Revisiting India's Trade Performance: The Role of Agriculture, Growth, and Demographic Pressures

[1]Dr. Md. Sarafraz Equbal

Abstract

This study investigates both the long-run and short-run influences of agricultural productivity, economic growth, and population growth on India's foreign trade during the post-reform era spanning 1990 to 2020.Using a symmetric Autoregressive Distributed Lag (ARDL) approach, the analysis captures both dynamic adjustments and long-run equilibrium relationships among the variables. The bounds testing procedure confirms the existence of co-integration. Empirical findings reveal that agricultural productivity and economic growth significantly enhance foreign trade in both the short run and long run, while population growth exerts a relatively modest influence. The error correction mechanism indicates rapid adjustment towards equilibrium after short-term shocks. The results highlight the importance of agriculture-led growth and demographic management in strengthening India's trade performance.

Keywords: *agricultural productivity, foreign trade, economic growth, population growth, symmetric ARDL model*

Introduction

Since the early 1990s, India's economic trajectory has been shaped by a series of liberalization, privatization, and globalization reforms. These measures marked a decisive transition towards an outward-oriented growth strategy. By reducing trade barriers, encouraging private sector participation, and facilitating integration with global markets, these reforms elevated foreign trade to a central role within India's development framework. Foreign trade has since contributed not only to economic growth but also to structural transformation, technological advancement, and productivity improvements across various sectors. While manufacturing and services are frequently identified as primary beneficiaries of trade liberalization, agriculture continues to play a vital, though less examined, role in shaping India's external sector performance (Pingali et al., 2019; FAOSTAT, 2019).

Agriculture remains a cornerstone of the Indian economy, employing nearly two-fifths of the workforce despite its declining share in gross domestic product. Its significance extends beyond ensuring domestic food security to include export earnings, rural income generation, and macroeconomic stability. Improvements in agricultural productivity facilitate the creation of exportable surpluses, reduce unit costs, and enhance the competitiveness of agricultural and agro-processed products in international markets. Empirical evidence from developing economies consistently demonstrates that productivity-led agricultural growth supports trade expansion and strengthens balance-of-payments positions (Awokuse & Xie, 2015; Phiri et al., 2020). In India, agriculture also provides essential raw materials for industry and supports export diversification, reinforcing its strategic importance in the trade–growth relationship.

Economic growth is another key determinant of foreign trade performance. Higher income levels expand productive capacity, improve infrastructure, and facilitate technological upgrading, all of which contribute to increased trade volumes. Growth-driven improvements in logistics, energy availability, and institutional quality further enhance a country's ability to participate effectively in global markets. Several studies indicate that economic growth stimulates exports through scale effects and increases import capacity by raising demand for capital goods and intermediate inputs (Pingali et al., 2019; Phiri et al., 2020). However, the extent to which growth leads to sustained trade expansion depends on sectoral linkages, particularly the integration of agriculture with industry and services.

Population growth introduces an additional and complex dimension to the agriculture–trade relationship. India's large and growing population presents both opportunities and challenges for trade performance. On one hand, population growth expands the labor force and domestic market

[1] *Department of Economics, University of Kashmir, Srinagar*

size, potentially supporting higher production and export capacity. On the other hand, rapid population growth can increase pressure on land, water, and food resources, thereby constraining agricultural productivity and export potential. Theoretical and empirical studies suggest that the net effect of population growth on trade and economic growth is ambiguous and highly context-specific (Miladinov et al., 2023; Jain et al., 2025). This complexity highlights the importance of incorporating demographic dynamics into empirical analyses of trade performance.

Despite a growing body of literature on the links between agriculture, economic growth, and trade, several gaps remain. Much of the existing research treats foreign trade as an indirect outcome of economic growth or aggregates agriculture within broader output measures, which may obscure its direct influence on trade performance (Awokuse & Xie, 2015; Baig et al., 2020). Furthermore, studies that focus explicitly on trade often emphasize manufacturing and services, with limited attention to agriculture's role in the post-reform era. Population dynamics are also rarely integrated with agricultural productivity and trade within a unified econometric framework, particularly in the Indian context.

