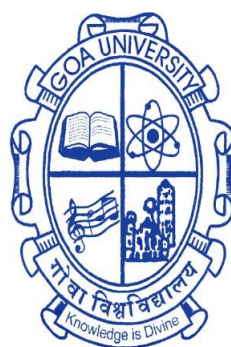


Competitiveness and Export Performance of India's Agricultural Products

A THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE
DEGREE OF
DOCTOR OF PHILOSOPHY
IN THE Goa Business School
GOA UNIVERSITY



By

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JANUARY 2026

DECLARATION

I, Ms. Averyl Pires, hereby declare that this thesis represents work which has been carried out by me and that it has not been submitted, either in part or full, to any other University or Institution for the award of any research degree.

Place: Taleigao Plateau.

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Ms. Averyl Pires

CERTIFICATE

I hereby certify that the above Declaration of the candidate, Ms. Averyl Pires, is true and the work was carried out under my supervision.

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Professor,
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CHAPTER I

INTRODUCTION

1.1. Background

India's integration into global trade plays a decisive role in shaping its economic prospects, particularly within the context of rising international competition. Export competitiveness has become a vital indicator of a nation's capacity to harness its natural resources, innovate in product development, adopt effective marketing strategies, and secure financial growth within the global marketplace. In this regard, the performance of an industry is strongly tied to its ability to remain competitive internationally, making the assessment of export competitiveness essential for understanding the strength of domestic products in terms of specialisation and diversification. Indian agricultural products enjoy a significant position in global markets, contributing to India's standing among the top ten exporters of agricultural commodities worldwide. Although agricultural exports have grown over time, their proportion within India's total export portfolio has experienced a relative decline. This trend reflects the shifting structure of India's export basket as well as the complex challenges facing the agricultural sector. The export performance of Indian agriculture is heavily influenced by global and domestic economic conditions. On the global front, developed nations continue to extend substantial support to their agricultural sectors through subsidies and institutional mechanisms, thereby enhancing their competitiveness. In contrast, the volatility of international agricultural prices has adversely affected the export prospects of developing economies like India. Domestically, policies concerning factor pricing, marketing reforms, investments in rural infrastructure, and advancements in agricultural research and technology play a crucial role in shaping export competitiveness. The competitiveness of India's agricultural exports is determined by several key factors that operate simultaneously at various levels of production, demand, and policy. The

efficient use of land and labour is fundamental, as larger cultivated areas and skilled agricultural labour contribute directly to increased production and higher export potential. The adoption of modern farming technologies and scientific cultivation practices further enhances productivity, enabling India to compete more effectively in foreign markets. Consumer demand, particularly from densely populated and rapidly growing economies, has also become a major driver of large-scale agricultural production, reinforcing the importance of aligning output with emerging global consumption patterns. Foreign Direct Investment (FDI) has played a transformative role by facilitating technology transfer, strengthening supply chain infrastructure, and improving the accessibility of international markets through better storage, transportation, and communication systems. Price policy remains another influential factor, as the inherent volatility of agricultural prices, largely dependent on unpredictable weather conditions, requires stable and rational pricing strategies to support global market demand. Finally, exchange rate movements and export incentives hold significant implications for export performance. Exchange rate adjustments, such as currency devaluation, can improve price competitiveness, while fiscal and monetary incentives help stimulate export activity by reducing the cost burdens faced by producers and exporters. Together, these interconnected factors shape the overall export competitiveness of Indian agriculture, influencing its ability to maintain and expand its position within the global agricultural trade landscape.

1.2. India's Agricultural Trade: A Brief Profile

India's agricultural trade has undergone a significant transformation since the economic reforms of 1991, marking the beginning of the Liberalisation–Privatisation–Globalisation (LPG) era. These reforms emerged from India's need to overcome a severe balance-of-payments crisis, chronic food shortages, and structural inefficiencies. With liberalisation, agriculture became a key area for export promotion, supported by policies aimed at

enhancing cost efficiency, improving quality standards, and fostering global competitiveness. The 1995 WTO Agreement on Agriculture further accelerated this transition by removing several quantitative restrictions on agricultural and consumer goods, thereby integrating India more deeply into global markets.

Between 1997 and 2005, the government introduced export subsidies and additional incentives for agro-based products, followed by the development of Agriculture Export Zones (AEZs) to strengthen market linkages and provide end-to-end support, from production to export. These initiatives enhanced farmer participation, improved marketing systems, and facilitated greater private-sector involvement. As a result, agriculture gradually shifted from a subsistence-oriented sector to one that is increasingly market-driven and export-oriented.

India's agricultural export performance over the past three decades reflects this structural transition. From 1991 to 2020, agricultural exports increased nearly 50-fold, rising from Rs. 7,838 crores to Rs. 3,05,469 crores, growing at a CAGR of around 13%. Agricultural imports also expanded significantly, from Rs. 1,205 crores in 1991 to Rs. 1,57,788 crores in 2020, due to rising domestic demand for edible oils, pulses, and other high-value commodities. While the import growth rate exceeded that of exports, India consistently maintained an agricultural trade surplus throughout the period. The share of agricultural exports in India's total merchandise exports fluctuated over time, rising from 17.8% in 1991 to 20.3% in 1996, then declining to 10.1% in 2006 as manufacturing and services gained prominence. Subsequently, it followed an uneven trend before climbing again to 14.2% in 2020. However, agricultural trade expanded faster than India's overall merchandise trade, reflecting the sector's growing integration with global markets (DGCI&S).

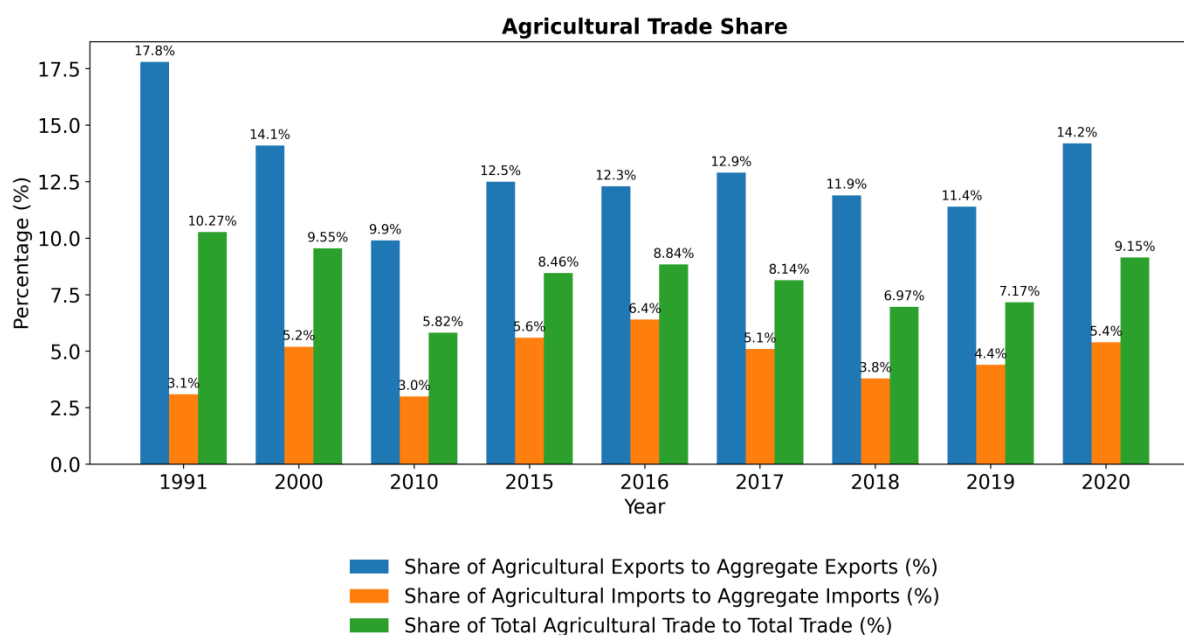
India is now among the world's leading producers and exporters of several agricultural

commodities. Major export items, including rice, spices, sugar, tea, cotton, coffee, and fresh vegetables, have shown remarkable growth in both production and export volumes. The country has moved from chronic food shortages in the 1960s to becoming food-sufficient and food-surplus, a transition supported by technological innovations, improved irrigation, increased investment, and policy reforms. As noted by Chand and Singh (2023), factors including agricultural R&D, modern farm inputs, expanded credit access, and supportive price and market policies have collectively enhanced productivity and export readiness.

According to WTO Trade Statistics (2020), India accounted for 2.07% of global agricultural exports and 1.46% of agricultural imports in 2019, highlighting its expanding role in global agri-trade. The steady rise in agricultural exports, along with renewed global demand, indicates significant potential for India to further strengthen its export competitiveness, diversify its product basket, and capture emerging opportunities in international markets.

Figure 1.1 illustrates the share of India's agricultural exports and imports in the country's total trade across selected years from 1991 to 2020. The figure highlights the broader structural shift in India's external sector during the post-reform period, especially as the economy diversified into manufacturing and services. A key observation is the steady decline in the share of agricultural exports in total exports. In 1991, agricultural goods accounted for 17.8 percent of India's total exports, but this share declined to around 12–14 percent in the 2010s. This reduction does not indicate a fall in agricultural export growth; rather, it reflects the more rapid expansion of non-agricultural exports such as engineering goods, petroleum products, pharmaceuticals, chemicals, and IT-enabled services.

Figure 1.1: India's Agricultural Trade Share



Source: Computed by author

Thus, agriculture's relative contribution to India's export basket has gradually decreased despite an increase in the absolute value of agri-exports. In contrast, the share of agricultural imports remains consistently low, ranging between 3 and 6 percent over the entire period. This suggests that India remains largely self-reliant in food production, importing mainly edible oils, pulses, and a few plantation crops during periods of domestic shortages. The low share of agricultural imports also reflects the impact of domestic support policies such as MSP, buffer stocks, and trade regulations. Finally, the combined agricultural trade share (exports plus imports) shows a moderate downward trend, declining from over 10 percent in the early 1990s to around 7–9 percent in recent years. This indicates that although agriculture remains an important component of India's trade, its relative share has declined as non-agricultural sectors have grown more rapidly.

1.3. Studies on India's Agricultural Export Competitiveness

Research on the export competitiveness of India's agricultural sector has traditionally focused on three major analytical approaches: RCA-based measures, Constant Market

Share (CMS) decomposition, and econometric analyses of export determinants. Early studies using Balassa's RCA index showed that India holds a strong comparative advantage in traditional commodities such as rice, spices, tea, cotton, and oilseeds, although this advantage varies across years and destinations (Balassa, 1965; Bhattacharya 2011). Later works refined this with RSCA and Revealed Competitiveness measures to capture long-term stability in competitiveness (Vollrath, 1991; Laursen, 2015). A second stream of research used the CMS framework to decompose India's export growth into world demand, commodity composition, and competitiveness effects. Several CMS-based studies concluded that India benefited largely from favourable world demand, while pure competitiveness effects remained inconsistent across commodities (Tiwari & Devi, 2017; Bano & Scrimgeour, 2012). Econometric studies added further insight by examining determinants such as exchange rate movements, domestic production, global prices, infrastructural constraints, and trade policies. These works collectively highlight that agricultural export performance in India is shaped by both structural domestic factors and shifting global market conditions (Kumar & Rai, 2019; Chand & Singh, 2023).

More recent literature has expanded to include analyses of India's trade margins and export diversification. Studies using extensive–intensive margin decomposition found that India's agricultural export growth has been driven mainly by the intensive margin, growth within existing products, rather than diversification into new commodities or markets (Aggarwal & Ray, 2020; Das & Paul, 2021). Emerging research applying the product space and economic complexity framework shows that India's agricultural exports remain concentrated in low-complexity items, with limited transition towards higher-value clusters (Hidalgo et al., 2007; Sharma et al., 2018). Despite these contributions, noticeable research gaps persist. Few studies analyse competitiveness at a highly disaggregated level (HS-4/HS-6), and even fewer integrate RCA, CMS, trade margins, and econometric modelling

within a single framework. Existing literature also overlooks structural transformation, opportunity gain, and proximity-based upgrading potential in India's agricultural export basket. These gaps justify the need for a comprehensive and multi-method analysis, such as the present study, which examines long-term competitiveness trends using diverse analytical tools.

1.4. Statement of the Research Problem

The current study is attempting to examine the export competitiveness of India's agricultural products in a global environment where agricultural trade has become increasingly competitive, yet India's export performance remains constrained by slow production growth, high domestic demand, lack of price competitiveness, inadequate infrastructure, and limited market intelligence. Although agricultural exports peaked in 2020, sustaining this momentum requires strengthening competitiveness through improved quality, diversification, and strategic market positioning. Competitiveness depends not only on production and pricing challenges but also on India's ability to meet global standards, enhance value addition, and respond to shifting international demand. Despite the recognised benefits of strong export competitiveness, such as foreign exchange earnings, improved market access, and more efficient export processes, India's agricultural sector continues to face structural, market-based, and policy-related barriers. Therefore, the specific research problem is to assess India's agricultural export performance in terms of comparative advantage, stability, diversification, trade specialisation, responsiveness to exchange rate movements, and the contribution of extensive and intensive trade margins, using comparative advantage indices, Constant Market Share (CMS) analysis, and other relevant analytical tools. This overarching problem is further broken down into the research questions presented below.

1.5. Research Questions

1. How does India's comparative advantage of agricultural exports manifest itself in the international market?
2. Which agricultural product categories have the greatest revealed comparative advantage in India as compared to other nations?
3. What is the pattern of stability of the comparative advantage of agricultural exports?
4. What are the changes in the trade specialisation pattern of agricultural exports between different points in time?
5. How can India's agricultural export growth be decomposed to identify the contribution of different market and product effects by using the Constant Market Share (CMS) analysis?
6. What is the contribution of the extensive and intensive margins to India's export growth?
7. What are the factors determining India's extensive and intensive trade margins?
8. How do agricultural exports respond to changes in the exchange rate in the post-reform period?

1.6. Objectives of the Study

The broad objective of the study is to analyse the performance of India's agricultural trade during 1991-2020. This is divided into the following specific research objectives,

1. To measure the comparative advantage of India's agricultural commodities vis-à-vis other countries using trade indicators.
2. To examine the stability and convergence of the comparative advantage of India's agricultural commodities based on Galtonian regressions.
3. To apply Constant Market Share (CMS) analysis for India's agricultural exports and to examine the trade margins (intensive and extensive) to identify the key sources and drivers

of export growth.

4. To measure the impact of exchange rates on agricultural exports in India in the post-reform period.

1.7. Hypotheses of the Study

H₁: India's agricultural commodities exhibit a significant Revealed Comparative Advantage in traditional and resource-based products.

H₂: The comparative advantage of Indian agricultural exports demonstrates β -convergence over time.

H₃: Extensive margins contribute more significantly to export growth than intensive margins.

H₄: Exchange rate depreciation positively influences India's agricultural exports in the long run.

1.8. Importance of the Study

This study holds significance for its theoretical integration, empirical depth, and policy relevance in advancing the understanding of India's agricultural export competitiveness. Theoretically, it contributes to trade literature by integrating multiple analytical frameworks such as Revealed Comparative Advantage (RCA), Constant Market Share (CMS) decomposition, and exchange rate dynamics, within a unified empirical structure. By linking static competitiveness measures (RCA, RSCA, TBI) with dynamic performance models (CMS and trade margins), the study offers a more comprehensive explanation of how structural, competitiveness, and macroeconomic factors together shape export outcomes. It further advances theoretical understanding by connecting comparative

advantage, structural transformation, and exchange rate effects in a developing-country context.

