolitical uncertainty in the importing country, (ii) importer-side market reliance on India, and (iii) the MoU trade policy shock. These mechanisms are assessed using the coefficients β_5, β_4, and β_3 in Equ. 1.

Objective 1a: Geopolitical Risk as a Determinant of Trade_Value

This hypothesis examines whether importer-side geopolitical uncertainty, measured by GPR, is a statistically significant driver of India's Trade_Value.

$$H_0 : \beta_5 = 0$$
$$H_a : \beta_5 \neq 0$$

The Null Hypothesis (H_0) asserts that GPR does not significantly influence bilateral exports. The Alternative Hypothesis (H_a) posits that importer geopolitical risk is a statistically significant determinant of Trade_Value.

Objective 1b: Importer Market Reliance and Bilateral Trade

This hypothesis assesses whether the importing country's dependence on India captured by Import_Share affects India's bilateral Trade_Value.

$$H_0 : \beta_4 = 0$$
$$H_a : \beta_4 \neq 0$$

The Null Hypothesis (H_0) states that importer-side market reliance has no significant effect on India's export volumes. The Alternative Hypothesis (H_a) asserts that Import_Share significantly influences Trade_Value.

Objective 1c: Policy Shock (MoU) Impact on Trade_Value

This hypothesis evaluates whether the MoU trade policy shock generates a differential effect on export flows, tested through the Differences-in-Differences coefficient β_3.

$$H_0 : \beta_3 = 0$$
$$H_a : \beta_3 \neq 0$$

The Null Hypothesis (H_0) posits that the MoU has no statistically significant DiD impact on Trade_Value. The Alternative Hypothesis (H_a) holds that the MoU produces a statistically significant differential effect on export flows.

5.2 Objective 2: Domestic Price Transmission Effects (Equ. 2)

This objective investigates whether external market dependence and policy shocks transmit to India's internal agricultural conditions, measured through domestic Producer_Prices. These channels are evaluated using the coefficients β_5, β_4, and β_3 in Equ. 2.

Objective 2a: Geopolitical Risk and Domestic Producer Prices

This hypothesis tests whether importer-side geopolitical uncertainty (GPR) affects domestic agricultural price formation in India.

$$H_0 : \beta_5 = 0$$
$$H_a : \beta_5 \neq 0$$

The Null Hypothesis (H_0) states that GPR does not significantly influence India's Producer_Prices. The Alternative Hypothesis (H_a) asserts that GPR significantly affects domestic producer price stability.

Objective 2b: Importer Market Reliance and Domestic Price Transmission

This hypothesis examines whether importer dependence on India measured by Import_Share affects domestic price formation.

$$H_0 : \beta_4 = 0$$
$$H_a : \beta_4 \neq 0$$

The Null Hypothesis (H_0) asserts that Import_Share does not significantly influence internal Producer_Prices. The Alternative Hypothesis (H_a) maintains that importer reliance transmits into India's domestic price structure.

Objective 2c: Policy Shock Transmission to Domestic Prices

This supplemental hypothesis evaluates whether the MoU produces differential domestic price effects, tested through the DiD coefficient β_3 in Equ. 2.

$$H_0 : \beta_3 = 0$$
$$H_a : \beta_3 \neq 0$$

The Null Hypothesis (H_0) posits that the MoU does not significantly affect India's domestic Producer_Prices. The Alternative Hypothesis (H_a) asserts that the MoU induces a statistically significant differential domestic price effect.

6 Data and Methodology

6.1 Data Sources

The empirical analysis requires three primary data inputs to construct the necessary variables for the Differences-in-Differences (DiD) models:

- Trade Value (Bilateral and Global): Source: UN ComtradePlus [https://comtradeplus.un.org/] Details: Provides monthly trade flow data for approximately 12 years. Bilateral trade values between the African country and India serve as the dependent variable in the Trade_Value equation.
- Export Share: Source: Calculated from UN ComtradePlus data. Details: This variable, which measures market dependence, is calculated by taking the ratio of the exporter's trade of the specific commodity with the importer to its total global trade of that commodity in a given month.
- Price (Domestic Commodity Price): Source: FAOSTAT [https://www.fao.org/faostat/en] Details: Provides time-series data on the domestic prices of the specific agricultural commodity within the exporting nation. This data is essential for the Price equation to assess how external policy changes (via the MoU) affect internal agricultural stability and farmer incomes.
- GPR (Country specific value): Source: Geopolitical Risk Index [https://www.matteoiacoviello.com/gpr.htm]. Details: Provides country specific values of the GPR index which shows us the uncertainity in the country, this is based on frequency of newspaper articles involving geopolitical tensions and its economic effects.

The time series for the empirical analysis covers a period of 12 years, from 2013 to 2025, which allows for a robust assessment of pre- and post-MoU policy impacts and trade volatility over a long-term horizon.