In response to these gaps, the present study offers a novel contribution by explicitly modeling foreign trade as the dependent variable and examining its relationship with agricultural productivity, economic growth, and population growth in India over the post-reform period from 1990 to 2020. By employing a symmetric Autoregressive Distributed Lag (ARDL) approach, the study captures both short-run dynamics and long-run equilibrium relationships among the variables, even when they exhibit mixed orders of integration (Pesaran & Shin, 1995). The integrated framework adopted in this study places agriculture at the center of trade analysis while also accounting for demographic pressures and growth dynamics. This approach provides new and policy-relevant insights into how agriculture-led development can enhance India's external sector performance in an increasingly globalized economy.

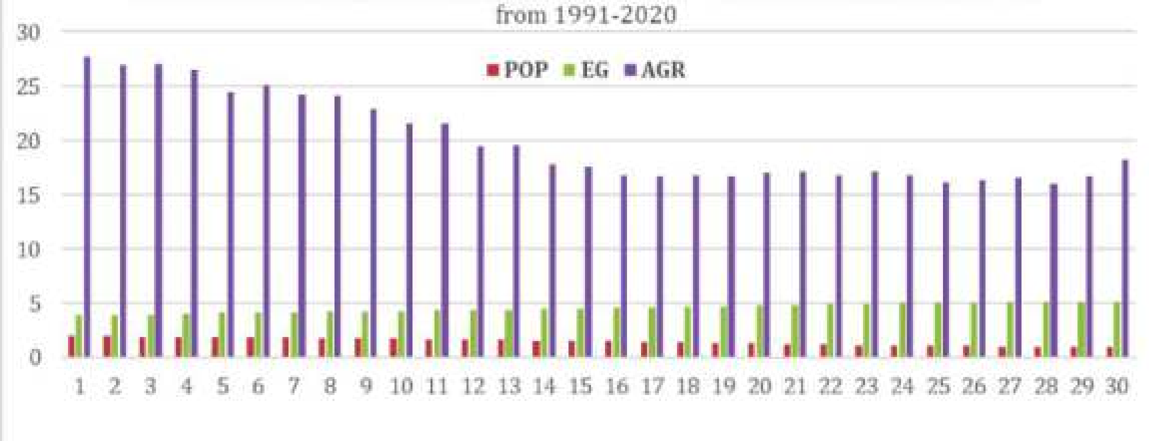

Figure 1. Economic growth, Agricultural productivty and population growth in India from 1991-2020

The remainder of the paper unfolds as follows. Section II critically surveys the relevant literature to situate the study within the existing body of knowledge. Section III details the data sources, model specification, and the time-series econometric framework underpinning the analysis. Section IV presents the empirical results and offers a rigorous interpretation of the findings. The paper concludes in Section V by synthesizing the main insights and drawing out their salient policy implications.

Literature Review

A growing strand of empirical literature has examined the role of agriculture in driving macroeconomic performance in developing economies. Numerous studies confirm that agricultural productivity contributes positively to economic growth by supplying raw materials, generating employment, and stimulating demand for industrial goods (Awokuse & Xie, 2015; Awoyemi et al., 2017; Mohammed et al., 2020). Using time-series and panel econometric techniques such as ARDL, FMOLS, and Johansen cointegration, researchers have consistently found long-run relationships between agriculture and GDP growth across countries including India, Nigeria, Ghana, and BRICS nations (Baig et al., 2020; Tsaurai, 2021). However, much of this literature treats trade as an indirect outcome of growth, rather than explicitly modeling foreign trade as a dependent variable influenced by agricultural performance.

Another body of research focuses specifically on foreign trade and economic growth, emphasizing export-led growth, trade openness, and globalization as key drivers of development. Empirical studies indicate that economic capacity and technological progress play a pivotal role in expanding trade volumes by enhancing productivity and strengthening the development of productive infrastructure (Phiri et al., 2020; Pingali et al., 2019). While these studies acknowledge agriculture's contribution to exports, they often aggregate agriculture within broader output measures or focus primarily on manufacturing and services. Consequently, the direct and quantifiable impact of agricultural productivity on foreign trade—particularly in the context of structural reforms—remains underexplored.