Empirically, the research presents a comprehensive analysis of India's agricultural export performance. It examines 24 agricultural product groups across 20 major trading partners over a 30-year period (1991–2020), using detailed disaggregation of export commodities at HS-2, HS-4, and HS-6 levels. The study provides new evidence on the evolution and convergence of comparative advantage, changes in trade specialisation patterns, and the decomposition of export growth using CMS to identify structural, competitiveness, and market effects. It also assesses the contribution of intensive and extensive trade margins to export expansion and evaluates the long-run impact of bilateral exchange rate movements using advanced econometric techniques such as PPML gravity models, System GMM, and PMG-ARDL. These empirical contributions enrich the understanding of product-level heterogeneity and long-term export dynamics that have received limited attention in earlier literature.

From a policy perspective, the study's findings have direct implications for India's Agri-export Policy, foreign trade diversification efforts, and exchange rate management. By identifying product categories with persistent or emerging comparative advantage, the results can assist policymakers in prioritising high-potential exports and strategically selecting partner markets. Insights into convergence patterns and product space dynamics support policies aimed at export diversification, value addition, and capability building. Additionally, understanding the sensitivity of agricultural exports to exchange rate fluctuations can help design more stable and growth-oriented trade and macroeconomic policies. Together, these contributions can strengthen long-term export competitiveness and enhance income opportunities for agricultural producers.

1.9. Research Methodology

The study employs a combination of descriptive and analytical methods to achieve its stated objectives. Both qualitative and quantitative analyses are undertaken, drawing on extensive literature from academic journals, books, working papers, institutional reports, and online databases. The analysis is based entirely on secondary data covering the period 1991–2020, sourced primarily from the WITS (World Integrated Trade Solution), APEDA (Agricultural and Processed Food Products Export Development Authority), UN COMTRADE, and WTO databases. The period 1991–2020 is selected as it captures the post-liberalisation phase of the Indian economy, beginning with the 1991 economic reforms that significantly transformed India's trade and agricultural export structure. This time span also allows for an examination of long-term trends and structural changes in agricultural exports across multiple decades under evolving global trade regimes.

1.9.1. Analytical Framework

Table 1.1 provides the analytical framework linking the research objective to its corresponding methodology, data source, and expected output, as summarised in the table below.

Table 1.1: Analytical Framework of the Study

Objective	Methodology	Data Source	Key Output
1. Measure the comparative advantage of India's	Revealed Comparative Advantage (RCA)	WITS	Product-wise and partner-wise- regional groupings & bilateral

agricultural commodities			RCA values
2. Analyse stability and convergence of comparative advantage	Other measures of RCA, RSCA & TBI; Galtonian regression, β -convergence analysis, product mapping & product spacing	WITS	Convergence coefficients and stability trends of RSCA & TBI
3. Decompose export growth and analyse trade margins	Constant Market Share (CMS) decomposition (Ahmadi & Esfahani, 2006), Intensive and Extensive Margin analysis (Hummels & Klenow, 2005) and the gravity model for determinants of trade margins	WITS, WDI, IMF, FAO, CEPII	Contribution of scale, competitive & second order effects and trade margin effects of extensive & intensive
4. Examine the impact of exchange rates on agricultural exports	PPML gravity model, System GMM, and PMG-ARDL	WITS, WDI, IMF, FAO, CEPII	Short and long-run exchange rate elasticities and partner-specific effects

1.9.2. Methodological Details

1. **Measurement of Comparative Advantage:** India's comparative advantage in agricultural exports is measured using RCA at the HS-4 level across major regional

blocs (EU-27, East Asia & Pacific, South Asia, Latin America, and LDCs) and for India's top 20 trade partners.

2. **Stability and Convergence Analysis:** RSCA and TBI values are analysed for persistence and temporal stability using Galtonian regression and β -convergence models to examine whether comparative advantages across products and partners are converging or diverging over time. RSCA and TBI indices are used to identify core products and map export specialisation.
3. **CMS and Trade Margin Decomposition:** The CMS approach (Ahmadi & Esfahani, 2006) decomposes export growth into scale, competitive, and second-order effects. Intensive and extensive margins (Hummels & Klenow, 2005) capture the role of existing versus new trade relationships. Determinants of trade margins are estimated using an augmented gravity model with FGLS and PPML estimators for robustness.
4. **Exchange Rate and Export Relationship:** The influence of bilateral exchange rate movements on agricultural exports is examined using PPML gravity models, System GMM, and PMG-ARDL. These models capture both short- and long-run effects while addressing zero trade flows, endogeneity, and heterogeneity across partners. Control variables include partner GDP, India's agricultural output, world agricultural prices, India's tariff, and the distance between India and trade partners.

Robustness and Sensitivity Analysis

Multiple validation checks are performed to ensure the reliability and robustness of results.

Sensitivity analysis is conducted by varying model specifications, time windows (decadal comparisons), and alternative competitiveness indicators. Cross-method verification, such as comparing PPML and FGLS estimates, CMS and trade margin decompositions, is used to confirm the consistency of findings. These robustness checks enhance the credibility and methodological rigour of the study's empirical results.

1.10. Limitations of the Study

The study relies on secondary data, and its validity depends on the accuracy and completeness of these sources. It covers the period from 1991 to 2020, and the conclusions drawn are therefore applicable only to this timeframe. The duration and scope of analysis for each objective are constrained by the availability of data. Additionally, the factors selected as determinants are limited to those for which data were accessible, leaving room for incorporating additional variables in future research. The study does not account for the impact of external shocks such as the COVID-19 pandemic, which may have influenced recent agricultural export dynamics.

1.11. Chapter Scheme

The study is systematically organised into seven chapters, each addressing specific aspects of India's agricultural trade performance and collectively contributing to the overall research objectives.

Chapter I introduces the study by presenting the background and context of India's agricultural trade within the global economy. It outlines India's trade profile, highlighting key trends and structural changes over time. The chapter clearly defines the research problem and explains the relevance and significance of the study in the context of trade competitiveness and export performance. It further specifies the objectives of the study and formulates the corresponding research hypotheses. The methodological framework adopted

to achieve these objectives is discussed, followed by an outline of the chapter scheme and the limitations of the study.

Chapter II develops the theoretical framework underpinning the study and provides a comprehensive review of existing literature on comparative advantage, export competitiveness, trade margins, and related empirical studies. This review situates the present research within the broader body of scholarly work and critically evaluates previous findings. Based on this assessment, the chapter identifies the research gap that the current study seeks to address.

Chapter III focuses on the theoretical foundation of the Revealed Comparative Advantage (RCA) index and presents an empirical analysis of India's RCA performance. The results and discussion include product-wise and country-wise classifications of comparative advantage, incorporating regional groupings and an analysis of India's top 20 bilateral trading partners.

Chapter IV extends the analysis by incorporating alternative measures of comparative advantage, including RSCA and TBI, along with product mapping, product spacing, and the stability of export specialisation. The chapter presents a detailed product-wise trend analysis and employs Galtonian regression to examine the persistence and stability of India's export patterns.

Chapter V examines the theoretical and empirical literature on Constant Market Share (CMS) analysis and trade margins. The results and discussion analyse the growth of India's agricultural exports through extensive and intensive margins and identify their determinants using an augmented gravity model.

Chapter VI analyses the evolution of India's exchange rate behaviour and its relationship with agricultural trade. Advanced econometric techniques such as PPML gravity models, System GMM, and PMG-ARDL are employed to capture both short-run and long-run

dynamics while addressing issues of zero trade flows and endogeneity.

Chapter VII concludes the study by summarising the major findings, drawing conclusions, offering policy recommendations, outlining the study's contributions, and suggesting avenues for future research.

CHAPTER II

AGRICULTURAL EXPORT COMPETITIVENESS – A THEORETICAL AND EMPIRICAL REVIEW

2.1 Introduction

The chapter presents a comprehensive review of the theoretical and empirical literature on India's agricultural export performance and identifies the research gap to conceptualise the research problem. A well-structured literature review not only identifies the evolution of ideas and frameworks in the field but also situates the present study within existing scholarly debates. An effective literature review provides both the context and justification for new research by critically examining what has been done and identifying the gaps that remain (Hart, 1998). The chapter adopts a concept-centric approach, organising the literature thematically around key determinants of export performance, rather than summarising individual studies in isolation, as suggested by Webster and Watson (2002). The literature review in the chapter adopted both a synthesis and an argument, linking prior research to the study's objectives and analytical model for a deeper understanding of the research problem (Ridley, 2012).

The chapter is structured to build a logical bridge between the research questions, theoretical underpinnings, and empirical findings. It begins by outlining major theoretical perspectives on international trade, including comparative advantage, new trade theory, and firm heterogeneity models. It then examines empirical evidence on export competitiveness, specialisation, and market share dynamics, with special reference to agricultural trade and developing economies. The subsequent sections explore literature on extensive and intensive trade margins, exchange rate movements, and other structural determinants shaping export growth.

By integrating these strands, the review establishes the conceptual foundations necessary for analysing India's agricultural exports over three decades. It also delineates how the current study extends prior research by combining comparative advantage indices, Constant Market Share (CMS) decomposition, and econometric modelling of trade margins and exchange rate dynamics. The insights drawn from this literature form the analytical framework guiding the empirical investigation presented in the following chapters.

2.2 Theoretical Framework of Agricultural Trade Performance:

The theoretical framework of agricultural trade performance integrates classical, modern, and empirical perspectives to explain how nations engage in and benefit from agricultural trade. Classical and neoclassical theories, such as those of Ricardo and Heckscher–Ohlin, emphasise comparative advantage, factor endowments, and specialisation, while modern trade theories highlight increasing returns, product differentiation, and firm heterogeneity as drivers of export expansion. The Constant Market Share (CMS) framework complements these by decomposing export growth into structural and competitiveness effects, offering insights into shifts in market performance. Theories on extensive and intensive margins further explain trade growth through diversification and deepening of export relationships, particularly under firm-level heterogeneity and productivity dynamics. Finally, exchange rate theories, including the Marshall–Lerner condition, J-curve hypothesis, and exchange rate pass-through, link macroeconomic fluctuations with export competitiveness. Together, these perspectives provide a comprehensive theoretical basis for analysing agricultural export performance, diversification, and competitiveness in a changing global environment.

2.2.1 Classical and Neoclassical Trade Theories

The theoretical foundations of international trade have evolved from classical to neoclassical thought, providing the analytical basis for understanding agricultural trade performance. Classical theories, developed during the late eighteenth and early nineteenth centuries, emphasised the role of specialisation and labour productivity as key determinants of trade patterns. These early frameworks established the principle that international trade enhances welfare by allowing nations to exploit their relative efficiencies in production. Neoclassical extensions, emerging in the twentieth century, refined these ideas by introducing factor endowments, resource allocation, and price mechanisms as determinants of comparative advantage. Together, these theories continue to underpin modern interpretations of agricultural trade and competitiveness, especially in explaining how differences in resources, technology, and productivity influence agricultural exports and imports.

Smith's Theory of Absolute Advantage: Adam Smith (1776), in *The Wealth of Nations*, laid the groundwork for trade theory through his concept of absolute advantage. He argued that countries should specialise in producing goods for which they have an absolute cost advantage, meaning they can produce more efficiently than other nations using the same amount of resources. By trading these goods, all countries can gain from specialisation and exchange, leading to higher global output and welfare. In the agricultural context, Smith's theory implies that nations endowed with fertile land, favourable climate, or advanced farming techniques can gain by exporting agricultural commodities where they hold an absolute advantage. For example, tropical countries with suitable agro-climatic conditions tend to export crops like coffee, tea, and spices, whereas temperate economies focus on grains or livestock. Smith's approach thus highlights the role of natural endowments and productive efficiency in shaping agricultural trade flows.

Ricardo's Theory of Comparative Advantage: David Ricardo (1817) advanced trade theory by introducing the concept of comparative advantage, which remains the cornerstone of classical trade analysis. Ricardo demonstrated that trade benefits nations even if one country is more efficient in producing all goods, as long as there are differences in relative production costs. According to this principle, countries should specialise in goods where their opportunity cost of production is lower relative to others. In agriculture, comparative advantage explains why nations with relatively lower opportunity costs in labour-intensive or land-intensive crops engage in their export, while importing other products that are more costly to produce domestically. This framework underscores the idea that trade patterns are driven by relative, not absolute, efficiencies. In the modern agricultural sector, comparative advantage continues to explain patterns of specialisation, where factors such as labour productivity, resource availability, and technological adaptation influence competitiveness over time.

Heckscher–Ohlin (H–O) Model: The Heckscher–Ohlin (H–O) model, developed by Eli Heckscher (1919) and Bertil Ohlin (1933), provided a neoclassical extension to classical trade theory. It postulates that trade arises due to differences in factor endowments among nations, specifically labour, land, and capital. Countries tend to export goods that intensively use their abundant and relatively cheap factors, and import goods that require scarce factors. Applied to agricultural trade, the H–O model suggests that land-abundant and labour-abundant countries have a natural advantage in producing agricultural commodities, whereas capital-abundant countries specialise in manufactured goods. This model has been particularly relevant in explaining the agricultural export structures of developing economies like India, where abundant labour and arable land contribute to competitive advantages in specific agricultural subsectors. The H–O framework also forms the basis for analysing how trade liberalisation and resource allocation affect agricultural

income distribution and structural transformation.

Stolper–Samuelson Theorem and Factor Price Equalisation: Building upon the H–O framework, the Stolper–Samuelson theorem (1941) and the factor price equalisation theorem further refined the relationship between trade, income distribution, and resource returns. The Stolper–Samuelson theorem posits that trade liberalisation benefits the owners of a country's abundant factor while harming those owning its scarce factor. In the agricultural context, this implies that opening up to trade raises returns to land and unskilled labour in land-abundant economies, while potentially reducing wages or profits in sectors using scarce factors. The factor price equalisation concept extends this reasoning, suggesting that free trade tends to equalise factor prices (wages, rents, and returns to capital) across countries, assuming identical production technologies and perfect competition (Krugman & Obstfeld, 2009). However, empirical evidence shows that full equalisation rarely occurs due to differences in technology, policy barriers, and factor mobility constraints, particularly prevalent in agricultural markets characterised by subsidies, tariffs, and non-tariff measures.

Relevance to Agricultural Trade Performance: Collectively, classical and neoclassical theories provide a robust foundation for analysing agricultural trade performance. They highlight how comparative cost advantages, factor endowments, and price mechanisms determine patterns of specialisation and competitiveness. While classical models emphasise productivity and specialisation, the neoclassical frameworks extend the analysis to include factor proportions and income distribution effects. These theories also offer insights into structural changes within agriculture, where dynamic shifts in productivity, resource use, and technology continually redefine a nation's comparative advantage. For

developing economies like India, understanding these theoretical underpinnings is crucial for explaining export diversification, competitiveness, and the evolution of trade patterns in agricultural commodities over time.