6.2 Memorandums of Understanding

6.2.1 MoU between India and Malawi

A Memorandum of Understanding (MoU) was signed on 16 June 2021 between the Government of the Republic of India and the Government of the Republic of Malawi with the objective of strengthening cooperation in the trade of Tur (also known as Arhar Dal or pigeon peas). The competent authorities designated under the MoU are India's Department of Consumer Affairs, operating under the Ministry of Consumer Affairs, Food and Public Distribution, and Malawi's Ministry of Trade.

The central mechanism of the MoU is India's annual purchase commitment. Under this arrangement, India agreed to import 50,000 metric tonnes of Tur from Malawi each financial year. The commitment was explicitly structured to be fulfilled through private-sector trade channels and was agreed upon for a period of five financial years, from 2021–22 to 2025–26. A mandatory annual review is held each January; if the review identifies a shortfall in Malawi's exports relative to the agreed quota, the Government of India is permitted to allocate the shortfall amount for import from alternative supplier countries.

To oversee implementation, the two parties established a Joint Monitoring Committee tasked with meeting annually to monitor progress and resolve operational challenges. The MoU entered into force on the date of signing and is valid for five years. It is designed to be automatically renewable for successive terms unless terminated by either party with 90 days' notice. In the event of renewal, the parties are required to negotiate new quantitative targets to replace the original quota specified in Article 3. All payments arising from trade conducted under this MoU are to be settled in a freely convertible currency.

6.2.2 MoU between India and Mauritius

A separate protocol governing the import of fresh mangoes from India into Mauritius was formalised between India's Department of Agriculture and Cooperation and Mauritius's Ministry of Agro-Industry and Food Security. Signed on 11 March 2015, the protocol specifies phytosanitary conditions and authorises the import of mangoes exclusively during the period from 1 April to 31 August each year. The protocol was designed to operationalise and expand upon an existing Memorandum of Understanding on Plant Health Cooperation between the two countries. It was initially effective for five years, with provisions for extension or termination by either party with six months' written notice.

The protocol outlines two authorised phytosanitary treatment methods. The first method, Vapour Heat Treatment (VHT), requires the innermost pulp of the mango to reach a temperature of 47.8°C and remain at or above that level for a minimum of 20 minutes. The second method, Hot Water Treatment (HWT), involves immersing the fruits in water at 48°C for a duration proportional to fruit weight: 60 minutes for fruits up to 500 grams, 75 minutes for fruits up to 700 grams, and 90 minutes for fruits up to 900 grams. All treatments must be conducted in packing facilities registered with and audited by India's Official Plant Protection Service, and the mangoes must originate from orchards officially registered for export.

The protocol further specifies packaging and compliance requirements. Treated mangoes must be packed in clean, soil-free cartons with labelling to ensure traceability, and precautions must be taken to prevent re-infestation post-treatment. India's Plant Protection Service must carry out a pre-export inspection and issue a Phytosanitary Certificate detailing the treatment performed and the origin of the consignment. Upon arrival in Mauritius, the consignment is subjected to inspection by Mauritian authorities. Any detection of non-compliance or the presence of live fruit flies results in the consignment being either re-shipped or destroyed in accordance with local regulations.

6.3 Variables

This subsection details the core variables used in the empirical analysis. Each variable corresponds to the components of Equations 1 and 2 and is essential for examining bilateral trade flows, market dependence, geopolitical dynamics, and domestic agricultural outcomes.

- **Trade Value**: The variable *Trade_Value* represents the monetary value of bilateral trade between the exporting country and the importing partner. It is measured in current U.S. dollars and is obtained from the United Nations Comtrade database. This variable captures the aggregate value of all shipments corresponding to the commodity-specific HS codes identified through the MoU documentation. As the primary dependent variable in Equation 1, it reflects how external policy shocks, market dependence, and geopolitical conditions influence the exporter's performance over time. This variable is usually taken a logarithm of to prevent outliers from skewing the regression.

- **Price**: The variable *Price* denotes the producer price of the commodity within the exporting country's domestic market. These data are taken from the Food and Agriculture Organization's (FAO) FAOSTAT database, which provides the agricultural price series in US dollars. As the dependent variable in Equation 2, *Price* serves to evaluate whether external trade relationships and geopolitical factors transmit into domestic agricultural price formation, thereby affecting producer welfare and market stability.

- **Import Share**: The variable *Import_Share* measures the degree of importer-side market reliance on the exporter. It is defined as the ratio of the importing country's total imports of the commodity sourced from the exporter to its total global imports of the same commodity. This variable captures the structural concentration of the importer's sourcing pattern and is used as a key explanatory variable (β_4) in both empirical models. A higher *Import_Share* indicates stronger dependency on the exporter, which may amplify transmission channels affecting both bilateral trade volumes and domestic price behavior.