Population dynamics add further complexity to the agriculture–trade–growth nexus. Existing literature highlights that population growth can either support trade by expanding labor supply and domestic markets or constrain it by increasing dependency burdens and resource pressures (Miladinov et al., 2023; Jain et al., 2025). Despite this recognition, empirical studies rarely integrate population growth with agricultural productivity and trade within a unified econometric framework. Moreover, for India's post-reform era, evidence capturing both short-run and long-run dynamics using a symmetric ARDL approach is scarce. This study addresses this gap by jointly examining agricultural productivity, economic growth, and population growth as long-run determinants of foreign trade in India, thereby offering a more comprehensive and policy-relevant understanding of trade dynamics in a reform-driven economy.

Data and Methodology

This section outlines the data sources, variable construction, and econometric strategy employed to investigate the relationship between agricultural productivity and foreign trade in India. Foreign trade is considered the principal dependent variable, representing the performance of India's external sector. It is proxied by trade openness, defined as the sum of exports and imports expressed as a percentage of gross domestic product (GDP). This measure is extensively used in the empirical literature as an indicator of an economy's degree of integration with global markets. Data on trade openness are obtained from the World Development Indicators (WDI) database of the World Bank, ensuring consistency and international comparability.

The central focus of the study is to examine the symmetric impact of agricultural productivity on foreign trade, while controlling for other macroeconomic factors that may influence trade performance. To mitigate the risk of omitted variable bias and enhance the robustness of the empirical model, key control variables—namely agricultural productivity, economic growth, and population growth—are incorporated based on strong theoretical and empirical justification. Time-series data on agricultural productivity and economic growth are obtained from the World Development Indicators, while population growth statistics are sourced from the United Nations Population Division. A detailed account of the variables employed, their corresponding proxies, and measurement specifications is provided in table 1. The empirical analysis is conducted using EViews 12 and covers the period 1990–2020, a timeframe that captures significant structural reforms and evolving trade dynamics in the Indian economy. This methodological framework allows for a systematic assessment of the long-run and short-run interactions between agricultural productivity and foreign trade.

Table 1: Description and Sources of Study Variables

Variable Name	Description of Variable	Data Source
Foreign Trade (FT)	Trade openness measured as total exports and imports of goods and services as a percentage of GDP, indicating integration with the global economy.	World Development Indicators (WDI), World Bank
Agricultural Productivity (AGR)	Value added from agriculture, forestry, and fishing, representing net output after deducting intermediate inputs.	World Bank National Accounts Data and OECD National Accounts Data Files
Economic Growth (EG)	GDP per capita, calculated as total GDP divided by midyear population.	World Bank National Accounts Data and OECD National Accounts Data Files
Population Growth (POP)	Annual exponential growth rate of the midyear population.	United Nations Population Division

Source : Compiled by author

Model specification

A standard Cobb–Douglas production–type function is utilized to illustrate the relationship between agricultural productivity and CO_2 emissions.

$$FT_T = \beta_1 + \beta_2 AGR_T + \beta_3 EG_T + \beta_4 POP_T + v_T \quad (1)$$

Here, FT_T denotes foreign trade, while AGR_T, EG_T & POP_T represent agricultural productivity, economic growth, and population growth, respectively, all measured at time period T.

Autoregressive Distributed Lag Model (ARDL) of Cointegration

To examine the nexus between human development and agricultural productivity, a wide range of econometric techniques is available. In line with the objectives of the study, the Autoregressive Distributed Lag (ARDL) approach, originally developed by Pesaran and Shin (1991), has been employed. In contrast to vector autoregressive (VAR) and other traditional models that are chiefly suited to systems comprising only endogenous variables, the ARDL framework offers greater flexibility by allowing the inclusion of both endogenous and exogenous regressors within a single specification. A key advantage of the ARDL methodology is that it does not require all variables to be integrated of the same order and allows for the simultaneous estimation of both short-run dynamics and long-run equilibrium relationships. However, the applicability of the ARDL model diminishes when the order of integration of the underlying series exceeds I(1).