2.2.2 Modern Trade Theories and Extensions

While classical and neoclassical trade theories provided the foundational understanding of international trade based on comparative advantage and factor endowments, they assumed homogeneous firms, constant returns to scale, and perfect competition. However, these assumptions failed to explain key empirical realities such as intra-industry trade among similar economies, product differentiation, and variations in firm-level export behaviour. To address these gaps, **modern trade theories**, notably the *New Trade Theory (NTT)* and the *New New Trade Theory (NNTT)*, emerged, incorporating increasing returns to scale, market imperfections, and firm heterogeneity into the analysis of international trade patterns. These frameworks have greatly expanded the understanding of agricultural trade, particularly in explaining how productivity, scale economies, and firm-level decisions shape export performance in developing economies.

Product Differentiation and Increasing Returns: Paul Krugman's (1980) New Trade Theory revolutionised international economics by introducing increasing returns to scale and product differentiation as key drivers of trade. Unlike traditional models, where trade arose solely due to comparative advantage, Krugman's model demonstrated that trade can occur even between countries with similar resource endowments if firms produce differentiated products under monopolistic competition. This framework explains how specialisation, driven by economies of scale, can enhance productivity and welfare even without factor endowment differences.

In the context of agricultural trade, product differentiation is increasingly relevant as countries diversify from bulk commodity exports to high-value and processed agricultural products. For instance, developing countries like India are expanding exports of branded spices, processed foods, and niche organic products, forms of differentiation that reflect both scale economies and market segmentation. The Krugman model thus provides an important theoretical lens for understanding how innovation, branding, and quality differentiation contribute to export competitiveness in modern agriculture.

Intra-Industry Trade and the New Trade Theory: A major implication of the New Trade Theory is the concept of intra-industry trade, where nations simultaneously export and import similar types of goods. Helpman and Krugman (1985) formalised this idea, showing that trade between countries with comparable income levels and technological capabilities can arise due to consumers' preference for variety and firms' pursuit of economies of scale. In agriculture, this phenomenon can be seen in the trade of processed food items or similar crop varieties (e.g., different types of rice or fruits) across countries.

This perspective challenges the earlier dichotomy between primary and manufactured goods, suggesting that agricultural trade is not solely inter-industry but increasingly intra-industry in nature. The global rise in agribusiness, food processing, and agro-industrial value chains underscores how specialisation and differentiation coexist in agricultural trade. For developing countries, participation in intra-industry trade reflects structural transformation, moving from raw commodity exports toward value-added agricultural products that integrate into global value chains.

The Melitz (2003) Model: Firm Heterogeneity and Export Participation- Building on the insights of New Trade Theory, Melitz (2003) introduced firm-level heterogeneity into international trade analysis, giving rise to what is now known as the New Trade Theory.

Melitz's model posits that only the most productive firms can overcome the fixed costs associated with exporting, leading to self-selection into international markets. Less productive firms remain focused on domestic sales, while the least efficient exit the market. Trade liberalisation thus reallocates resources toward more productive firms, raising overall industry productivity.

This framework is particularly insightful for understanding agricultural trade performance in developing economies, where heterogeneity among producers is substantial. In countries like India, export participation in agriculture often depends on factors such as access to infrastructure, technology adoption, and firm scale. Larger agribusinesses and cooperatives are better positioned to meet international standards and certification requirements, while smallholders face barriers related to cost and information asymmetry. The Melitz model helps explain why trade reforms may lead to productivity-enhancing reallocations rather than uniform export expansion across all producers.

Implications for Agricultural Trade in Developing Countries: Together, the New and New Trade Theories extend the understanding of agricultural trade beyond traditional comparative advantage. They highlight the roles of economies of scale, product innovation, and firm-level productivity in determining trade patterns. For developing countries, these theories underscore the importance of policies that promote technological upgrading, quality enhancement, and export diversification. Encouraging agro-processing industries, improving logistics, and reducing fixed export costs can enable a larger share of firms to participate in global agricultural markets.

By integrating insights from Krugman (1980), Helpman and Krugman (1985), and Melitz (2003), modern trade theories offer a more dynamic framework to interpret agricultural export performance. They emphasise that competitiveness is not merely determined by

factor endowments, but also by innovation, market structure, and firm capabilities, factors increasingly critical for agricultural transformation in the 21st century.

2.3 Review of Empirical Literature

Empirical studies on comparative advantage, stability, convergence, Constant Market Share (CMS) decomposition, trade margins, and exchange-rate dynamics provide comprehensive insights into how countries specialise and compete in global agricultural markets. Using RCA/RSCA indices along with CMS and extensive–intensive margin analysis, researchers evaluate export competitiveness, structural change, and the drivers of market performance. The literature shows that technological upgrading, policy reforms, exchange-rate movements, and supply-chain capabilities shape both India’s comparative advantage and its evolving agricultural export patterns.

2.3.1 Comparative Advantage in Agricultural Trade

Empirical research on comparative advantage provides essential insights into how countries specialise and compete in agricultural trade. Ricardo's foundational idea, later operationalised by Balassa (1965) through the Revealed Comparative Advantage (RCA) index, remains central to measuring export competitiveness. RCA identifies whether a country is relatively more efficient in exporting a product than the global average. Over time, scholars refined the measure to address asymmetry and comparability issues, leading to normalised versions such as NRCA and RSCA (Vollrath, 1991; Laursen, 2015). These indicators now underpin much of the empirical work examining agricultural competitiveness, diversification, and structural change across economies.

Global and Regional Evidence on Comparative Advantage: Empirical studies show that comparative advantage evolves with productivity, technology, and trade openness. Early analyses by Balassa (1965) and Yeats (1985) emphasised that competitiveness reflects both factor endowments and dynamic efficiency. Vollrath (1991) expanded the RCA framework

by incorporating relative export and trade advantage measures. Evidence from developed regions indicates persistent comparative advantage in high-value processed foods, dairy, and meat. Bojnec and Fertő (2014) found that EU countries increasingly specialise in processed agri-foods, reflecting value-chain upgrading. In contrast, many sub-Saharan African countries retain RCA in traditional commodities like cocoa, coffee, and cotton, though supply constraints limit long-term stability (FAO, 2022). Across Asia, structural reforms have shaped competitiveness: Thailand and Vietnam maintain strong RCA in rice and seafood, while Indonesia and Malaysia have shifted toward palm oil and processed foods (FAO, 2022). These patterns highlight regional heterogeneity and the influence of policies, logistics, and technological capabilities.

Evidence from India: Commodity-wise and Partner-wise Analyses: India's agricultural trade shows persistent RCA in traditional sectors and gradual diversification into high-value and processed commodities. Early post-reform studies recorded strong RCA in tea, spices, rice, and cotton (Kumar & Chand, 2014). More recent analyses using RSCA and NRCA reveal strong but fluctuating competitiveness in cereals, spices, and marine products, while processed and perishable goods show greater volatility due to infrastructure gaps and non-tariff barriers (Gulati et al., 2019). Sharma (2018) noted improved competitiveness in marine products and basmati rice but weakening performance in raw cotton and sugar due to policy uncertainty. Bilaterally, India maintains strong export ties with the US, EU, and the Middle East for seafood, spices, and basmati rice, while South Asian markets remain key for cereals and pulses. FAO (2022) reports that India's share of world agricultural exports rose from 1 percent in the early 1990s to over 2.5 percent by 2020, though competitiveness remains concentrated in a limited set of products.

Comparative Studies with Major Agricultural Exporters: Cross-country comparisons

show structural differences in competitive strength. Brazil maintains a high RCA in soybeans, sugar, and meat due to mechanisation, research, and strong logistics (FAO, 2022). Thailand consistently performs well in rice, rubber, and processed foods. India, however, exhibits more fragmented comparative advantage, influenced by small farm sizes, variable policies, and logistical bottlenecks. Vollrath (1991) and Kumar & Chand (2014) note that while Brazil and Thailand show stable long-term competitiveness, India's RCA often fluctuates due to policy interventions. Sharma (2018) further documented how export bans and minimum export price policies disrupt competitiveness in crops like onions and pulses.

Methodological Evolution and Stability Analysis: Methodological refinements have strengthened comparative advantage measurement. While Balassa's (1965) RCA remains widely used, its limitations led to alternatives like Vollrath's (1991) trade advantage indices, Yeats' (1985) disaggregation emphasis, Laursen's (2015) RSCA, and Yu et al.'s (2009) NRCA. Stability analyses using transition matrices and Markov models (Wörz, 2005; Bojnec & Fertő, 2014) show that competitiveness is persistent in products with established supply chains but volatile in high-value perishables (Gulati et al., 2019). Econometric integration, combining RCA-type indices with panel regressions, reveals that productivity, logistics, and exchange rates significantly influence competitiveness (Nicita, 2013). For India, Kumar & Chand (2014) highlighted the role of liberalisation and productivity growth in strengthening RCA.

Overall, the empirical literature shows that agricultural comparative advantage is dynamic and shaped by technology, policy, and market conditions. While countries like Brazil and Thailand have consolidated competitiveness, India shows both resilience in traditional sectors and volatility in emerging segments. Advances in RCA-related methodologies and

stability analyses provide stronger tools for understanding these evolving patterns.

2.3.2 Stability and Convergence of Comparative Advantage

The study of comparative advantage dynamics extends beyond static assessments to examine how export specialisation patterns evolve over time. Temporal stability and convergence of comparative advantage indicate whether a country's export strengths persist or shift due to structural transformation, technological diffusion, or policy change. Stability reflects whether product-level competitiveness remains consistent, whereas convergence assesses whether countries' comparative advantages become more similar or divergent over time.

Concepts of Temporal Stability and Convergence Testing: Temporal stability implies that a country's revealed comparative advantage (RCA) patterns remain constant across periods. Persistent RCA suggests structural rigidity or path dependence, as noted by Proudman and Redding (2000), who found strong persistence due to industrial capabilities and cumulative learning. Instability, by contrast, signals adaptability and diversification. Convergence analysis evaluates whether comparative advantage levels move toward a common equilibrium. σ -convergence measures the dispersion of RCA indices; declining dispersion indicates convergence. β -convergence tests whether sectors with initially low RCA catch up with stronger performers; a negative β coefficient implies convergence. These tools help assess whether globalisation and technological progress foster equalisation in competitiveness or entrench divergence.

Empirical Methods: Markov Transition, Sigma and Beta Convergence: Empirical research employs Markov transition matrices, σ -convergence, and β -convergence. Hinloopen and Van Marrewijk (2001) advanced the Markov approach, where RCA values are grouped into classes, and transition probabilities indicate whether products remain in

the same category or shift over time. High diagonal probabilities signal strong stability; off-diagonal movements indicate structural change. They found that developed countries show strong RCA persistence, while emerging economies exhibit greater mobility as they diversify. σ -convergence tracks the standard deviation of RCA or RSCA across periods; declining values indicate convergence. Fertö and Hubbard (2003), analysing EU agricultural trade, found mixed outcomes; some subsectors converged due to integration, while others diverged because of structural differences. β -convergence, typically estimated through regressions, tests whether sectors with lower initial RCA improve faster. A negative β coefficient supports convergence and reveals dynamic adjustments in competitiveness.

Findings from Cross-Country Studies: Cross-country evidence shows mixed dynamics. Proudman and Redding (2000), using OECD data, found substantial stability in trade specialisation, with limited convergence across advanced economies. Their findings pointed to technological accumulation and increasing returns, reinforcing existing strengths, creating "convergence clubs" rather than global uniformity. Hinloopen and Van Marrewijk (2001) reported moderate RCA persistence globally, with developing economies demonstrating greater mobility due to liberalisation and structural transformation. Fertö and Hubbard (2003) found that while EU integration facilitated σ -convergence, agricultural RCA remained partly path-dependent due to natural endowments and long-standing policy regimes.

India-Specific Evidence on RCA Stability and Convergence: Indian studies show gradual but uneven adjustments in export competitiveness. Mishra and Kumar (2016) examined 1991–2013 export patterns and found persistence in several traditional agricultural products alongside growing mobility into processed and value-added goods.

Their Markov analysis showed moderate RCA stability, with movement mainly occurring within low and moderate classes. Sanjeev (2020), using σ and β convergence, found narrowing disparities among agricultural subsectors, indicating σ -convergence, but β -convergence remained slow due to structural constraints. The study emphasised the need for technological upgrading, supply-chain strengthening, and institutional reforms to accelerate convergence.

Overall, the literature suggests that comparative advantage exhibits strong persistence, especially in advanced economies, while convergence emerges slowly in developing economies undergoing structural change. Combined use of Markov transition, σ -convergence, and β -convergence provides a comprehensive framework for understanding how comparative advantage evolves within a globalising economy.

2.3.3 Trade Specialisation and Structural Shifts in Agricultural Exports

The evolution of agricultural trade structures reflects interactions between comparative advantage, policy reforms, and globalisation. Trade specialisation, the concentration of exports in specific commodities, mirrors structural economic transformation. As development progresses, countries shift from traditional, resource-based exports toward more diversified and value-added agricultural products. Empirical literature highlights the dual processes of specialisation and diversification, often measured using indices such as the Herfindahl-Hirschman Index (HHI), Theil Index, and entropy-based concentration measures.

Global Evidence on Trade Pattern Evolution: Empirical studies show that economic growth and liberalisation drive structural changes in export composition. Balassa (1979) argued that export diversification accompanies industrial and agricultural transformation, with countries gradually moving from primary to processed goods. This reflects income

effects, technological diffusion, and product cycle dynamics. De Benedictis and Tajoli (2011) found that openness and institutional quality shape whether developing economies diversify or remain concentrated. Their entropy-based results show that many developing countries initially specialise in a few high-demand commodities before diversifying as incomes and capabilities rise. Agricultural trade is especially sensitive to price shocks, policy changes, and environmental constraints, all of which influence diversification. Overall, global findings emphasise that specialisation evolves with technological and institutional change; while specialisation creates efficiency gains, excessive concentration exposes economies to volatility.

Sectoral Shifts in Indian Agricultural Exports Post-1991 Reforms: India's post-1991 trade reforms triggered significant structural shifts. Before liberalisation, agricultural exports were dominated by traditional commodities such as tea, coffee, cotton, and spices. Subsequent decades saw increasing shares of high-value and processed exports, marine products, basmati rice, horticulture, and floriculture. Veeramani (2008) showed that trade liberalisation enhanced India's responsiveness to world demand, with declining HHI values and moderate diversification in the late 1990s and early 2000s. India's WTO accession in 1995 further supported export-oriented production in horticulture, processed foods, and animal products. Joshi (2012) similarly documented compositional changes from 1980 to 2010, highlighting expansion in cereals, processed foods, and animal-based products. These shifts were supported by Agricultural Export Zones, improved cold storage, and growth in agri-processing. Market diversification toward the Middle East and East Asia strengthened India's global positioning. FAOSTAT-based studies confirm increasing global shares in rice, sugar, spices, and seafood. India now displays a dual pattern: continued specialisation in traditional strengths and gradual diversification into value-added exports.

Diversification vs. Concentration: Empirical Indicators: Concentration measures such as HHI and the Theil Index quantify structural change. Studies consistently report declining HHI and Theil values since the 1990s (Veeramani, 2008; Joshi, 2012), especially during the 2000s rise of processed exports. However, reversals occur during global price cycles or policy shocks, such as export bans on rice and pulses in the late 2000s. De Benedictis and Tajoli (2011) stress that diversification in developing economies depends heavily on policy stability, institutional quality, and logistics. Without these, diversification may stall and expose economies to volatility.