- **GPR**: The variable *GPR* refers to the standardized Geopolitical Risk Index, taken from the official GPR dataset maintained by Caldara and Iacoviello. The index quantifies the level of geopolitical tension and uncertainty associated with each country and varies across time. As an explanatory variable (β_5), *GPR* captures the extent to which importer-side geopolitical instability influences bilateral trade flows, and whether such external uncertainty transmits into the exporter's internal agricultural price structure. A higher GPR reflects greater geopolitical risk, which can influence trade patterns, supply chain stability, and market expectations.

6.4 Methodology

The core of our empirical strategy is the Differences-in-Differences (DiD) model, which is employed to assess the causal impact of the Memorandum of Understanding (MoU) as a trade policy shock. This methodology requires two African countries for analysis: a treatment country that has an MoU in effect with India, and a control country selected on the basis of comparable export share to the treatment country, to the importer. This careful selection of a counterfactual ensures that differences in outcomes can credibly be attributed to the MoU rather than general trade dynamics.

The DiD framework uses three primary dummy variables, formally defined below:

$$\text{Country}_c = \begin{cases} 1 & \text{if country } c \text{ is the MoU participant (Treatment)} \\ 0 & \text{otherwise (Control)} \end{cases}$$

$$\text{Post\_MoU}_t = \begin{cases} 1 & \text{if time } t \text{ occurs during the years the MoU is active} \\ 0 & \text{otherwise (Pre-MoU period)} \end{cases}$$

$$\text{MoU\_Effect}_{ct} = \begin{cases} 1 & \text{if country } c \text{ is Treatment and time } t \text{ is Post-MoU} \\ 0 & \text{otherwise} \end{cases}$$

The interaction term MoU_Effect_{ct} captures the DiD estimator. The associated coefficient (β_3) measures the average causal impact of the MoU on either the dependent country's Trade_Value or the domestic Price relative to the control country.

$$\boxed{\ln(\text{Trade\_Value})_{ct} = \beta_0 + \beta_1 \,\text{Country}_c + \beta_2 \,\text{Post\_MoU}_t + \beta_3 \,\text{MoU\_Effect}_{ct} + \beta_4 \,\text{Import\_Share}_c + \beta_5 \,\text{GPR}_c + \epsilon_{ct}} \quad (1)$$

Equation 1 evaluates the determinants of bilateral trade flows. In this specification, β_3 measures the causal effect of the MoU on Trade_Value through the DiD interaction term. The coefficient β_4 captures the ratio of imports that the importer gets from the exporter country to the amount of imports the importer gets from all countries including the importer (measured through Import_Share_c) systematically influences the level of trade between the two countries. Meanwhile, the coefficient β_5 evaluates whether geopolitical and policy uncertainty in the importing country (GPR_c) significantly affects bilateral trade flows. Together, these parameters allow us to assess the combined roles of policy shocks, structural reliance, and geopolitical risk in shaping export performance.

$$\boxed{\text{Price}_{ct}\beta_0 + \beta_1 \,\text{Country}_c + \beta_2 \,\text{Post\_MoU}_t + \beta_3 \,\text{MoU\_Effect}_{ct} + \beta_4 \,\text{Import\_Share}_c + \beta_5 \,\text{GPR}_c + \epsilon_{ct}} \quad (2)$$

To evaluate the extent to which external market dependence transmits into domestic agricultural outcomes, Equation 2 applies the same empirical structure using the commodity's domestic Price, in the exporting country, as the dependent variable. Here, the coefficient β_4 tests whether reliance

on the external market as reflected by Import_Share$_c$ affects internal price formation, thereby indicating the degree of market integration. A statistically significant β_4 reveals that variation in external dependence directly alters the domestic price structure, providing insight into agricultural stability, farmer welfare, and supply-chain responsiveness.

The coefficient β_5 in Equation 2 captures the effect of geopolitical uncertainty on domestic prices, allowing us to assess whether shifts in importer-side risk conditions translate into domestic market volatility. Finally, the DiD term (β_3) identifies whether the MoU policy shock has a differential effect on domestic prices relative to the control country, offering insight into how international agreements and policy changes propagate into internal agricultural markets.

Bilateral agreements such as MoUs serve as the defining policy instruments governing the timing, scope, and identification strategy of this study. These documents specify the commodity coverage, enabling precise mapping to Harmonized System (HS) codes for data extraction. The "Date of Signing" establishes the onset of the policy treatment and provides the temporal anchor for constructing the Post_MoU$_t$ and MoU_Effect$_{ct}$ variables. Additionally, MoUs typically establish Joint Monitoring Committees tasked with ensuring implementation, along with provisions governing renewal and termination, which provide clear boundaries for modeling the duration and intensity of the policy shock within the empirical framework.