The ARDL approach relies on standard F-statistics and t-statistics to assess the significance of lagged variables within a univariate error-correction framework. This flexibility and robustness make the ARDL model particularly suitable for analyzing dynamic relationships in time-series data.

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_1 y_{t-2} + \cdots \beta_p y_{t-p} + a_0 x_t + a_0 x_{t-1} + \cdots + a_q x_{t-q} + \varepsilon_t \quad \text{Eq. (2)}$$

Where ε_t is the white noise error term.

Equation ((1) can be represented in ARDL form as:

$$lnFT_t = \alpha_1 + \sum_{i=1}^{p} \alpha_2 lnFT_{t-j} + \sum_{i=1}^{q} \alpha_3 lnAGR_{t-i} + \sum_{i=1}^{r} \alpha_4 lnEG_{t-i} + \sum_{i=1}^{s} \alpha_5 lnPOP_{t-i} + \rho_1 lnFT_{t-1} + \rho_2 lnAGR_{t-1} + \rho_3 lnEG_{t-1} + \rho_4 lnPOP_{t-1} + v_{1t} \quad (3)$$

Where p, q, r, and s is the optimal lag length, α_1, α_2, α_3, and α_4 are the short-run responses, while ρ_1, ρ_2, ρ_3, ρ_4, and ρ_5 represent the long run responses of independent variables and ν represents error term

Empirical Results and Discussion This section presents the econometric estimation of the specified model. First, the order of integration of the variables is examined using the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests. Subsequently, the bounds testing approach to cointegration is employed to determine the existence of a long-run relationship among the variables. Upon confirmation of cointegration, both the long-run and short-run coefficients are estimated. Finally, a series of diagnostic tests is conducted to assess the adequacy and stability of the estimated model.

Stationarity Test

The empirical analysis begins with a preliminary examination of the statistical properties of the data. To assess the stationarity characteristics of the underlying time-series variables, standard Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests are employed. These tests are conducted for all variables at both levels and first differences to determine their respective orders of integration. The results of the unit root tests are reported in Table 1 and serve as the basis for selecting the appropriate econometric methodology.

Variables	**ADF-Test**		**PP-Test**		**OI**
	Level	**First Difference**	**Level**	**First Difference**	
HD	-0.7023	-5.4812***	0.2457	-13.2186***	I(1)
AGR	0.6148	-10.1265***	-0.3659	-6.5874***	I(1)
POP	-0.9136	-3.9128***	-1.2784	-3.8651***	I(1)
EG	-5.4129	-1.4176***	-1.7243	-3.9027***	I(1)

*Note: OI denotes the order of integration. ENV refers to Environmental Sustainability, AGR to Agricultural Productivity, POP to Population Growth, and EG to Economic Growth. The symbol *** indicates statistical significance at the 1% level.*

Table 1: Unit root tests

As reported in Table 1, two standard unit root tests—the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests—are employed to examine the stationarity properties of the variables. While the ADF test is widely used in empirical studies, greater emphasis is placed on the PP test, as it provides more robust results by accounting for potential serial correlation and heteroskedasticity in the error terms. The results indicate that all variables become stationary after first differencing, with the corresponding p-values being statistically significant at the 1 percent level. Consequently, the variables are confirmed to be integrated of order one, I(1), under both testing procedures.

The presence of variables integrated at the I(1) level satisfies the necessary precondition for the application of the Autoregressive Distributed Lag (ARDL) approach, as proposed by Pesaran and Shin (1995). Accordingly, the ARDL bounds testing procedure is employed to examine the existence of a long-run equilibrium relationship among the variables. The bounds test assesses the possibility of cointegration by comparing the computed F-statistic with the critical value bounds. Prior to undertaking this analysis, Table 2 presents the descriptive statistics of the underlying variables, providing preliminary insights into their central tendencies and dispersion.