Role of Trade Liberalisation, Technology, and Policy Incentives: Post-1991 reforms reduced export controls, encouraged private investment, and enhanced competitiveness. WTO commitments and domestic initiatives such as the National Horticulture Mission and Food Processing Policy (2001) promoted value addition. Technological progress, high-yielding varieties, precision farming, and cold chain expansion helped India meet global standards and enter higher-value markets. FAOSTAT evidence indicates rising alignment with global demand for processed and specialty products. Yet export volatility, SPS barriers, and infrastructure gaps continue to constrain diversification. Studies emphasise that sustaining diversification requires coherent supply-side policies and continued investment in technology and logistics.

Overall, cumulative evidence suggests that India's agricultural exports have diversified significantly since the early 1990s, though the pace remains gradual. India's trajectory mirrors the global transition described by Balassa (1979) and De Benedictis and Tajoli (2011), with continued dependence on policy coherence and infrastructural improvements to sustain diversification and competitiveness.

2.3.4 Constant Market Share (CMS) Analysis in Agricultural Exports

The Constant Market Share (CMS) analysis provides a robust analytical framework to examine changes in a country's export performance over time. It is grounded in the idea that a nation's export growth can be decomposed into different components that reflect both structural and competitiveness effects. The CMS model serves as a bridge between trade theory and empirical performance analysis, allowing researchers to isolate the factors contributing to export gains or losses relative to world trade trends. Originally developed in the mid-twentieth century, the framework has been refined over time to incorporate various decompositions and applications, including those specific to agricultural trade and product diversification.

Conceptual Foundation of CMS Analysis: The CMS model was first proposed by Tyszynski (1951) to assess post-war export performance among European economies. The central premise of the CMS approach is that a country's export growth can be compared with global trade expansion under the assumption of constant market shares. Any deviation from this expected growth indicates a change in competitiveness. Thus, the method quantifies how much of a country's export growth is due to structural factors, such as the composition of products or markets, and how much is attributable to shifts in competitiveness.

Richardson (1971) advanced the theoretical and mathematical structure of the CMS framework by developing a decomposition model that separates total export change into distinct components: (i) *structural effect*, (ii) *competitiveness effect*, and (iii) *residual or interaction effect*. The structural effect captures changes in export performance resulting from the distribution of exports across faster- or slower-growing markets or product categories. The competitiveness effect measures the country's ability to increase or maintain its market share relative to competitors, reflecting factors such as price

competitiveness, product quality, and marketing strategies. The residual effect represents the interaction between market structure and competitiveness, accounting for simultaneous changes in both dimensions.

Refinements and Extensions of the CMS Framework: Subsequent scholars have refined the CMS methodology to improve its interpretative power and empirical application. Jepma (1986) introduced refinements that allowed for the decomposition of export growth into additional subcomponents, facilitating a more detailed understanding of competitiveness across products and markets. Fagerberg and Sollie (1987) further developed the analytical rigour of the CMS approach by incorporating technological change and productivity dynamics into the competitiveness component, thereby linking trade performance more closely with innovation and efficiency. Milana (1988) provided a generalised mathematical formulation for CMS decomposition, emphasising its compatibility with index number theory and statistical consistency.

A major adaptation of the CMS model was proposed by **Ahmadi-Esfahani (1995)**, who reformulated the method to better account for interaction effects and applied it specifically to agricultural trade analysis. Her contribution was particularly important because agricultural markets exhibit unique characteristics such as price volatility, product heterogeneity, and the influence of trade policies. The revised CMS decomposition, often termed the *multiplicative form*, offered improved insights into the competitiveness of agricultural exports by differentiating between structural shifts in global demand and genuine competitive performance changes.

Assumptions and Limitations: Despite its analytical strengths, the CMS framework operates under certain simplifying assumptions. It assumes that global demand and market structures remain exogenous and that the export performance of a country can be evaluated

independently of macroeconomic feedback effects. Moreover, it treats competitiveness as a residual component, which may obscure underlying causal factors such as technological progress, exchange rate movements, or policy interventions. Critics such as Jepma (1986) and Milana (1988) have noted that CMS results should be interpreted cautiously, as the decomposition is primarily descriptive rather than explanatory. Nevertheless, when applied carefully, particularly alongside econometric models or dynamic trade analyses, CMS provides meaningful insights into the evolving competitiveness and structure of agricultural exports.

Adaptation to Agricultural Trade: In the context of agriculture, the CMS framework has become a valuable empirical tool for analysing export competitiveness and diversification. It allows researchers to identify whether a country's agricultural export growth stems primarily from favourable market structures (e.g., rising global demand for specific commodities) or from intrinsic improvements in competitiveness such as productivity gains, product upgrading, or effective marketing strategies. For developing economies like India, the CMS approach helps assess the extent to which agricultural exports have adapted to changing world demand patterns and whether structural transformation has enhanced export resilience.

By decomposing agricultural export growth into structural and competitiveness effects, policymakers can infer whether performance improvements are due to external market conditions or domestic efficiency gains. The CMS analysis also facilitates product diversification studies by revealing shifts in export composition toward dynamic or stagnant product categories. This makes the CMS model particularly relevant in evaluating long-term trade strategies, assessing the sustainability of export growth, and identifying sectors with latent competitive potential.

Empirical evidence: developed and developing country applications: CMS applications across developed countries often show that export gains stem largely from favourable structural effects, specialisation in high-growth markets, while competitiveness effects tend to be smaller or mixed (Richardson, 1971; Leamer & Stern, 1970). OECD studies frequently highlight that world-demand composition explains much of export performance in certain periods. In developing countries, CMS typically shows rising exports driven by structural effects but accompanied by negative competitiveness effects, indicating loss of market share despite favourable demand (Jepma, 1986). This is common in agriculture, where supply constraints, SPS barriers, and quality issues hinder conversion of positive structural conditions into competitiveness gains. Sectoral CMS findings further show that bulk commodity exporters often rely on structural gains, while countries investing in upgrading, standards, and logistics demonstrate stronger competitiveness in processed and differentiated agricultural products.

CMS applications to Indian agriculture exports: India has been widely examined using CMS (Shinoj & Mathur, 2008; Kumar & Sidhu, 2013; Suresh & Bhat, 2018). Studies consistently find that structural effects played a major role in India's early post-1991 agricultural export expansion, particularly for products experiencing rising global demand (basmati rice, spices, and oilseeds). Competitiveness effects are generally mixed: many agricultural subsectors show weak or negative competitiveness due to SPS barriers, certification gaps, and logistics inefficiencies. However, processed segments, including certain spices and packaged foods, show improving competitiveness linked to policy incentives and private upgrading. HS-4 level decompositions reveal significant product heterogeneity, with some products contributing strong competitiveness gains while others rely mostly on structural advantages. Cross-period comparisons highlight policy effects, including WTO-related reforms and export-promotion schemes, which in some cases

shifted export growth from structural dependence toward competitiveness improvements (Kumar & Sidhu, 2013).

Comparative results and cross-study patterns: Common patterns include dominance of structural effects in primary-commodity-driven export expansions; stronger competitiveness effects in differentiated or processed products; and mixed results in developing countries where policy shocks generate temporary structural gains but weaken long-term competitiveness. Disaggregation greatly improves policy relevance.

2.3.5 Extensive and Intensive Margins of Export Growth

The concepts of extensive and intensive trade margins provide a theoretical framework for understanding the composition and dynamics of export growth. The extensive margin reflects the diversification of exports, measured by the number of products or markets a country engages with, while the intensive margin denotes the growth in export value of existing products or destinations (Hummels & Klenow, 2005). Together, they capture both the breadth and depth of a country's trade performance. The decomposition of export growth into these two margins has become a standard approach for analysing trade expansion and competitiveness in both developed and developing economies.

The theoretical distinction between extensive and intensive margins is closely tied to firm-level heterogeneity models in international trade. Helpman, Melitz, and Rubinstein (2008) extended the Melitz framework to explain that only the most productive firms can overcome fixed export costs, leading to variation in export participation across firms and countries. This firm-level heterogeneity determines the extensive margin, as new firms enter export markets or new products are introduced, while productivity improvements and efficiency gains within existing firms enhance the intensive margin. In this context, export

growth is not uniform but driven by firm dynamics and market selection processes, where trade liberalisation and policy reforms influence both margins differently.

In agricultural trade, these theoretical insights are particularly relevant due to the structural and productivity constraints faced by producers in developing countries. Agricultural exports often involve a combination of traditional and emerging products, where the extensive margin captures diversification into higher-value or non-traditional commodities. Amiti and Freund (2010) emphasised that productivity growth and infrastructure improvements significantly influence the ability of economies to expand along the extensive margin, while trade facilitation and cost reductions enhance the intensive margin. Besedes and Prusa (2011) further highlighted the role of export relationships' duration and stability, arguing that long-term export success depends not only on market entry but also on sustaining competitiveness through quality, efficiency, and reliability.

Thus, the theoretical underpinnings of extensive and intensive margins combine firm-level productivity, structural transformation, and policy environments. Applied to agricultural trade, this framework helps explain patterns of export diversification, the emergence of new product categories, and the persistence of trade relationships. It offers a dynamic understanding of how economies like India transition from resource-based exports to more complex, competitive agricultural products over time.

Understanding export growth through extensive and intensive margins has become central to modern trade empirics. The intensive margin reflects deeper trade with existing partners, while the extensive margin captures new products, destinations, or firms. Decomposing export growth into these margins provides insights into whether expansion stems from diversification or scaling up. Over the past two decades, the literature has combined theories of firm heterogeneity with micro and macro decomposition techniques to explain

each margin's role.

Global evidence and methodological approaches: Seminal work formalised margins decomposition and linked it to productivity and firm selection. Hummels and Klenow (2005) decomposed export growth into variety (extensive) and quality/scale (intensive), showing that both shape welfare and trade patterns. Their measurement strategies separated quantity, quality, and extensive-margin contributions. Building on Melitz-type models, later studies linked firm productivity to entry and survival, determining extensive margins through new firm or product entry and intensive margins through scale and upgrading. Methodologically, researchers use product–destination decomposition, firm-level panels, and aggregate variance decomposition. Addressing zeros, HS reclassification, and separating price from quantity effects remains essential, as price swings can distort margin measurement.

Empirical regularities show heterogeneity by development stage. High-income countries tend to grow through intensive-margin deepening and quality upgrading, while developing countries initially expand through extensive-margin diversification before transitioning to intensive-margin improvements (Hummels & Klenow, 2005). Sector, policy regime, and time period further influence these patterns.

Extensive and intensive margins in agriculture: Applying margins to agriculture reveals distinct features due to perishability, product heterogeneity, and the predominance of small producers. Empirical findings show that many developing economies first expand agriculture exports through extensive-margin niche discovery (horticulture, spices), while intensive-margin gains strengthen as supply chains and standards compliance improve. Price volatility and perishability complicate decomposition unless price effects are controlled. Besedes and Prusa (2011) stress that the survival of product-market pairs is

crucial: many new agricultural export relationships exit early due to SPS barriers, logistics constraints, or seasonal variability. Hence, margins analysis incorporates entry rates, survival probabilities, and compliance investment to distinguish temporary from durable diversification.

Empirical applications in developing countries and India: Work on developing countries often uses customs or firm-level datasets. Amiti and Freund (2010) show that China's early export growth was extensive-margin driven, later shifting toward quality upgrading and intensive-margin expansion. Besedes and Prusa (2011) highlight that only surviving entrants contribute meaningfully to long-run growth. For India, post-liberalisation agricultural export growth initially involved extensive-margin expansion, new products and destinations, driven by market discovery. However, survival remains limited without improved logistics, standards, and productivity. Recent analyses (e.g., Deb & Sarma, 2021) show that extensive-margin gains were strong, but the intensive margin expanded mainly where cold chains, processing, and contract farming improved. Subsector variation is significant: marine products and basmati rice exhibit strong intensive-margin growth, while many horticulture and processed products show short-lived extensive-margin surges.

2.3.6 Determinants of Extensive and Intensive Trade Margins

The literature identifies several determinants. Firm productivity drives selection and survival (Melitz framework), shaping persistent intensive-margin growth. Trade agreements reduce costs and stimulate extensive-margin entry but require standards compliance to translate into intensive-margin gains. Logistics and trade facilitation shape both margins by reducing uncertainty and costs. SPS standards, certification, and institutions influence survival probabilities. Entry costs and discovery processes determine

whether extensive-margin gains persist. Macro factors such as exchange rates and prices affect incentives but must be separated from true margin effects. Recent empirical work using survival models and firm-level regressions shows that converting short-term extensive-margin gains into durable intensive-margin growth requires improvements in productivity, logistics, standards, and stable market access, key priorities for India's agricultural export competitiveness.

Empirical research on the determinants of extensive and intensive trade margins has evolved alongside advances in trade theory and econometric modelling. The decomposition of export growth into these two components, where the extensive margin captures new trade relationships or product diversification, and the intensive margin reflects deepening of existing trade flows, has enabled researchers to identify structural and institutional drivers of export performance. The empirical literature relies increasingly on gravity models estimated through Feasible Generalised Least Squares (FGLS), Poisson Pseudo Maximum Likelihood (PPML), and System Generalised Method of Moments (System GMM) to address heteroskedasticity, zero trade flows, and endogeneity.

The seminal contribution of Helpman, Melitz, and Rubinstein (2008) extended the gravity framework by incorporating firm heterogeneity, demonstrating that the two margins respond differently to trade costs, market potential, and productivity. Their model showed that extensive margins, entry into new markets or products, are more sensitive to fixed export costs and market entry mechanisms, whereas intensive margins depend primarily on variable trade costs and demand conditions. Empirical applications using PPML estimators, following Silva and Tenreyro (2006), have become standard due to their robustness in handling zero or small trade flows. Egger (2002) similarly emphasised the usefulness of panel data and FGLS in capturing unobserved heterogeneity and dynamic

trade responses.

Recent literature highlights infrastructure quality, policy reforms, and institutional frameworks as critical determinants of trade margins. Efficient ports, logistics, and transport systems reduce trade costs and support both diversification (extensive margin) and expansion (intensive margin). Trade facilitation, customs reforms, and digitalisation enhance market access and product survival, reinforcing long-term export growth. Policy variables, including tariff liberalisation, trade agreements, and export promotion schemes, encourage new product entry while supporting existing trade flows. Global demand, typically captured through partner GDP, affects the intensive margin, while domestic supply-side productivity and innovation influence the extensive margin.

In the Indian context, empirical studies link extensive and intensive margin dynamics to structural reforms and globalisation. Batra and Kumar (2007), using a gravity framework, showed that India's early post-liberalisation export expansion was driven mainly by the intensive margin, whereas later decades experienced stronger growth in the extensive margin, particularly in agriculture and light manufacturing. They noted that trade agreements and tariff cuts supported market entry for new products, while infrastructure bottlenecks constrained intensive-margin growth. Kumar and Chaudhary (2019), using a PPML-based gravity model, found that reforms under the Foreign Trade Policy and improvements in India's logistics performance index positively affected both margins, with stronger effects on the extensive margin in Asian markets.

Comparative evidence from BRICS economies provides similar insights. Studies on China and Brazil link extensive-margin growth to institutional quality and large-scale logistics investment, while exchange rate stability and global demand shifts primarily influence the intensive margin. Countries like Russia and South Africa exhibit higher concentration in

intensive margins due to commodity dependence and slower diversification.