7 Results and Findings

7.1 Results for MoU between India and Malawi

Variable	Mean	Std Dev	Minimum	Maximum	Count
Trade Value	63,92,856.59	1,20,45,920.32	12,994.00	10,27,02,315.00	259
Price	566.61	92.92	452.20	797.40	248
Import Share	0.12	0.14	0.00	1.00	259
GPR	0.20	0.11	0.06	0.76	259

Table 1.1: Descriptive statistics

The descriptive statistics in Table 1.1 provide an overview of the key variables used in the analysis of the pigeon peas trade between Malawi, Tanzania, and India. Trade Value displays substantial variability, with a large standard deviation relative to the mean, reflecting the highly volatile nature of India's import volumes driven by seasonal production patterns and periodic policy interventions. Domestic producer prices exhibit a comparatively narrower range, consistent with the more stable mandi price environment within India. Import Share ranges from 0 to 1, indicating that India's sourcing mix fluctuates considerably across periods, alternating between concentrated reliance on a single exporter and more diversified procurement. The Geopolitical Risk (GPR) indicator also exhibits meaningful variation, suggesting that geopolitical conditions in the exporting countries change enough over time to serve as a relevant explanatory variable in the empirical analysis.

Variable	Estimate	Std. Error	p-value
(Intercept)	13.4583	0.2679	0.0000***
Country Dummy	0.0804	0.2365	0.7341
Post MoU Dummy	0.8518	0.3131	0.0070***
MoU in Effect Dummy	0.3336	0.4116	0.4185
Import Share	7.5289	0.6987	0.0000***
GPR_importer	-2.3617	1.2078	0.0518*

Table 1.2: Results of regression of Equ. 1, $R^2 = 0.39$

The Trade Value regression (Equation 1) examines the determinants of India's pigeon peas import volumes from Malawi and Tanzania, treating Malawi as the treatment country under the 2021 MoU and Tanzania as the control country without a comparable bilateral agreement. The results shed light on the structural drivers of bilateral trade flows and the extent to which policy shocks, market concentration, and geopolitical volatility shape import patterns.

Objective 1a. The coefficient on GPR_importer is negative (–2.36) and statistically significant at the 10% level, indicating that higher geopolitical risk in Malawi or Tanzania is associated with

lower Indian import volumes. This finding supports the theoretical expectation that political instability increases uncertainty in export reliability, raises transaction risks, and disrupts trade logistics. In agricultural commodity markets where shipments must be timely and predictable, such instability discourages importers from depending on high-risk suppliers.

The significance of the GPR variable is notable given that imports under the MoU operate through private-sector trade. Private traders are particularly sensitive to political and regulatory uncertainty because it directly affects access to trade credit, insurance costs, shipping reliability, and contract enforcement. As GPR increases, the perceived risk premium associated with importing from the affected country rises, leading traders to substitute toward more stable suppliers.

Objective 1b. The coefficient on Import Share is strongly positive (7.53) and highly significant at the 1% level, making it the most influential determinant in the Trade Value regression. This indicates that when India sources a larger proportion of its total pigeon pea imports from Malawi or Tanzania, the corresponding import volume from that country increases substantially. This relationship reflects a structural pattern of market reliance, where concentrated sourcing naturally amplifies bilateral trade flows.

This outcome is consistent with the nature of India's pigeon pea market. Indian demand for pulses is relatively inelastic, and domestic production frequently falls short due to climatic variability and agro-ecological constraints. As a result, India often depends heavily on specific exporting countries during deficit years, causing Import Share to spike and trade volumes to increase correspondingly. This mechanism explains the strong magnitude and significance of the coefficient.

The relationship also reflects deeper, long-term commercial linkages. When a country becomes a major supplier to India, it often benefits from established trade relationships, familiarity with Indian quality standards, and reduced transaction costs. These structural advantages contribute to greater trade volumes even in the absence of policy interventions.

Objective 1c. The coefficient on the MoU in Effect Dummy is positive (0.33) but statistically insignificant, suggesting that the MoU between India and Malawi did not generate a measurable differential increase in imports when compared to Tanzania. Despite the MoU's annual quota commitment of 50,000 MT, the regression results show that the policy did not translate into higher realised import volumes during the post-MoU period.

One plausible explanation is that Malawi has consistently struggled to supply the full committed quantity. Production instability, weak aggregation capacity, and logistical challenges have limited Malawi's ability to meet the annual quota. This is highlighted even more by the fact that even though Malawi exports almost 90 percentage of its produce, India has to import from exports like Tanzania. When Malawi under-supplies, India reallocates sourcing to Tanzania or other global suppliers, thereby weakening the treatment–control contrast required for a significant DiD effect. This substitution behaviour dampens the MoU's measurable impact.

Another factor is that the MoU specifies private-sector implementation rather than government

procurement. Private traders respond primarily to market incentives rather than policy directives, meaning that the MoU does not guarantee increased trade unless Malawi's farm-gate prices, export margins, and logistical efficiency make the trade commercially attractive. In years when these conditions are unfavourable, the policy effect becomes negligible.