	FT	AGR	EG	POP
Mean	1.203418	20.18452	4.612384	1.498762
Median	1.048927	18.02671	4.598213	1.531406
Maximum	1.912763	28.10435	5.244918	2.087315
Minimum	0.702914	16.28419	3.915402	0.964227
Std. Dev.	0.384615	3.721508	0.392176	0.318449
Skewness	0.398721	0.689214	-0.014632	-0.118504
Kurtosis	1.741265	1.982337	1.758921	1.664283
Jarque-Bera	2.864509	3.756821	1.872640	2.215704
Probability	0.238742	0.152984	0.391267	0.330118
Sum	36.10254	605.5356	138.3715	44.96286
Sum Sq. Dev.	4.316228	415.9082	4.328417	3.039562
Observations	30	30	30	30

Table 2: Descriptive statistics *Source: Compiled by authors.*

Table 2 indicates that the standard deviation of each variable is lower than its corresponding mean, suggesting relatively low dispersion and stable variation in the underlying series over the study period. Furthermore, the Jarque–Bera statistics and their associated p-values support the assumption of normality, indicating that the variables are approximately normally distributed.

Furthermore, the existence of a long-run relationship among the variables is assessed using the ARDL Bounds testing approach, as reported in Table 3. The computed F-statistic exceeds the upper critical bound, thereby confirming the presence of cointegration among the variables. This finding implies that the variables move together in the long run despite short-term fluctuations.

Given the establishment of cointegration, the long-run coefficients are subsequently estimated using the ARDL framework, and the results are presented in the following table.

Significance Level	Lower Bound I(0)	Upper Bound I(1)	F-Statistic Value	Remark
			4.2876*	**Cointegration exists**
10%	2.29	3.19		
5%	2.72	3.61		
2.5%	3.11	4.02		
1%	3.58	4.32		
Note: Calculated by authors. * denotes the significance level of 1%.**				

Table 3: F-Bounds Test (Symmetric ARDL)

Table 3 indicates that the computed test statistic surpasses the upper bound critical value, I(1), at all conventional significance levels. This outcome confirms the existence of a long-run cointegrating relationship between human development (HD) and the set of explanatory variables. Given the establishment of cointegration, the long-run and short-run dynamics of human development with respect to the explanatory variables are subsequently estimated, as reported in Table 4.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGR	0.587214	0.093615	6.274832	0.0000
EG	0.519476	0.236908	2.193467	0.0406
POP	0.061382	0.019874	3.087521	0.0058
C	-0.701953	1.482167	-0.473586	0.6402

Table 4: ARDL Long-run Results *Source: Compiled by authors.*

The long-run ARDL estimates indicate that agricultural productivity (AGR) exerts a strong and positive influence on foreign trade, with a coefficient of 0.5872 that is statistically significant at the 1 percent level. This suggests that, ceteris paribus, a 1 percent improvement in agricultural productivity leads to approximately a 0.59 percent increase in foreign trade over the long run. The relatively large elasticity underscores the pivotal role of agriculture in shaping India's trade performance. Sustained gains in productivity generate exportable surpluses, stimulate agro-based industries, and enhance the global competitiveness of agricultural and allied products, thereby positioning agriculture as a key structural driver of trade expansion.

Economic growth (EG) also demonstrates a positive and statistically significant long-run effect on foreign trade, with a coefficient of 0.5195 significant at the 5 percent level. This implies that a 1 percent increase in economic growth raises foreign trade by about 0.52 percent in the long run. The finding reflects the capacity-enhancing effects of growth, including higher income levels, improved infrastructure, and greater production efficiency, all of which contribute to expanding trade volumes. Economic expansion further promotes export diversification and strengthens the ability to import capital goods, thereby deepening integration into the global economy.

Population growth (POP), in contrast, shows a comparatively modest but positive long-run coefficient of 0.0614, which remains statistically significant. This indicates that a 1 percent rise in population growth increases foreign trade by roughly 0.06 percent in the long run. The smaller magnitude reflects the dual nature of demographic change: while a growing population expands the labor supply and domestic market size, it also intensifies pressure on resources and consumption requirements. The positive effect suggests that India has been able to leverage demographic expansion to support trade, particularly when accompanied by improvements in productivity and economic growth. Overall, the results highlight that foreign trade growth is primarily driven by productivity-led agricultural development and sustained economic expansion, with population growth playing a supportive but comparatively limited role.