Furthermore, dynamic panel approaches such as System GMM address endogeneity between trade margins and policy variables, revealing feedback loops where export growth spurs institutional and infrastructure improvements. For India, the evidence underscores that expanding the extensive margin requires advances in trade facilitation, technology, and supply-chain efficiency, while macroeconomic stability and competitiveness drive intensive-margin expansion.

In sum, the empirical literature shows that extensive and intensive margins are shaped by structural, institutional, and demand-side factors. Methodological advances through PPML, FGLS, and System GMM have strengthened empirical findings, and evidence from India and BRICS economies highlights infrastructure, policy coherence, and global integration as central to sustaining export growth across both margins.

2.3.7 Exchange Rate and Agricultural Export Performance

Exchange rate movements play a critical role in shaping a nation's export competitiveness, particularly in developing economies where agricultural exports constitute a major share of total trade. The theoretical linkages between exchange rates and export performance are grounded in classical and modern trade models that emphasise price competitiveness, elasticity effects, and transmission mechanisms. The **Marshall–Lerner condition** provides an early theoretical foundation, suggesting that a depreciation of the domestic currency improves the trade balance if the sum of the absolute values of export and import demand elasticities exceeds unity (Goldstein & Khan, 1985). In the context of agricultural trade, where price responsiveness may be constrained by supply rigidities or quality factors, this condition highlights the importance of price sensitivity and demand elasticity in export adjustment.

Closely related is the **J-curve hypothesis**, which postulates that following currency depreciation, a country's trade balance initially deteriorates before improving over time, as the quantity response to new relative prices lags behind immediate price effects (Bahmani-Oskooee, 1991). This temporal dimension of trade adjustment has been empirically validated for several developing economies, indicating that agricultural exports often exhibit delayed responses due to production cycles, transportation lags, and market contracts.

The **exchange rate pass-through mechanism** further explains how exchange rate fluctuations are transmitted to export prices, influencing the competitiveness of agricultural goods (Dornbusch, 1988). High volatility in exchange rates can deter exporters from engaging in long-term contracts, reduce investment in export-oriented sectors, and increase hedging costs (Clark et al., 2004). Consequently, the nature of exchange rate regimes, whether fixed, managed, or floating, affects export performance differently. In developing countries, limited financial instruments and imperfect markets amplify the adverse effects of volatility.

Recent literature emphasises that exchange rate effects are also mediated by policy, infrastructure, and structural reforms. Nicita (2013) highlights that while competitive exchange rates support export diversification, their benefits are contingent on complementary measures such as trade facilitation, logistics, and institutional quality. For agricultural economies, a stable and predictable exchange rate environment encourages farmers and exporters to expand production and participate in global value chains. Thus, theoretical and empirical evidence converges on the notion that exchange rate management, along with supportive domestic policies, is central to sustaining agricultural export competitiveness in an increasingly volatile global economy.

Globally, studies show that exchange rate fluctuations have significant and often nonlinear effects on export performance. Bahmani-Oskooee and Kantipong (2001), in their analysis of Thailand's bilateral trade, found that exchange rate volatility exerts a negative impact on exports, especially agricultural goods with inelastic demand and limited hedging options. Their findings indicate that uncertainty discourages long-term contracting and foreign trade participation. Similarly, Chit, Rizov, and Willenbockel (2010), using dynamic panel estimation for emerging East Asian economies, concluded that greater volatility dampens export growth, with the effect stronger in agricultural and light manufacturing sectors than in industrial goods. These studies highlight that exchange rate stability is as crucial as the level of the exchange rate in sustaining export momentum.

The literature also identifies asymmetric responses to exchange rate changes. Depreciation tends to boost exports more strongly than appreciation suppresses them, due to structural rigidities, export commitments, and slow adjustment processes. Studies using ARDL and panel co-integration approaches find that long-run depreciation generally improves export performance, while short-run effects are softer due to adjustment lags and policy interventions. Additionally, exchange rate volatility, captured through GARCH-type models, reduces export performance by raising uncertainty in expected returns, especially in agriculture, where producers are risk-averse, and price stability is vital for production and marketing decisions.

In the Indian context, the exchange rate–export relationship reflects the post-1991 shift from a fixed to a market-determined regime. Greater flexibility increased the responsiveness of exports to currency changes but also heightened exposure to volatility. Narayan (2006), using ARDL bounds testing, found a long-run equilibrium relationship between the exchange rate and export growth, with depreciation improving export

performance. Short-run responses, however, remained weak due to structural rigidities. Dash and Kaur (2012) examined the effect of volatility on India's non-oil exports and reported that volatility negatively affects exports, although forward cover and policy measures muted the short-run impact.

Agricultural exports show distinct sensitivity to exchange rate movements because they depend on global prices, demand conditions, and domestic interventions. Dhasmana (2015), using a VECM framework, found a positive long-run association between depreciation and agricultural export expansion, with stronger effects for high-value items such as spices, tea, and marine products, and weaker responsiveness for cereals and sugar due to government controls. Exchange rate volatility was found to reduce exporters' risk-taking capacity.

The Reserve Bank of India (RBI, 2022) similarly noted that despite periods of rupee appreciation, India's agricultural exports remain resilient due to diversification, market access initiatives, and competitiveness gains. Evidence using System GMM and PPML estimators confirms that depreciation enhances export earnings, whereas excessive volatility hampers long-term planning and investment. The RBI emphasises that structural factors, logistics, trade facilitation, and technology mediate exporters' responsiveness to currency fluctuations.

Evidence from other emerging economies, such as Brazil and Indonesia, aligns with India's experience. Exchange rate depreciation boosts agricultural exports, but the advantages diminish under high volatility. Nonlinear ARDL studies also show that developing-country exporters react more strongly to depreciation than appreciation, reflecting asymmetric adjustment patterns.

In summary, the empirical literature shows that exchange rate levels and volatility significantly affect agricultural export performance through price competitiveness and uncertainty channels. Depreciation generally promotes export growth, whereas volatility suppresses it. The effects vary across commodities and time periods, shaped by market integration, infrastructure, and policy regimes. For India, stable and competitive exchange rate management, supported by better logistics, institutional reforms, and export diversification, is essential for sustaining agricultural export growth in a volatile global environment.

2.4 Synthesis of Literature and Research Gaps

The review of theoretical and empirical literature reveals that agricultural export performance and competitiveness are shaped by a complex interaction of structural, institutional, and macroeconomic factors. Classical trade theories, such as those of Ricardo and Heckscher-Ohlin, laid the foundation for understanding comparative advantage based on productivity and factor endowments. However, the limitations of these models in explaining dynamic trade patterns, product diversification, and technological upgrading led to the development of new trade theories and empirical frameworks. These include the Constant Market Share (CMS) analysis, the Gravity model, and decomposition techniques that distinguish between the extensive and intensive margins of trade. Together, these frameworks have deepened understanding of how nations, particularly developing economies, evolve within global value chains.

Theoretical Insights: The CMS approach, originally proposed by Tyszynski (1951) and refined by Leamer and Stern (1970), assumes that export growth can be decomposed into structural, competitiveness, and market effects. The model attributes changes in a country's exports to its competitiveness relative to global demand trends. This framework is valuable

in distinguishing between growth driven by favourable market conditions and that resulting from an improvement in a country's export capability. Similarly, the extensive–intensive margin framework, popularised by Hummels and Klenow (2005), allows researchers to analyse whether export growth arises from expanding existing markets (intensive margin) or entering new markets and products (extensive margin). These theoretical perspectives are central to understanding how economies diversify, sustain competitiveness, and adapt to external shocks.

The Gravity model, grounded in Anderson and van Wincoop's (2003) theoretical formulation, provides a powerful tool for estimating bilateral trade flows based on economic size, distance, and trade costs. When extended with policy and institutional variables, it captures the effects of trade agreements, infrastructure, logistics, and exchange rate movements. Recent adaptations, such as the Poisson Pseudo-Maximum Likelihood (PPML) estimator, correct for heteroskedasticity and zero trade flows, improving empirical reliability. Complementing these are convergence and stability models, which assess whether competitiveness indicators such as the Revealed Symmetric Comparative Advantage (RSCA) converge across products or partners over time, signaling structural transformation in trade.

Empirical Findings across Themes: Globally, empirical studies using the CMS model have decomposed export growth for diverse countries and sectors. Research on manufacturing exports (e.g., Ahmadi-Esfahani, 2006; Nyamekye et al., 2021) shows that competitiveness effects, rather than structural market growth, often explain differences in export performance. In agriculture, CMS analysis has been applied to a few emerging economies, revealing that product and destination diversification significantly enhances export resilience. Studies on extensive and intensive margins (e.g., Amurgo-Pacheco and

Pierola, 2008; Besedes & Prusa, 2011) find that the export growth of developing countries is primarily driven by the intensive margin in the short term and by the extensive margin over the long term, as economies discover new products and markets.

Regarding exchange rates, empirical findings remain mixed. Some studies report that exchange rate appreciation reduces export competitiveness, while others find negligible or delayed effects due to structural rigidities. In India's case, existing research has focused primarily on aggregate exports or broad commodity groups. While studies such as Mukherjee and Poirson (2000) and Kapoor and Sareen (2019) explore short-run linkages between exchange rate movements and trade flows, few examine agricultural exports or long-term dynamics using advanced models.

At the methodological frontier, recent literature emphasises the importance of integrating comparative advantage measures (RCA, RSCA, TBI) with structural decomposition and dynamic econometric frameworks. Studies using β - and σ -convergence analysis (e.g., Fertő and Hubbard, 2003; Sanidas & Shin, 2010) reveal that competitive structures tend to converge over time in open economies, reflecting structural upgrading and specialisation. However, such analyses remain rare in agricultural trade, particularly for large, diversified exporters such as India.

Methodological Limitations in Existing Studies: Despite rich theoretical development, existing empirical research reveals several methodological shortcomings. First, much of the literature remains fragmented, using isolated approaches, RCA indices, CMS decomposition, or Gravity models, without integrating them into a unified empirical framework. Second, most studies rely on aggregate data or short time spans, limiting the ability to identify long-term structural changes or convergence patterns. Third, estimation methods in earlier studies often suffer from econometric limitations such as ignoring zero

trade flows, endogeneity, or dynamic interactions between exports and macroeconomic variables.

The CMS framework, though conceptually powerful, has frequently been applied in static settings with limited product disaggregation. Similarly, studies on extensive and intensive margins often stop short of identifying their determinants or linking them with competitiveness indicators. The convergence and stability literature, though growing, rarely combines RSCA with structural decomposition or diversification metrics derived from the Product Space approach. Furthermore, most studies examining the exchange rate–export linkage in agriculture employ simple linear regression or co-integration models, overlooking dynamic panel techniques such as System GMM, PMG-ARDL, and PPML estimators that can capture heterogeneity and long-run dynamics.

Underexplored Aspects in the Indian Context: India’s agricultural export literature reflects these gaps even more sharply. Empirical studies have largely examined specific commodities such as spices, tea, coffee, or marine products, often neglecting the broader agricultural export basket. Comparative advantage analyses using RCA and RSCA indices provide useful insights but seldom consider multiple levels of product disaggregation (HS-2 and HS-4) or partner-specific variations. Likewise, most studies fail to explore the temporal stability or convergence of competitiveness across subsectors and regions.

Few attempts have been made to apply CMS decomposition to India’s agricultural sector, even though the method effectively distinguishes structural effects from competitiveness-driven changes. Studies that exist are confined to short periods or aggregated product categories, limiting their explanatory power. Similarly, while global research has increasingly focused on extensive and intensive trade margins, the Indian agricultural

literature still lacks disaggregated analyses identifying whether export growth arises from new product entries or deepening existing markets.

The influence of the exchange rate, particularly bilateral exchange rate fluctuations, on agricultural exports remains underexplored. Most Indian studies consider the exchange rate at an aggregate level, ignoring product heterogeneity and long-run dynamics. Empirical work using advanced estimators like PPML gravity models, System GMM, or PMG-ARDL remains scarce, despite their proven ability to address heteroskedasticity, endogeneity, and non-stationarity in trade data.

Thematic Synthesis and Research Gaps: Synthesising the above evidence reveals three broad patterns. First, theoretical and empirical studies collectively highlight the importance of competitiveness, diversification, and macroeconomic stability in driving agricultural export growth. Second, methodological fragmentation and limited temporal depth restrict understanding of how these factors interact dynamically. Third, the Indian context remains underrepresented in global discussions due to limited integration of methods and data coverage.

Four major research gaps emerge from this synthesis:

1. **Lack of Integrated Frameworks:** Most existing research treats comparative advantage, CMS decomposition, trade margins, and exchange rate analysis as separate domains. There is a clear need for integrated frameworks that combine these dimensions to provide a holistic picture of export performance.
2. **Limited Temporal and Structural Analysis:** Few studies explore long-term convergence or structural transformation in India's agricultural competitiveness.

Understanding stability, divergence, and club formation in RSCA patterns over time remains a critical research void.

3. **Sparse Product- and Partner-Level Evidence:** There is little evidence combining disaggregated product-level (HS-2, HS-4) and country-level (bilateral) analyses, which are essential for identifying emerging markets and potential diversification paths.
4. **Inadequate Modelling of Exchange Rate Volatility:** Existing research seldom incorporates exchange rate volatility or employs modern dynamic estimators (PPML, System GMM, PMG-ARDL) that can handle cross-sectional dependence and long-run causality.

Contribution of the Present Study: Addressing these limitations, the present study develops an integrated analytical framework combining comparative advantage indicators (RCA, RSCA, TBI) with CMS decomposition and trade margin analysis, complemented by econometric modelling of exchange rate effects. It covers a 30-year period (1991–2020) across 24 agricultural product groups and 20 major trading partners, thereby capturing both structural and macroeconomic dimensions of export performance. By applying advanced techniques such as PPML gravity estimation, System GMM, and PMG-ARDL, this study provides robust empirical evidence on competitiveness dynamics, convergence behaviour, and exchange rate sensitivity in India’s agricultural exports.

Through this synthesis, the research contributes methodologically, empirically, and substantively to the literature. It offers a comprehensive understanding of how India’s agricultural export structure has evolved in the post-reform era, identifies drivers of competitiveness across time and products, and establishes a framework that bridges theoretical, structural, and macroeconomic determinants of export growth.

2.5 Conceptual Framework of the Study

The conceptual framework of this study integrates theoretical and empirical perspectives to explain the determinants and dynamics of India's agricultural export performance. It links comparative advantage, export competitiveness, market share dynamics, trade margins, and exchange rate movements within a unified structure influenced by macroeconomic and structural factors. Drawing upon the contributions of Krugman (1980) on new trade theory, Richardson (1971) on constant market share (CMS) analysis, Melitz (2003) and Hummels & Klenow (2005) on trade margins, and Dornbusch (1988) and Bahmani-Oskooee (1991) on exchange rate dynamics, the framework captures how productivity, competitiveness, policy, and macroeconomic conditions jointly shape agricultural export outcomes in an open economy like India's.

At the foundation lies **comparative advantage**, reflecting specialisation and relative competitiveness across agricultural products. Derived from classical and new trade theories, comparative advantage is measured through the Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage (RSCA), and the Trade Balance Index (TBI). Higher RSCA values indicate stronger competitiveness and product specialisation, which form the initial driver of India's agricultural export performance.