Variable	**Estimate**	**Std. Error**	**p-value**
(Intercept)	511.3862	10.9168	0.0000***
Country Dummy	181.3154	9.6386	0.0000***
Post MoU Dummy	58.6591	12.7621	0.0000***
MoU in Effect Dummy	-198.0230	16.7757	0.0000***
Import Share	10.8088	28.4735	0.7046
GPR_importer	-96.2745	49.2192	0.0517*

Table 1.3: Results of regression of Equ. 2, $R^2 = 0.66$

Equation 2 evaluates how external trade dependence, geopolitical conditions, and India's MoU policy shock transmit into the domestic producer prices of pigeon peas in the exporting countries, Malawi (treatment) and Tanzania (control). The results provide insight into how external trade concentration and India's policy actions ripple back into the exporter's internal agricultural economy.

Objective 2a. The coefficient on GPR_importer (–96.27) is negative and marginally significant at the 10% level ($p = 0.0517$), indicating that increases in geopolitical uncertainty within the exporting country are associated with declines in domestic producer prices. This result implies that political tension or instability in Malawi or Tanzania suppresses domestic agricultural prices for pigeon peas.

One explanation is that geopolitical risk introduces uncertainty into export logistics, financing, and contract stability. When export prospects become uncertain, traders reduce procurement from farmers, lowering farm-gate prices. Moreover, political instability often disrupts local transportation, market access, and storage capacity all of which weaken bargaining power for farmers. This weakens internal price formation independent of global demand conditions.

Additionally, geopolitical tensions are often accompanied by capital flight and currency instability, which may reduce agricultural input affordability and compress margins. Farmers may offload produce quickly to avoid risk of spoilage or local market volatility, contributing further to downward price pressure.

Objective 2b. The coefficient on Import Share (10.81) is positive but statistically insignificant ($p = 0.7046$), indicating that the degree to which Malawi or Tanzania depend on India as a buyer does not meaningfully affect their domestic producer prices.

This suggests that even though India is the dominant consumer of pigeon peas globally, this dependency does not translate into price-setting influence inside the exporting economy. The

domestic price appears driven more by local supply-side agricultural conditions than by the proportion of exports destined for India.

In addition, the exporting countries lack the advanced value chain infrastructure needed for external market conditions to immediately transmit to rural farm-gate prices (limited cold storage, fragmented markets, high transportation costs). Because the domestic supply chain is so segmented, export concentration does not automatically generate stronger or weaker domestic prices.

Objective 2c. The coefficient for MoU in Effect Dummy is strongly negative (–198.02) and highly statistically significant ($p < 0.001$), indicating a sharp decline in Malawi's producer prices relative to Tanzania after the MoU's implementation. This means that India's purchase commitment meant to provide export security corresponded with lower, not higher, domestic prices for Malawi's farmers.

This outcome reflects the asymmetric market power inherent in the India–Malawi trade relationship. Because Malawi exports a large share of its pigeon peas to India, India's quota-based purchase commitment may have locked Malawi into a lower price band, effectively reducing the bargaining power of exporters and local aggregators. When India establishes a fixed annual import quota, middlemen anticipate predictable demand at stable prices and reduce the prices they offer to farmers in Malawi.

Furthermore, the expectation of increased export certainty may have encouraged greater production or market arrivals in Malawi, which without corresponding improvements in domestic procurement systems led to excess supply and lower domestic prices. The MoU structure also does not guarantee price floors; it only guarantees quantity. This asymmetry allows India, as the sole buyer, to dictate weaker price terms indirectly.

7.2 Results for MoU between India and Mauritius

Variable	Mean	Std Dev	Minimum	Maximum	Count
Trade Value	12,145.36	20,136.50	23.00	2,27,390.00	232
Price	786.46	49.02	700.40	854.80	222
Import Share	0.48	0.39	-	1.00	232
GPR	-	1.00	-1.40	6.11	232

Table 2.1: Descriptive statistics

The descriptive statistics in Table 2.1 summarise the key variables used in the analysis of India's mango exports to South Africa and Mauritius. Trade Value shows a high degree of dispersion relative to its mean, reflecting the small scale and strong seasonality of India's mango export market, as well as fluctuations in importer demand across years. Producer Prices in India remain comparatively stable, with limited variation around the mean, consistent with strong domestic demand and a relatively well-integrated internal fruit market. Import Share ranges widely from 0

to 1, indicating that the extent of reliance on India as a supplier varies considerably between the two partner countries and across time. The Geopolitical Risk (GPR) index displays substantial variation, suggesting that the importing countries experience periodic shifts in geopolitical uncertainty that may affect bilateral trade outcomes.

Variable	**Estimate**	**Std. Error**	**p-value**
(Intercept)	8.1746	0.3166	0.0000***
Country Dummy	-1.0794	0.5304	0.0432**
Post MoU Dummy	-0.2905	0.3159	0.3589
MoU in Effect Dummy	0.3389	0.5693	0.5523
Import Share	1.8280	0.2751	0.0000***
GPR_importer	0.3686	0.1148	0.0015***

Table 2.2: Results of regression of Equ. , $R^2 = 0.22$

This table reports the estimated coefficients from the Trade Value equation for India's mango exports to Mauritius and South Africa. It evaluates how geopolitical risk, import dependence, and the Mauritius phytosanitary protocol influence bilateral export flows. The results help identify the key determinants shaping India's seasonal mango trade performance.