The short-run dynamics derived from the ARDL model are presented in Table 6. These results reflect the immediate impact of changes in the explanatory variables on the dependent variable and offer insights into the speed and nature of adjustment toward the long-run equilibrium.

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(LGDP)	0.362418	0.351902	1.029903	0.0168
D(LGDP(-1))	0.712584	0.329771	2.160935	0.0427
D(AGR)	0.013284	0.005106	2.602418	0.0179
D(AGR(-1))	0.009841	0.005873	1.676412	0.1086
CointEq(-1)*	-0.764295	0.149782	-5.102637	0.0001

Table 5: ARDL Short-run Results *Source: Compiled by authors.*

In the short run, both agricultural productivity and economic growth exert a positive effect on foreign trade, although their impacts are smaller than those observed in the long-run estimates. The error correction term is negative and highly significant, indicating a strong and rapid adjustment toward the long-run equilibrium following short-term disturbances. This suggests that any deviations from equilibrium caused by temporary shocks are corrected efficiently, underscoring the inherent stability of India's trade dynamics and the buffering role of agriculture-driven growth. Meanwhile, short-run variations in population growth appear to have a minimal immediate impact, implying that demographic influences on trade are more pronounced over longer time horizons.

Following the estimation of the ARDL model, the next step involves conducting a series of diagnostic tests to evaluate the adequacy and reliability of the specified model. In this study, particular emphasis is placed on tests for heteroskedasticity and serial correlation, namely the Breusch–Pagan–Godfrey test and the Breusch–Godfrey LM test. These procedures are employed to ensure that the residuals satisfy the classical regression assumptions, thereby confirming the robustness and validity of the estimated results.

Diagnostic Test	F-statistic	Prob.
Heteroskedasticity Test: Breusch–Pagan–Godfrey	0.5127	0.4783
Breusch–Godfrey Serial Correlation LM Test	0.2369	0.7085

Table 6: Diagnostic Tests *Source: Compiled by author.*

Figure 1 presents the CUSUM and CUSUMSQ tests, which are commonly employed to assess the structural stability of the estimated model over the sample period. The CUSUM test examines the stability of the recursive residuals, while the CUSUMSQ test evaluates potential sudden or gradual shifts in the variance of the residuals. In both plots, the cumulative sum lines remain within the 5 percent critical bounds throughout the period of analysis. This indicates the absence of structural breaks or parameter instability in the model. Consequently, the estimated coefficients are considered stable over time, suggesting that the underlying relationship among the variables is consistent and reliable for policy interpretation and forecasting purposes.