Building on this base, the framework incorporates **export competitiveness and market share dynamics**, as explained by Richardson's (1971) Constant Market Share (CMS) model. The CMS decomposition separates export growth into structural, market, competitiveness, and interaction effects, helping to identify whether performance improvements stem from external demand conditions or from India's intrinsic competitiveness. Within India's agricultural context, this provides insights into how shifts in world demand and domestic efficiency interact to determine export outcomes.

The next linkage involves **trade margin dynamics**, based on Melitz (2003) and Hummels & Klenow (2005). Export growth can occur along two dimensions—the extensive margin (entry into new products or markets) and the intensive margin (expansion of existing exports). Comparative advantage and competitiveness improvements translate into higher trade margins when firms are productive and supported by infrastructure, policy reforms, and trade agreements. Extensive and intensive margins thus represent micro-level mechanisms through which comparative advantage and market share effects manifest in observable export growth.

Complementing these structural and firm-level dynamics are **exchange rate effects**. Exchange rate movements alter relative export prices, profitability, and competitiveness. Depreciation generally enhances export performance by improving price competitiveness, while excessive volatility can deter new export entry or diversification. Over time, exchange rate adjustments can reinforce comparative advantage in tradable sectors, making them a critical macroeconomic determinant of export behaviour.

At the macro level, **structural factors** such as trade policy, technology, and infrastructure condition these relationships. They influence comparative advantage (supply-side strength), CMS effects (demand responsiveness), trade margins (firm-level behaviour), and exchange rate transmission (price mechanisms). Collectively, these forces determine India's agricultural export growth, diversification, and stability.

Conceptual Framework of the Study



Figure 2.1: Conceptual Framework of the Study

Explanation of Hypothesised Relationships- The hypothesised relationships presented in the conceptual framework are theoretical in nature and help build the study's analytical model.

1. Comparative Advantage → Export Competitiveness (Krugman, 1980)

Higher comparative advantage enhances agricultural export competitiveness and market share by encouraging product specialisation and efficient resource use.

H₁: Comparative advantage positively influences export competitiveness.

2. Export Competitiveness → Market Share Effects (Richardson, 1971)

Sustained competitiveness raises export growth beyond what is explained by global demand, reflecting a strong competitiveness effect in CMS decomposition.

H₂: Competitiveness effects significantly explain variations in agricultural export performance.

3. Comparative Advantage → Trade Margins (Melitz, 2003; Hummels & Klenow, 2005)

Comparative advantage encourages the entry of new products or markets (extensive margin) and expansion of existing exports (intensive margin).

H₃: Comparative advantage promotes both extensive and intensive margins of exports.

4. Market Share Effects (CMS) → Trade Margins

Gains in market share can arise from diversification (extensive) or deeper market penetration (intensive), transmitting CMS competitiveness effects through trade margins.

H₄: Competitiveness improvements identified in CMS analysis positively influence trade margins.

5. Exchange Rate Dynamics → Comparative Advantage and Trade Margins (Dornbusch, 1988; Bahmani-Oskooee, 1991)

Exchange rate depreciation enhances export competitiveness and intensive margins, while excessive volatility can hinder the entry of new products.

H₅: Exchange rate depreciation and stability enhance comparative advantage and intensive margins; volatility negatively affects extensive margins.

6. Integrated Relationship: From Macro Conditions to Export Growth

Structural factors (policy, infrastructure, global demand, technology) influence:

- Comparative Advantage (supply-side capacity)
- CMS Effects (demand-side responsiveness)
- Trade Margins (firm-level adjustment)
- Exchange Rate (price transmission mechanism)
- Together, these determine agricultural export growth, diversification, and resilience.

Table 2.1 Empirical Implications of the Framework

Theoretical Base	Empirical Tool / Variable	Expected Relationship / Sign
Krugman (1980); Balassa (1965)	RCA, RSCA indices	+ve → Export competitiveness
Richardson (1971)	CMS Decomposition	+ve → Export growth

	(Competitiveness Effect)	
Melitz (2003); Hummels & Klenow (2005)	Extensive & Intensive Margin Estimation	+ve → Export expansion
Dornbusch (1988); Bahmani-Oskooee (1991)	Exchange Rate & Volatility (PPML / GMM estimation)	Depreciation → +ve; Volatility → -ve

The framework conceptualises India's agricultural export performance as an outcome of interacting mechanisms. Comparative advantage forms the foundation of export potential, while competitiveness (CMS) and trade margins translate that potential into realised export growth. Exchange rate movements moderate these relationships by influencing price competitiveness and profitability. Structural and policy factors provide the enabling environment for this process. Together, these dynamics determine the pace, composition, and stability of India's agricultural exports from 1991 to 2020.

2.6 Summary of the Chapter

This chapter provided the theoretical and empirical foundations for analysing India's agricultural export performance within the broader framework of international trade. It began with a systematic review of the evolution of international trade theory, tracing the development from classical and neo-classical theories of absolute and comparative advantage to modern trade theories that emphasise increasing returns to scale, imperfect competition, product differentiation, and firm heterogeneity. Classical contributions by Adam Smith and David Ricardo were discussed to establish the basic rationale for trade, while later developments highlighted the limitations of these models in explaining contemporary trade patterns.

The chapter then examined the contributions of New Trade Theory and New New Trade Theory, with particular emphasis on the seminal works of Krugman (1980) and Melitz

(2003). These theories provide important insights into export specialisation, market concentration, and firm-level dynamics, explaining why only more productive firms participate in export markets and how trade liberalisation influences both extensive and intensive margins of trade. Such theoretical advancements are especially relevant in understanding agricultural exports, where scale economies, market access, and firm productivity play a crucial role in shaping export outcomes.

A detailed discussion of the Constant Market Share (CMS) framework followed, highlighting its usefulness as an analytical tool for decomposing export growth into structural, competitiveness, and interaction effects. The CMS approach was shown to be particularly relevant for agricultural trade analysis, as it captures the combined influence of changing global demand, commodity composition, and country-specific competitiveness. The review demonstrated how CMS has been widely applied in both developed and developing country contexts to distinguish between export growth driven by favourable world demand conditions and that resulting from improvements in domestic competitiveness.

The empirical literature reviewed in this chapter emphasised the role of productivity enhancement, infrastructure development, logistics efficiency, trade policy reforms, and exchange rate movements in influencing export performance. Studies focusing on India's agricultural exports revealed that export growth has largely been driven by favourable structural effects and intensive-margin expansion in traditional commodities, while competitiveness effects have remained uneven across products and over time. The literature also underscored the increasing importance of market diversification, value addition through agri-processing, and compliance with quality, safety, and sanitary standards in sustaining long-term export competitiveness.

The chapter concluded by developing a comprehensive conceptual framework integrating

comparative advantage indicators, export margins, CMS decomposition, and exchange rate dynamics. This framework provides a coherent basis for analysing long-term export performance and structural transformation in India's agricultural sector and sets the stage for the subsequent chapter, which outlines the research methodology, model specification, and econometric techniques employed in the study.

CHAPTER III

COMPARATIVE ADVANTAGE OF INDIA'S AGRICULTURAL EXPORTS – AN ANALYSIS

3.1. Introduction

Classical theories of international trade explain competitiveness in terms of differences in technology, productivity, and factor endowments, as articulated in the Ricardian and Heckscher–Ohlin frameworks. While these theories provide a strong conceptual foundation for understanding comparative advantage, they face practical difficulties in empirically measuring competitiveness, particularly due to the challenge of observing pre-trade relative prices and opportunity costs. To overcome these limitations, Balassa (1965) introduced the Revealed Comparative Advantage (RCA) index as an empirical measure of trade competitiveness based on observed export performance rather than theoretical price comparisons. The RCA index compares a country's export share of a product with its corresponding share in world exports; values greater than one indicate revealed comparative advantage, while values below one signify comparative disadvantage. Owing to its simplicity, transparency, and ease of computation, RCA has become one of the most widely used indicators for assessing export specialisation and international competitiveness.

The classical foundation of comparative advantage stems from the Ricardian model, which attributes it to technological differences, and the H-O model, which links it to factor endowments and relative factor costs. Although both treat determinants as static, real-world comparative advantage evolves with technological change, institutional reforms, and productivity improvements. Conventional theory suggests countries should specialise where they hold competitive strength (Hoang et al., 2017), but short-run rigidity persists due to gradual structural shifts (Ferto et al., 2008). Later studies highlight dynamic competitiveness driven by innovation, productive capacity, labour productivity, and market share growth (Fagerberg, 1988; Siggel, 2006).

Despite its usefulness, RCA remains static and faces limitations such as asymmetry, excluding imports, cross-country comparison issues, and aggregation bias. Nonetheless, its relevance persists due to ease of interpretation and policy applicability (Gorton et al., 2000). RCA supports sector prioritisation, international benchmarking, policy formulation, and strategic planning across governments, industries, development agencies, and private firms (Hoang et al., 2017; Siggel, 2006).

Several studies have examined India's agricultural trade competitiveness using the RCA framework, but most focus on aggregate exports, a single commodity group, or short time spans. Limited research analyses comparative advantage across multiple product levels (HS-2 and HS-4), which is crucial for identifying structural and product-specific shifts. Existing work largely evaluates RCA at the global level, with minimal attention to regional or bilateral patterns, despite growing trade agreements and market diversification. Therefore, a comprehensive, long-term assessment (1991–2020) across products and markets is essential. Addressing this gap, the study applies RCA analysis using product-level, regional, and bilateral analyses.

Based on this objective, the following hypothesis is proposed:

H₁: India's agricultural commodities exhibit a significant Revealed Comparative Advantage in traditional and resource-based products.

This hypothesis serves as the empirical foundation for the subsequent analysis, guiding the measurement and interpretation of comparative advantage across multiple dimensions of India's agricultural trade.

The RCA framework offers valuable insights into how India's agricultural export competitiveness has evolved globally. Since agricultural trade is sensitive to factor endowments, policy shifts, and demand, RCA helps identify products with sustained advantage and those losing strength. This chapter applies RCA at three levels: **product-**

wise (HS-2 and HS-4) to determine specialised commodities, **regional groupings** to assess alignment with major trade blocs, and **bilateral analysis** for 20 key partners to evaluate partner-specific competitiveness. Together, these analyses provide a holistic understanding of India's agricultural comparative advantage across products, regions, and trading partners.

3.2. Methodology

This study employs the Revealed Comparative Advantage (RCA) index, introduced by Balassa (1965), to measure India's agricultural trade competitiveness across products, regions, and bilateral trading partners. The RCA index evaluates whether a country has a comparative advantage by comparing its export share of a specific product with the corresponding world export share, thereby providing a relative measure of export competitiveness. The analysis examines the hypothesis that India's agricultural commodities possess a significant revealed comparative advantage, particularly in traditional and resource-based product groups, using trade data sourced from the World Integrated Trade Solution (WITS) database.

The study covers India's agricultural exports from 1991 to 2020 and analyses commodities at the HS-2 and HS-4 levels. HS-2 level data highlights broader product groups and structural trade patterns, whereas HS-4 level data offers detailed insights into individual commodities, enabling identification of specific strengths and weaknesses. This dual-level approach captures both macro trends and product-specific dynamics.

Beyond product-level analysis, RCA is computed across key regional groupings—East Asia Pacific, South Asia, Least Developed Countries (LDCs), European Union (EU-27), and Latin America, to assess India's comparative advantage in agricultural commodities relative to major trade blocs. Additionally, bilateral RCA is calculated against 20 major trading partners: United Arab Emirates, Bangladesh, China, Egypt, Germany, Hong Kong,

Indonesia, Iran, Japan, Kuwait, Malaysia, Nepal, Netherlands, Russia, Saudi Arabia, Singapore, Thailand, United Kingdom, United States of America, and Vietnam, providing market-specific insights into India's competitive positioning.

The RCA index of country 'i' for a particular commodity 'j' is measured by the product's share in the country's exports in relation to its share in world trade.

$$RCA_{ij} = \frac{\frac{X_{ij}}{X_{it}}}{\frac{X_{wj}}{X_{wt}}}$$

Where X_{ij} and X_{wj} are the values of country 'i' exports of product 'j' and world exports of product 'j'. While X_{it} and X_{wt} refer to the country's total exports and the world's total exports. Such an index of exports can be measured by comparing a given country's export share from the total export in relation to the world's total exports. If the index is greater than 1, a country is said to have a comparative advantage compared to other countries or the rest of the world.

In addition to the global measure, the RCA framework can be extended to a bilateral context, where a country's export performance of a particular commodity is evaluated with respect to a specific trading partner rather than the world as a whole. Bilateral RCA allows for a more disaggregated assessment of competitiveness across partner countries, thereby capturing variations in trade patterns, market access, and partner-specific comparative advantages.

As Fertó (2003) explains, RCA can be interpreted dichotomously (advantage if $RCA > 1$), ordinally (ranking products or countries), and cardinally (measuring intensity and direction). This study adopts Chandran's (2010) classification: strong advantage ($RCA > 2$), high advantage (1–2), disadvantage (0.5–1), and strong disadvantage ($RCA < 0.5$), allowing assessment not only of the presence but also the strength of India's advantage. By integrating product-level, regional-level, and bilateral-level evaluations, the methodology

provides a comprehensive view of India's agricultural competitiveness, linking specific product performance with broader regional and partner-based trade positioning.

3.3. Results

3.3.1. Ranks based on Mean RCA for HS-2 Classification

To assess India's comparative advantage in agricultural commodities, the study first analyses export performance at the HS-2 product classification level. Table 3.1 reports the mean RCA values for 24 agricultural product categories, which are further classified into four groups—strong, high, low, and weak RCA, following Chandran's (2010) thresholds. This classification helps identify commodities where India consistently enjoys an advantage in global markets and those where it remains relatively uncompetitive.

The results in Table 3.1 reveal distinct patterns in India's agricultural trade competitiveness. India exhibits strong RCA ($RCA > 2$) in six product categories: Fish; Coffee, tea, maté and spices; Cereals; Lac, gums, resins and other vegetable saps; Vegetable plaiting materials and vegetable products; and Residues.