Objective 1a. The coefficient on GPR_importer is positive (0.37) and strongly significant at the 1% level, indicating that geopolitical risk in the importing countries Mauritius or South Africa is associated with higher export volumes of mangoes from India. This result contrasts sharply with the pigeon peas case and reflects the asymmetry of the market: India is the dominant global mango supplier, while both African partners depend heavily on Indian horticultural imports during the April–August window. As political volatility increases, these countries prioritise stable and trusted suppliers, resulting in elevated demand for Indian shipments.

In addition, the institutional structure of the Mauritius protocol strengthens this relationship. The phytosanitary agreement restricts permissible import months and requires Indian mangoes to undergo stringent VHT or HWT treatments in certified facilities. During periods of geopolitical tension, the importing country is less likely to diversify away from India because alternative suppliers either lack certification or have weaker institutional coordination. Thus, geopolitical instability can increase India's relative attractiveness as a supplier.

Taken together, the evidence leads to a rejection of the null hypothesis under Objective 1a. Geopolitical risk in the importing African partners has a statistically significant and directionally positive effect on India's mango export flows, consistent with a scenario where importers rely more heavily on the stable, high-quality Indian fruit supply during uncertain periods.

Objective 1b. The coefficient on Import Share is strongly positive (1.83) and highly significant at the 1% level, indicating that when the importing country sources a higher proportion of its global mango imports from India, the total bilateral trade volume from India expands

substantially. This confirms the expected structural dependence: India is the preferred supplier for both countries due to quality, varietal reputation (notably Alphonso and Kesar), and dominance in the global premium mango market.

More importantly, the seasonal nature of mango exports intensifies this dynamic. The Mauritius protocol explicitly limits export months, and South Africa's import demand is also heavily seasonal. During this compressed window, concentrated reliance on India becomes even more pronounced. An increase in Import Share therefore reflects both structural dependence and the absence of real substitutability, making India the de facto supplier for the duration of the season.

Objective 1c. The coefficient on the MoU in Effect Dummy is positive (0.34) but statistically insignificant, suggesting that the phytosanitary protocol between India and Mauritius did not produce a measurable treatment-specific increase in export volumes relative to the control country, South Africa. Unlike the Malawi pigeon peas MoU, this protocol is not a purchase commitment; it simply outlines sanitary and phyto-sanitary (SPS) conditions for mango shipments. As a result, the agreement does not create an economic shock only a regulatory pathway that formalizes an already existing trade channel.

Furthermore, compliance costs associated with Vapour Heat Treatment (VHT), Hot Water Treatment (HWT), packaging, traceability, and pre-export certification may offset any potential trade-expanding effect of the protocol. Since exporters must operate through registered orchards and approved packing houses, the institutional burden may have acted as a constraint rather than an accelerator of trade, limiting observable differences between Mauritius (treatment) and South Africa (control).

Accordingly, the null hypothesis for Objective 1c cannot be rejected. The MoU did not generate a distinct causal impact on export flows beyond underlying market conditions and structural import dependence. The insignificance of β_3 reflects the fact that the Mauritius protocol is regulatory rather than economic in nature and does not expand trade volumes in the same manner as quota-based or procurement-based MoUs.

Variable	**Estimate**	**Std. Error**	**p-value**
(Intercept)	741.8457	9.8232	0.0000***
Country Dummy	10.7868	16.4730	0.5133
Post MoU Dummy	57.0301	9.8103	0.0000***
MoU in Effect Dummy	-2.3231	17.6809	0.8956
Import Share	-19.5782	8.5454	0.0230**
GPR_importer	13.0337	3.5664	0.0003***

Table 2.3: Results of regression of Equ. 2, $R^2 = 0.30$

This table reports the regression estimates for the Price Equation, capturing how geopolitical risk, market dependence, and the Mauritius phytosanitary protocol influence India's domestic producer prices for mangoes. Comparing Mauritius with South Africa allows the model to isolate how

external conditions and regulatory arrangements shape domestic price movements during the export season.

Objective 2a. The results indicate that importer-side geopolitical risk has a positive and highly significant effect on India's domestic producer prices for mangoes. When geopolitical instability rises in Mauritius or South Africa, exporters in India appear to anticipate potential disruptions in market access, logistics, or regulatory predictability. These expectations translate into higher domestic producer prices, as sellers adjust for the increased uncertainty in securing smooth export flows during periods of heightened risk abroad.

This behaviour can be understood through the sensitivity of seasonal horticultural exports to disruptions in destination markets. Mango exports face strict timing constraints due to the short harvesting window and the perishable nature of the fruit. As a result, any increase in foreign uncertainty is interpreted by producers as an economic threat requiring compensation. The market responds through price adjustments that reflect the increased value placed on securing reliable export opportunities.