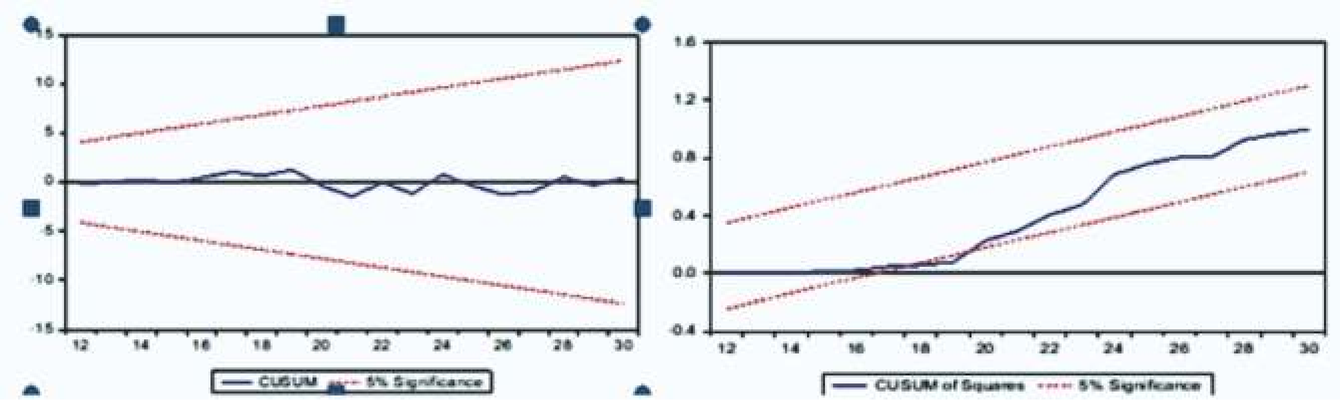

Figure 1. CUSUM and CUSUMSQ plots

Conclusion and policy implication

This study provides comprehensive empirical evidence on the inter-linkages between agricultural productivity, economic growth, population dynamics, and foreign trade in India during the post-reform period. Using a symmetric ARDL framework, the analysis confirms the existence of a stable long-run relationship among the variables. The results reveal that agricultural productivity and economic growth are the primary drivers of foreign trade expansion, while population growth plays a supportive but relatively modest role. These findings reaffirm the structural importance of agriculture in sustaining India's trade performance.

In the long run, agricultural productivity exerts a strong and positive influence on foreign trade, highlighting its role in generating exportable surpluses, supporting agro-based industries, and enhancing international competitiveness. Productivity-led agricultural growth contributes to stable and durable trade gains by reducing production costs, improving quality standards, and enabling diversification into higher value-added exports. Economic growth further strengthens trade by expanding productive capacity, improving infrastructure, and facilitating integration into global value chains. Together, these factors underscore the importance of agriculture-led growth in India's outward-oriented development strategy.

Population growth, although statistically significant, exhibits a smaller magnitude of impact on foreign trade. This suggests that demographic expansion alone isinsufficient to drive trade growth unless accompanied by productivity improvements and economic expansion. The findings imply that India's demographic potential can support trade only when supported by effective human capital development, skill formation, and resource management. Without such complementary policies, population pressures may dilute productivity gains and constrain trade performance.

From a policy perspective, the results underscore the need to integrate agricultural policy with trade strategy. Public investment in agricultural research and development, irrigation, mechanization, and climate-resilient technologies is essential for sustaining productivity growth. Strengthening rural infrastructure—such as storage facilities, cold chains, transport networks, and digital marketplaces—can reduce post-harvest losses and enhance export competitiveness. Promoting agro-processing and value addition will further integrate agriculture into global value chains and reduce dependence on primary commodity exports.

Trade policy should actively support agriculture-led exports by simplifying export procedures, improving quality certification systems, and negotiating better market access for agricultural and agro-processed products. Aligning domestic agricultural reforms with international trade commitments can help maximize gains from globalization while safeguarding farmer interests. At the same time, balanced population management policies focusing on education, health, and skill development are crucial for transforming demographic growth into a productive asset that supports trade and growth.

Overall, the study highlights that sustainable expansion of foreign trade in India requires a coherent and integrated policy framework linking agricultural productivity, economic growth, and demographic dynamics. By reinforcing agriculture's role within the broader development agenda, India can build a more resilient, inclusive, and competitive external sector. Future research may extend this analysis by exploring regional heterogeneity, sector-specific trade flows, and nonlinear or asymmetric dynamics to further enrich understanding of agriculture–trade linkages in emerging economies.

Limitations and Future Research Directions

Despite its contributions, the study is subject to several limitations that should be acknowledged. First, the analysis relies on aggregate national-level data, which may conceal substantial regional heterogeneity in agricultural productivity, economic structure, and trade performance across states. India's diverse agro-climatic conditions, infrastructure endowments, and policy environments imply that the observed relationships at the national level may not fully capture localized dynamics. In addition, the use of aggregate indicators may obscure sectoral variations within agriculture and trade, where different commodities and subsectors respond differently to productivity changes and external demand conditions. Data constraints also limit the inclusion of certain institutional and structural factors that could influence trade outcomes.

Future research could address these limitations by employing disaggregated state-level or commodity-level data to better capture regional and sectoral differences. Incorporating additional macroeconomic and policy-related variables—such as exchange rates, trade policy measures, infrastructure indicators, and technological adoption—would provide a more comprehensive understanding of the determinants of trade performance. Moreover, extending the analysis to nonlinear or asymmetric frameworks, including threshold models or nonlinear ARDL approaches, could reveal whether the effects of productivity and growth vary across different phases of economic development. Such extensions would offer deeper insights into the mechanisms underlying India's trade-led growth trajectory and support the formulation of more targeted and effective policy interventions.

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