Table 3.1: India's RCA Ranks for HS-2 Classification

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
01	Live Animals	0.04	Weak RCA
02	Meat	1.11	High RCA
03	Fish	3.25	Strong RCA
04	Dairy Products	0.23	Weak RCA
05	Products of Animal Origin	1.32	High RCA
06	Live Tree	0.32	Weak RCA
07	Edible Vegetable	1.19	High RCA
08	Edible Fruit	1.89	High RCA

09	Coffee, Tea, Mate & Spices	6.41	Strong RCA
10	Cereals	3.55	Strong RCA
11	Products of Milling Industry	0.73	Low RCA
12	Oil Seed	1.44	High RCA
13	Lac, Gums, Resins & Other Vegetable Saps	12.68	Strong RCA
14	Vegetable Plaiting Materials & Vegetable Products	4.96	Strong RCA
15	Animal/Veg Fat Oils	0.88	Low RCA
16	Preparation of Meat/Fish	0.27	Weak RCA
17	Sugar	1.70	High RCA
18	Cocoa	0.08	Weak RCA
19	Preparation of Cereal/Flour	0.36	Weak RCA
20	Preparation of Vegetable/Fruit/Nut	0.39	Weak RCA
21	Miscellaneous Edible	0.66	Low RCA
22	Beverages	0.14	Weak RCA
23	Residues	3.17	Strong RCA
24	Tobacco	1.39	High RCA

Source: Computed from WITS data

Among these, Lac, gums, resins and other vegetable saps stand out with the highest mean RCA of 12.68, underscoring India's exceptional global competitiveness in this category. The high RCA group ($1 < RCA \leq 2$) includes seven categories, Meat; Products of animal origin; Edible vegetables; Edible fruits; Oilseeds; Sugar; and Tobacco. Within this category, Edible fruits recorded the highest mean RCA of 1.89, highlighting India's competitive edge in horticultural exports. India registers a low RCA ($0.5 < RCA \leq 1$) in three product groups: Products of the milling industry; Animal/vegetable fats and oils; and Miscellaneous edible products. The most competitive among them is Animal/vegetable fats and oils, with a mean RCA of 0.88, though still below the threshold of a strong advantage. Finally, weak RCA ($RCA < 0.5$) is observed in eight categories, including Live animals; Dairy products; Live trees; Preparations of meat/fish; Cocoa; Preparations of cereals/flour; Preparations of vegetables, fruits and nuts; and Beverages. Among these, Live animals

recorded the lowest RCA of 0.04, reflecting India's negligible global competitiveness in this segment.

Overall, the findings indicate that India's comparative advantage is highly concentrated in a few agricultural categories, particularly in spices, cereals, fish, and plant-based saps/resins, while a wide range of other commodities remain uncompetitive at the global level.

3.3.2. Ranks based on Mean RCA for HS-4 Classification

After examining India's agricultural competitiveness at the HS-2 level, the analysis now shifts to the HS-4 classification, which provides a more detailed picture of specific product categories within each broader group. This finer classification helps to identify particular commodities where India demonstrates either relative strength or persistent weaknesses in global trade.

1) Live Animals

Table 3.2: India's RCA Ranks for HS-4 Classification for Live Animals

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
01	Live Animals	0.04	Weak RCA
0101	Live horses, asses, mules and hinnies	0.01	Weak RCA
0102	Live bovine animals	0.00	Weak RCA
0103	Live swine	0.00	Weak RCA
0104	Live sheep and goats	0.44	Weak RCA
0105	Live poultry	0.08	Low RCA
0106	Other live animals	0.02	Weak RCA

Source: Computed from WITS data

The results in Table 3.2 show that India's live animal exports remain weakly competitive, with all HS-4 products recording RCA values below 0.5. Live poultry (HS 0105) has the highest RCA of 0.08, still far below the comparative advantage threshold, while other products such as live bovine (HS-0102) and live swine (HS-0103) record 0.00, indicating no competitiveness. Structural and sanitary barriers, including lack of LPAI vaccination protocols and high feed costs, weaken export potential. Although hybrid poultry adoption has improved productivity, it has not yet translated into global competitiveness, making cost efficiency and sanitary compliance crucial for future performance.

2) Meat

The RCA results in Table 3.3 for the HS-4 meat sector indicate that India is competitively positioned overall, with a mean RCA value of 1.11 for meat and edible meat offal. However, competitiveness varies considerably across individual product lines. Frozen bovine meat (HS- 0202) stands out as the most competitive item, recording a strong RCA value of 5.87, which aligns with India's established position as a leading global exporter of frozen buffalo meat to key markets such as Malaysia, Vietnam, Egypt, Indonesia, and Iraq. In contrast, meat of sheep and goats (HS-0204) shows moderate competitiveness with an RCA of 0.98, positioning it close to the high RCA threshold. Edible bovine offal (HS-0206) remains weakly competitive at 0.39, reflecting limited global market presence. Other meat categories, including poultry meat (HS-0207), swine meat (HS-0203), and processed or preserved meat products (HS-0210), also fall within the weak RCA category. This pattern highlights India's comparative advantage as highly concentrated in frozen bovine meat, driven by strong export-oriented processing and market demand.

Table 3.3: India's RCA Ranks for HS-4 Classification for Meat

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
02	Meat and edible meat offal	1.11	High RCA

0201	Meat of bovine animals, fresh or chilled	0.31	Weak RCA
0202	Meat of bovine animals, frozen	5.87	Strong RCA
0203	Meat of swine, fresh, chilled or frozen	0.00	Weak RCA
0204	Meat of sheep or goats, fresh, chilled or frozen	0.98	Low RCA
0205	Meat of horses, asses, mules or hinnies	0.00	Weak RCA
0206	Edible offal of bovine animals	0.39	Weak RCA
0207	Meat and edible offal of poultry	0.01	Weak RCA
0208	Other meat and edible meat offal	0.03	Weak RCA
0209	Pig and poultry fat, fresh, chilled, frozen	0.02	Weak RCA
0210	Meat and offal, salted/smoked; meat flours	0.03	Weak RCA

Source: Computed from WITS data

3) Fish

The RCA results for the HS-4 classification of the fish sector (Table 3.4) show India's strong comparative advantage, with an overall RCA of 3.25. However, competitiveness varies widely across product categories. Crustaceans (HS-0306) lead with an exceptionally high RCA of 8.43, followed by molluscs (HS-0307) at 3.46 and frozen fish (HS-0303) at 2.62, forming the core of India's seafood export strength. In contrast, live fish (HS-0301), fresh or chilled fish (HS-0302), fish fillets (HS-0304), and salted or smoked fish (HS-0305) fall into the weak RCA group, with values below 0.5, indicating limited market competitiveness. This concentration reflects India's strong position in bulk seafood exports but weak performance in higher-value processed fish products. While the broader HS-2 category shows strong RCA due to crustaceans and frozen fish, India has substantial scope to diversify and upgrade its seafood value chain, particularly in processed and value-added products.

Table 3.4: India's RCA Ranks for HS-4 Classification for Fish

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
03	Fish & crustacean, mollusc & other aquatic	3.25	Strong RCA
0301	Live fish	0.10	Weak RCA
0302	Fish, fresh or chilled (excl. 03.04)	0.24	Weak RCA
0303	Fish, frozen (excl. 03.04)	2.62	Strong RCA
0304	Fish fillets & other fish meat, fresh/chilled	0.41	Weak RCA
0305	Fish, salted/dried/smoked; fish flours	0.35	Weak RCA
0306	Crustaceans, fresh/chilled/frozen; flours & pellets	8.43	Strong RCA
0307	Molluscs & aquatic invertebrates; flours/meals	3.46	Strong RCA

Source: Computed from WITS data

4) Dairy Products

Table 3.5 indicates India's HS-4 dairy sector exhibits generally weak global competitiveness, as key categories such as milk and cream, buttermilk and yogurt, whey, butter, and cheese and curd all record RCA values below 0.5, indicating limited export strength. However, some niche products show stronger performance. Bird eggs in shell (HS-0407) and not in shell (HS-0408) record RCA values of 1.17 and 3.00, reflecting moderate to strong competitiveness. Natural honey (HS-0409) also performs well with an RCA of 1.46, aligning with India's position among the world's major honey producers. Thus, while dairy exports remain weak overall, eggs and honey offer promising export potential.

Table 3.5: India's RCA Ranks for HS-4 Classification for Dairy Products

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
04	Dairy products; birds' eggs; natural honey; edible	0.23	Weak RCA
0401	Milk and cream, not concentrated/sweetened	0.03	Weak RCA

0402	Milk and cream, concentrated/sweetened	0.30	Weak RCA
0403	Buttermilk, yogurt, etc.	0.04	Weak RCA
0404	Whey & other natural milk constituents	0.11	Weak RCA
0405	Butter & milk fats/oils	0.31	Weak RCA
0406	Cheese and curd	0.02	Weak RCA
0407	Bird eggs in shell, fresh/preserved/cooked	1.17	High RCA
0408	Birds' eggs not in shell; egg yolks	3.00	Strong RCA
0409	Natural honey	1.46	High RCA
0410	Edible products of animal origin	0.05	Weak RCA

Source: Computed from WITS data

5) Products of Animal Origin

Table 3.6 presents India's HS-4 level products of animal origin, which show strong overall competitiveness, with a high RCA value of 1.32. Within this group, several niche products demonstrate exceptionally strong export strength. Human hair and waste (HS-0501) records the highest RCA of 29.16, making it a distinctive export commodity, supported by large temple-sourced supply chains. Bones and horn-cores (HS-0506) also show strong competitiveness with an RCA of 13.81, reflecting India's major role in animal by-product trade.

Table 3.6: India's RCA Ranks for HS-4 Classification for Products of Animal Origin:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
05	Products of animal origin	1.32	High RCA
0501	Human hair and waste, unworked	29.16	Strong RCA
0502	Pigs' bristles; brush-making hair; waste	0.42	Weak RCA
0503	Horsehair and waste	1.60	High RCA
0504	Guts, bladders and stomachs of animals (excl. fish)	0.27	Weak RCA

0505	Skins and other parts of birds, feathers	0.05	Weak RCA
0506	Bones and horn-cores	13.81	Strong RCA
0507	Ivory, tortoise-shell, whalebone, etc.	4.68	Strong RCA
0508	Coral; shells of molluscs, crustaceans (unworked)	0.79	Low RCA
0509	Natural sponges of animal origin	0.13	Weak RCA
0510	Ambergris, castoreum, civet & musk; cantharides	2.68	Strong RCA
0511	Animal products n.e.s.; dead of Chapters 1 & 3	0.83	Low RCA

Source: Computed from WITS data

Other strong performers include ivory and related materials (HS-0507) with an RCA of 4.68, and ambergris and similar products (HS-0510) with an RCA of 2.68. Horsehair (HS-0503) also falls in the competitive range at 1.60. However, pigs' bristles, guts and bladders, bird skins and feathers, and natural sponges record weak RCA values, indicating limited competitiveness. Overall, India's advantage is concentrated in specialised niche animal-derived products.

6) Live Tree

Table 3.7 presents India's HS-4 category of live trees, plants, bulbs, roots, and cut flowers, which shows weak global competitiveness, with an overall RCA value of 0.32. Most subcategories, bulbs and rhizomes (HS-0601), live plants and cuttings (HS-0602), and cut flowers (HS-0603) record weak RCA values of 0.14, 0.11 and 0.41, indicating limited export strength despite India's horticultural diversity.

Table 3.7: India's RCA Ranks for HS-4 Classification for Live Tree:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
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06	Live tree & other plant; bulb, root; cut flower	0.32	Weak RCA
0601	Bulbs, tubers, rhizomes; chicory plants & roots	0.14	Weak RCA
0602	Other live plants, cuttings, slips; mushroom spawn	0.11	Weak RCA
0603	Cut flowers & flower buds for ornamental purposes	0.41	Weak RCA
0604	Other parts of plants for ornamental purposes	1.37	High RCA

Source: Computed from WITS data

However, ornamental plant parts (HS-0604) perform strongly with an RCA of 1.37, reflecting India's competitive position in niche floriculture markets. India exports these products largely to the United States, Germany, and the Netherlands and has emerged as the world's second-largest exporter in this segment. Although overall competitiveness is low, ornamental plant exports highlight a key area for strategic growth, suggesting potential through improved infrastructure, quality standards, and stronger market linkages.

7) Edible Vegetables

Table 3.8 presents India's edible vegetables category, which shows an overall high RCA of 1.19, but most fresh vegetables, including potatoes, tomatoes, cabbages, lettuce, carrots, cucumbers, and legumes, record weak RCA values, reflecting limited export competitiveness. Despite high production, constraints such as perishability, inadequate cold-chain facilities, and price fluctuations hinder fresh vegetable exports.

Table 3.8: India's RCA Ranks for HS-4 Classification for Edible Vegetables:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
07	Edible vegetables and certain roots & tubers	1.19	High RCA
0701	Potatoes, fresh or chilled	0.45	Weak RCA
0702	Tomatoes, fresh or chilled	0.17	Weak RCA
0703	Onions, shallots, garlic, leeks etc., fresh or chilled	5.83	Strong RCA
0704	Cabbages, cauliflowers, kohlrabi, kale	0.02	Weak RCA

0705	Lettuce and chicory, fresh or chilled	0.01	Weak RCA
0706	Carrots, turnips, salad beetroot	0.06	Weak RCA
0707	Cucumbers and gherkins	0.25	Weak RCA
0708	Leguminous vegetables, shelled or unshelled	0.13	Weak RCA
0709	Other vegetables, fresh or chilled	0.51	Low RCA
0710	Vegetables, frozen	0.42	Weak RCA
0711	Vegetables provisionally preserved	6.56	Strong RCA
0712	Dried vegetables, whole, cut, sliced, broken or powdered	1.94	High RCA
0713	Dried leguminous vegetables, shelled	2.61	Strong RCA
0714	Roots & tubers with high starch content	0.08	Weak RCA

Source: Computed from WITS data

In contrast, processed products show a strong advantage: provisionally preserved vegetables (HS-0711) record an RCA of 6.56, dried legumes (HS-0713) 2.61, and dried vegetable powders (HS-0712) 1.94. Thus, India remains weak in fresh vegetable exports but competitive in processed and dried segments, emphasising value addition for export growth.

8) Edible Fruit

Table 3.9: India's RCA Ranks for HS-4 Classification for Edible Fruit:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
08	Edible fruit and nuts; peel of citrus fruit or melons	1.89	High RCA
0801	Coconuts, Brazil nuts & cashew nuts, fresh or dried	29.77	Strong RCA
0802	Other nuts, fresh or dried	0.62	Low RCA
0803	Bananas, including plantains, fresh or dried	0.15	Weak RCA
0804	Dates, figs, pineapples etc., fresh or dried	2.42	Strong RCA
0805	Citrus fruit, fresh or dried	0.13	Weak RCA
0806	Grapes, fresh or dried	1.01	High RCA
0807	Melons and papaws, fresh	0.25	Weak RCA
0808	Apples, pears & quinces, fresh	0.10	Weak RCA

0809	Apricots, cherries, peaches, plums & sloes	0.01	Weak RCA
0810	Other fresh fruit, nes	0.42	Weak RCA
0811	Fruit and nuts, frozen	0.21	Weak RCA
0812	Fruit & nuts, provisionally preserved	17.11	Strong RCA
0813	Fruit, dried	0.57	Low RCA
0814	Peel of citrus fruit or melons, fresh/frozen/dried	0.22	Weak RCA

Source: Computed from WITS data

Table 3.9 presents India's edible fruits category, showing strong global competitiveness with an overall RCA of 1.89. Coconuts, Brazil nuts, and cashew nuts (HS-0801) record an exceptionally high RCA of 29.77, reflecting India's leading role as a major exporter of coconuts and cashews, including products such as activated carbon, coconut oil, desiccated coconut, and virgin coconut oil. Fruit and nuts provisionally preserved (HS-0812) also show strong competitiveness with an RCA of 17.11, while dates, figs, and pineapples (HS-0804) record 2.42. Grapes (HS-0806) perform moderately with an RCA of 1.01. Other subcategories remain weak in global markets.