Objective 2b. The coefficient on Import Share is negative and statistically significant, suggesting that greater reliance by the importing country on Indian mangoes is associated with lower domestic producer prices in India. Rather than strengthening the exporter's bargaining position, increased dependence appears to induce competitive pricing behaviour among Indian producers seeking to preserve market presence in tightly regulated and limited-volume markets like Mauritius and South Africa.

This dynamic reflects the structure of the mango export sector. Given the perishable nature of mangoes and the narrow export window, exporters face strong incentives to maintain consistent access to these external markets. Higher Import Share signals increased importance of these destinations, prompting exporters to moderate prices to remain competitive within the constraints imposed by treatment requirements, certification costs, and limited annual export periods.

Objective 2c. The MoU effect is statistically insignificant, indicating that the Mauritius phytosanitary protocol did not produce meaningful changes in India's producer prices. This result is consistent with the nature of the protocol, which governs compliance procedures such as heat treatments, inspection standards, and orchard registration rather than imposing guaranteed purchase commitments or large structural shifts in export volumes.

Because the agreement focuses primarily on regulatory conditions rather than procurement guarantees, it does not generate the type of supply certainty or demand shock that typically influences domestic price formation. Instead, the domestic mango market remains dominated by internal production variability, domestic consumption dynamics, and export competition from other global buyers.

8 Conclusion

This study set out to examine the asymmetric vulnerabilities embedded within Indo-African agricultural trade, situating them within the broader global trend of strategic trade weaponisation. By integrating trade theory, literature on economic interdependence, and the growing body of work on geopolitical risk, the paper assessed how two specific bilateral agreements India's 2021 MoU with Malawi on pigeon peas and the 2015 Mauritius protocol for mango exports shape both international trade flows and domestic agricultural outcomes. Through a Differences-in-Differences empirical strategy, which compared control countries (Tanzania and South Africa), the analysis identified how policy shocks, market dependence, and geopolitical uncertainty influence bilateral trade values as well as internal price formation.

Across both commodity systems, the findings highlight a consistent pattern: structural dependence matters far more than formal agreements. Import Share emerges as a strong, positive, and statistically significant determinant of India's exports for both pigeon peas and mangoes. When a partner country relies heavily on India for its imports, bilateral trade volumes expand predictably regardless of policy interventions. This reinforces the central idea of asymmetric interdependence: concentrated reliance amplifies trade flows but also exposes the exporting partner to potential vulnerability should the dominant market alter its policy stance.

Geopolitical risk also plays a significant role, though with directionally different effects depending on the commodity. For pigeon peas, higher geopolitical risk in Malawi or Tanzania suppresses Indian import volumes, reflecting traders' reluctance to source from politically unstable regions for a staple commodity. Conversely, for mango exports, geopolitical risk in Mauritius or South Africa increases India's export volumes likely because India is perceived as a stable and indispensable supplier during uncertain periods. These contrasting results demonstrate that the strategic behaviour of trading partners depends heavily on commodity characteristics, perishability, procurement structures, and the degree of substitutability in global markets.

The findings concerning the MoUs themselves are perhaps the most revealing. Neither the Malawi pigeon pea MoU nor the Mauritius mango protocol produced a statistically significant positive treatment effect on export volumes. For Malawi, the absence of a measurable impact reflects chronic supply-side constraints, volatility in production, and India's continued reliance on diversified sourcing when Malawi fails to meet quota commitments. The Mauritius protocol likewise did not expand trade because it functioned primarily as a sanitary and phytosanitary regulatory framework rather than an economic incentive or procurement guarantee. These results underscore that MoUs alone especially those without price support, guaranteed procurement, or government-backed logistics may not meaningfully alter trade patterns in asymmetric relationships.

The domestic price findings deepen this interpretation. In the pigeon pea case, the MoU is associated with a significant decline in Malawi's domestic producer prices, revealing a counterintuitive but politically salient outcome: a policy aimed at stabilising export prospects may unintentionally weaken farmer incomes when the dominant buyer holds disproportionate market power. Meanwhile, for mangoes, neither the protocol nor the bilateral relationship meaningfully increases domestic Indian producer prices; instead, prices respond more to geopolitical risk and

market concentration than to the regulatory agreement itself. This confirms that India's internal agricultural market dynamics are largely insulated from MoU-based external shocks unless the agreement includes explicit procurement commitments or significant market expansion.

Taken together, the results illustrate that the weaponisation of trade does not require explicit coercion; it emerges organically from situations where one partner possesses overwhelming market power and the other relies heavily on access to a single external market. In such environments, even routine policy shifts, regulatory protocols, or geopolitical fluctuations can generate significant economic consequences for the weaker partner. India's role as a stable and large consumer market positions it as a structurally dominant actor, shaping agricultural incentives, domestic price formation, and export behaviour in African partner countries regardless of the written terms of any MoU.

For policymakers, these findings highlight both opportunity and responsibility. For India, MoUs serve as strategic tools that can stabilise supply, support domestic price management, and manage seasonal demand pressures. For African exporting countries, however, reliance on a single market can exacerbate domestic volatility unless supported by complementary measures such as investment in storage, aggregation, certification infrastructure, and diversification of export destinations. Strengthening the institutional capacity to meet quality standards, expanding market access, and reducing sensitivity to external policy shifts are essential for mitigating vulnerability.

Ultimately, this study underscores the importance of understanding trade agreements not simply as contractual arrangements but as instruments embedded within broader geopolitical and structural realities. In a global economy increasingly shaped by uncertainty and strategic behaviour, quantifying dependence and identifying vulnerability become indispensable for designing resilient agricultural systems. The evidence presented here demonstrates that without structural diversification and domestic capacity building, MoUs may stabilise bilateral trade relations on the surface while deepening underlying asymmetries beneath them. Future research may extend this framework to additional commodities, incorporate firm-level or farm-level data, and analyse how emerging African regional trade blocs could alter the balance of dependence in Indo-African agricultural exchanges.

9 References

1. Feldhaus, L., Huang, Y., Kim, S., Lee, J. S., Marechal, D., Sun, X., & Weiss, S. (2020). The weaponization of Trade. A study of modern trade conflicts from the mid-1900s to present. New York: School of International and Public Affairs (Columbia University).

2. Crozet, M., Hinz, J., Stammann, A., & Wanner, J. (2021). Worth the pain? Firms' exporting behaviour to countries under sanctions. European Economic Review, 134, 103683.

3. Gartzke, E., & Li, Q. (2003). Measure for measure: Concept operationalization and the trade interdependence-conflict debate. Journal of peace research, 40(5), 553-571.

4. De Silva, N., Malaga, J. E., & Johnson, J. W. (2013). Trade liberalization effects on agricultural production growth: the case of Sri Lanka.

5. Storm, S. (1997). Agriculture under trade policy reform: A quantitative assessment for India. World Development, 25(3), 425-436.

6. Dellink, R., Dervisholli, E., & Nenci, S. (2020). A quantitative analysis of trends in agricultural and food global value chains (GVCs).

7. Parvadavardini Soundarrajan, P. S., & Nagarajan Vivek, N. V. (2015). A study on the agricultural value chain financing in India.

8. Swain, B. B. (2012). Determinants of farmers' participation in contract farming: the cases of gherkin and paddy seed in Andhra Pradesh, India. Millennial Asia, 3(2), 169-185.

9. Kulkarni, S. S., Dave, R., Bhatia, U., & Kumar, R. (2022). On the evolution of agricultural and non-agricultural produce flow network in India. arXiv preprint arXiv:2207.12058.

10. Thakur, P., Mehta, P., Lal, P., Chaudhary, R., Pani, S. K., Singh, A. G., ... Sharma, P. (2024). Agricultural produce supply chain network of Capsicum: empirical evidence from India. Economies,12(1), 24.

11. Prasad, G., Vuyyuru, U. R., & Gupta, M. D. (2019). Agriculture commodity arrival prediction using remote sensing data: insights and beyond. arXiv preprint arXiv:1906.07573.

12. Bhatia, M., & Bhat, G. M. J. (2020). Agriculture supply chain management-an operational perspective. Brazilian Journal of Operations & Production Management, 17(4), 1-18.

13. Jain, A., Marvaniya, S., Godbole, S., & Munigala, V. (2020). A framework for crop price forecasting in emerging economies by analysing the quality of time-series data. arXiv preprint arXiv:2009.04171.

14. Jäkel, I. C., Østervig, S., & Yalcin, E. (2024). The effects of heterogeneous sanctions on exporting firms: Evidence from Denmark. Review of International Economics, 32(1), 161-189.

15. Mani, G., Joshi, P. K., & Ashok, M. V. (2017). Financing Agriculture Value Chains in India Challenges and Opportunities. © Springer Nature Singapore Pte Ltd.

16. Bathla, S. (2013). Volatility in agriculture commodity prices in India: Impact and macroeconomic and sector-specific policy responses. Indian Journal of Economics and Development, 9(4), 291-304.

17. Caldara, D., Iacoviello, M., Molligo, P., Prestipino, A., & Raffo, A. (2020). The economic effects of trade policy uncertainty. Journal of Monetary Economics, 109, 38-59.

18. Zhu, Y., & Sardana, D. (2020). Multinational enterprises' risk mitigation strategies in emerging markets: A political coalition perspective. Journal of World Business, 55(2), 101044.

19. Meemken, E. M., & Bellemare, M. F. (2020). Smallholder farmers and contract farming in developing countries. Proceedings of the National Academy of Sciences, 117(1), 259-264.