9) Coffee, tea, mati and spices

Table 3.10: India's RCA Ranks for HS-4 Classification for Coffee, tea, mati and spices:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
09	Coffee, tea, mati and spices	6.41	Strong RCA
0901	Coffee; coffee husks & skins; coffee substitutes	2.33	Strong RCA
0902	Tea, whether or not flavoured	15.93	Strong RCA
0903	Maté	0.03	Weak RCA
0904	Pepper; Capsicum or Pimenta	14.94	Strong RCA
0905	Vanilla	2.63	Strong RCA
0906	Cinnamon and cinnamon-tree flowers	0.44	Weak RCA

0907	Cloves	0.85	Low RCA
0908	Nutmeg, mace and cardamom	8.88	Strong RCA
0909	Seeds (anise, fennel, coriander, cumin, juniper etc.)	23.60	Strong RCA
0910	Ginger, saffron, turmeric, curry etc.	13.33	Strong RCA

Source: Computed from WITS data

Table 3.10 presents India's coffee, tea, mate, and spices category, showing strong competitiveness with an overall RCA of 6.41. The highest RCA is recorded for anise, fennel, coriander, cumin, and similar seeds (HS-0909) at 23.60, highlighting India's global dominance. Tea (HS-0902) follows with an RCA of 15.93, while pepper and capsicum (HS-0904) and ginger, turmeric, and related spices (HS-0910) record RCAs of 14.94 and 13.33. Other strong products include nutmeg and cardamom (HS-0908), vanilla (HS-0905), and coffee and substitutes (HS-0901). Overall, India remains a globally competitive leader in major spice and tea exports.

10) Cereals

Table 3.11: India's RCA Ranks for HS-4 Classification for Cereals:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
10	Cereals	3.55	Strong RCA
1001	Wheat and meslin	0.77	Low RCA
1002	Rye	0.03	Weak RCA
1003	Barley	0.61	Low RCA
1004	Oats	0.03	Weak RCA
1005	Maise (corn)	1.26	High RCA
1006	Rice	15.94	Strong RCA
1007	Grain sorghum	1.60	High RCA
1008	Buckwheat, millet & other cereals	2.92	Strong RCA

Source: Computed from WITS data

Table 3.11 shows a strong overall RCA of 3.55 for India's cereal exports. Rice (HS-1006) dominates with an RCA of 15.94, reflecting India's strong global position. Buckwheat, millet, and other cereals (HS-1008) also perform well with an RCA of 2.92, while maize (HS-1005) and sorghum (HS-1007) record RCAs of 1.26 and 1.60. Growth in cereal exports, especially rice and millets, is supported by coordinated efforts among farmers, processors, exporters, and policymakers. Thus, India maintains strong comparative advantage in cereals, particularly rice and millets.

11) Production Mill

Table 3.12 shows that India's milling industry, covering malt, starches, inulin, and wheat-based products, has a low overall RCA of 0.73, indicating limited global competitiveness. However, some subcategories perform well. Flour and meal of dried leguminous vegetables (HS-1106) records a strong RCA of 2.99, while wheat or meslin flour (HS-1101) shows moderate competitiveness with an RCA of 1.40.

Table 3.12: India's RCA Ranks for HS-4 Classification for Production Mill:

HS-Cod e	Commodity Classification	Mean RCA Value	RCA Rank
11	Production milling industry; malt; starches; inulin; wheat	0.73	Low RCA
1101	Wheat or meslin flour	1.40	High RCA
1102	Cereal flours (excl. wheat/meslin)	0.90	Low RCA
1103	Cereal groats, meal and pellets	0.85	Low RCA
1104	Cereal grains otherwise worked (excl. rice)	0.24	Weak RCA
1105	Potato flour, meal, flakes, granules & pellets	0.33	Weak RCA
1106	Flour/meal of dried leguminous vegetables	2.99	Strong RCA

1107	Malt	0.06	Weak RCA
1108	Starches and inulin	0.58	Low RCA
1109	Wheat gluten	0.07	Weak RCA

Source: Computed from WITS data

Other products, including cereal flours (excluding wheat), groats, and starches, record RCAs below 1, reflecting weak export strength. Despite large wheat production, high domestic consumption limits export potential. India's comparative advantage is therefore concentrated in niche legume-based milling products.

12) Oilseeds

Table 3.13 shows a high overall RCA of 1.44 for India's oilseeds sector, indicating strong competitiveness. Groundnuts (HS-1202) lead with an RCA of 13.30, followed by other oil seeds and oleaginous fruits (HS-1207) with 12.36. Plants and parts for medicinal or aromatic use (HS-1211) and copra (HS-1203) also perform strongly with RCAs of 6.85 and 6.75; India ranks third globally in copra exports.

Table 3.13: India's RCA Ranks for HS-4 Classification for Oilseeds:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
12	Oil seed, oleaginous fruits; misc. grain, seed	1.44	High RCA
1201	Soya beans	0.10	Weak RCA
1202	Ground-nuts, not roasted/cooked	13.30	Strong RCA
1203	Copra	6.75	Strong RCA
1204	Linseed	1.12	High RCA
1205	Rape or colza seeds	0.03	Weak RCA
1206	Sunflower seeds	0.17	Weak RCA
1207	Other oil seeds & oleaginous fruits	12.36	Strong RCA
1208	Flours & meals of oil seeds	1.66	High RCA

1209	Seeds, fruits & spores used for sowing	0.73	Low RCA
1210	Hop cones & lupulin	0.02	Weak RCA
1211	Plants & parts of plants	6.85	Strong RCA
1212	Seaweeds, algae, sugar beet & cane; vegetable products	0.16	Weak RCA
1213	Cereal straw & husks	0.19	Weak RCA
1214	Swedes, mangolds & similar forage products	0.01	Weak RCA

Source: Computed from WITS data

Flours and meals of oilseeds (HS-1208) and linseed (HS-1204) show moderate competitiveness. Thus, India's strengths are concentrated in groundnuts, copra, and related products.

13) Lac, gums, resins & other vegetable saps

Table 3.14 shows a strong overall RCA of 12.68 for India's lac, gums, resins, and vegetable saps and extracts category, indicating high competitiveness. Lac and natural gums, resins, and balsams (HS-1301) record a very strong RCA of 19.51, demonstrating India's global dominance. Vegetable saps and extracts (HS-1302) also show strong competitiveness with an RCA of 11.52.

Table 3.14: India's RCA Ranks for HS-4 Classification for Lac, gums, resins & other vegetable saps

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
13	Lac; gums, resins & other vegetable saps & extracts	12.68	Strong RCA
1301	Lac; natural gums, resins, gum-resins & balsams	19.51	Strong RCA
1302	Vegetable saps & extracts	11.52	Strong RCA

Source: Computed from WITS data

These products are widely used in pharmaceuticals, food processing, and industry. The results highlight India's specialised advantage in natural extract-based products, with

strong potential for further export growth and value-added development.

14) Vegetable plaiting materials & vegetable products

Table 3.15: India's RCA Ranks for HS-4 Classification for Vegetable plaiting materials & vegetable products:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
14	Vegetable plaiting materials; vegetable products	4.96	Strong RCA
1401	Vegetable materials used primarily for plaiting	0.16	Weak RCA
1402	Vegetable materials used primarily as stuffing	3.08	Strong RCA
1403	Vegetable materials used primarily in brooms	16.61	Strong RCA
1404	Vegetable products not elsewhere specified or included	6.77	Strong RCA

Source: Computed from WITS data

Table 3.15 shows a strong overall RCA of 4.96 for India's vegetable plaiting materials and related products, indicating solid global competitiveness. Vegetable materials used primarily in brooms (HS-1403) record a very strong RCA of 16.61, reflecting India's leading export position. Vegetable products not elsewhere specified (HS-1404) show an RCA of 6.77, and stuffing materials (HS-1402) record an RCA of 3.08, both indicating strong competitiveness. The results highlight India's advantage in specialised, value-added vegetable products used in household and industrial applications, suggesting further export expansion potential.

15) Animal/vegetable fats & oils

Table 3.16: India's RCA Ranks for HS-4 Classification for Animal/vegetable fats & oils:

HS-	Commodity Classification	Mean RCA	RCA Rank
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Code		Value	
15	Animal/veg fats & oils & their cleavage products	0.88	Low RCA
1501	Lard, pig & poultry fat, rendered	0.02	Weak RCA
1502	Fats of bovine animals, sheep or goats	0.43	Weak RCA
1503	Lard stearin, lard oil, oleo-oil etc.	0.38	Weak RCA
1504	Fish or marine mammal fats & oils	0.41	Weak RCA
1505	Wool grease & fatty substances	1.33	High RCA
1506	Other animal fats and oils	0.03	Weak RCA
1507	Soya-bean oil	0.09	Weak RCA
1508	Ground-nut oil	3.26	Strong RCA
1509	Olive oil	0.00	Weak RCA
1510	Other oils & fractions	0.06	Weak RCA
1511	Palm oil & fractions	0.01	Weak RCA
1512	Sunflower/safflower/cotton-seed oil	0.05	Weak RCA
1513	Coconut/palm kernel/babassu oil	0.25	Weak RCA
1514	Rape, colza or mustard oil	0.09	Weak RCA
1515	Other fixed vegetable fats/oils incl. jojoba oil	13.52	Strong RCA
1516	Animal/veg fats & oils and fractions	1.06	High RCA
1517	Margarine, edible preparations	0.27	Weak RCA
1518	Animal/veg fats & oils... chemically modified	1.84	High RCA
1519	Industrial fatty acids, acid oils	1.30	High RCA
1520	Glycerol	0.46	Weak RCA
1521	Vegetable waxes, beeswax	0.34	Weak RCA
1522	Degras; residues of fatty substances	0.11	Weak RCA

Source: Computed from WITS data

Table 3.16 shows that India records an overall RCA of 0.88 in animal and vegetable fats and oils, reflecting limited competitiveness at the aggregate level. However, strong advantages appear in select HS-4 products. Other fixed vegetable fats and oils, including jojoba oils (HS-1515), have a high RCA of 13.52, while groundnut oil and its fractions (HS-1508) record 3.26, indicating strong export presence. Moderate competitiveness is

observed in HS-1518, HS-1505, HS-1519, and HS-1516, with RCAs ranging from 1.06 to 1.84. These results show competitiveness is concentrated in specific high-value vegetable oils, suggesting scope for value addition and market diversification.

16) Preparation of meat & fish

Table 3.17 shows that India has a weak overall RCA of 0.27 in prepared meat, fish, crustaceans, and molluscs, indicating limited global competitiveness. Only extracts and juices of meat, fish, and aquatic invertebrates (HS-1603) show a relatively strong RCA of 1.16, suggesting niche potential. Other subcategories, including sausages (HS-1601), prepared or preserved meat (HS-1602), prepared fish (HS-1604), and prepared crustaceans (HS-1605), record RCAs below 1, reflecting weak competitiveness. Overall, India's export strength in this sector is minimal and concentrated in a single niche product, highlighting the need for improved processing capacity and market development.

Table 3.17: India's RCA Ranks for HS-4 Classification for Preparation of meat & fish:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
16	Prep of meat, fish or crustaceans, molluscs etc.	0.27	Weak RCA
1601	Sausages and similar products; food preparations	0.02	Weak RCA
1602	Other prepared or preserved meat, meat offal or blood	0.02	Weak RCA
1603	Extracts and juices of meat, fish and aquatic invertebrates	1.16	High RCA
1604	Prepared or preserved fish; caviar and substitutes	0.14	Weak RCA
1605	Crustaceans and other aquatic invertebrates preparations	0.85	Low RCA

Source: Computed from WITS data

17) Sugar

Table 3.18 shows that India records a high overall RCA of 1.70 in the sugar and sugar confectionery category, indicating strong global competitiveness. Molasses (HS-1703) has the highest RCA of 3.89, followed by cane or beet sugar (HS-1701) with an RCA of 2.47, reflecting strength in raw and intermediate sugar exports. Other sugars and syrups (HS-1702) show moderate competitiveness with an RCA of 0.56, while sugar confectionery products (HS-1704) record a low RCA of 0.28. Overall, India's comparative advantage is concentrated in raw sugar products, with limited competitiveness in value-added confectionery, signalling scope for diversification and processing upgrades.

Table 3.18: India's RCA Ranks for HS-4 Classification for Sugar and sugar confectionery:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
17	Sugars and sugar confectionery	1.70	High RCA
1701	Cane or beet sugar and chemically pure sucrose	2.47	Strong RCA
1702	Other sugars in solid form; sugar syrups; artificial honey	0.56	Low RCA
1703	Molasses resulting from the extraction or refining of sugar	3.89	Strong RCA
1704	Sugar confectionery (including white chocolate), not containing cocoa	0.28	Weak RCA

Source: Computed from WITS data

18) Cocoa

Table 3.19: India's RCA Ranks for HS-4 Classification for Cocoa:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
18	Cocoa and cocoa preparations	0.08	Weak RCA
1801	Cocoa beans, whole or broken, raw or roasted	0.01	Weak RCA
1802	Cocoa shells, husks, skins and other cocoa waste	0.04	Weak RCA
1803	Cocoa paste, whether or not defatted	0.01	Weak RCA
1804	Cocoa butter, fat and oil	0.26	Weak RCA
1805	Cocoa powder, not containing added sugar	0.01	Weak RCA
1806	Chocolate and other food preparations containing cocoa	0.09	Weak RCA

Source: Computed from WITS data

Table 3.19 shows that India records a very weak overall RCA of 0.08 in cocoa and cocoa preparations, indicating minimal global competitiveness. All subcategories, including cocoa beans (HS-1801), cocoa paste (HS-1803), cocoa butter (HS-1804), and chocolate products (HS-1806), record RCAs far below 0.5. This reflects India's low production and export scale, making cocoa a non-competitive sector. The findings suggest that cocoa exports are limited, mostly domestically focused, and would require major investment and technology upgrades to improve competitiveness.

19) Preparation of cereal & flour

Table 3.20 shows that India's overall RCA in prepared cereals, flour, starch, milk products, and pastrycook is weak at 0.36, indicating limited competitiveness. Tapioca and substitutes prepared from starch (HS-1903) are a notable exception, with a strong RCA of 4.39, reflecting niche competitiveness. Malt extract and other flour-based preparations (HS-1901) show moderate competitiveness with an RCA of 0.56.

Table 3.20: India's RCA Ranks for HS-4 Classification for Preparation of cereal & flour:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
19	Prep. of cereal, flour, starch/milk; pastrycook	0.36	Weak RCA
1901	Malt extract; food preparations of flour, etc.	0.56	Low RCA
1902	Pasta, such as spaghetti, macaroni, noodles	0.08	Weak RCA
1903	Tapioca and substitutes prepared from starch	4.39	Strong RCA
1904	Prepared foods of swollen or roasted cereals	0.39	Weak RCA
1905	Bread, pastry, cakes, etc. communion wafers	0.32	Weak RCA

Source: Computed from WITS data

Other products, including pasta (HS-1902), prepared cereals (HS-1904), and bread and pastries (HS-1905), record RCAs below 0.5. India's advantage is thus concentrated in niche tapioca-based products, suggesting scope for diversification and value addition.

20) Preparation of vegetable, fruit & nut

Table 3.21: India's RCA Ranks for HS-4 Classification for Preparation of vegetable, fruit & nut:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
20	Prep of vegetable, fruit, nuts or other parts	0.39	Weak RCA
2001	Vegetables, fruit, etc. preserved by vinegar	4.68	Strong RCA
2002	Tomatoes prepared or preserved otherwise	0.01	Weak RCA
2003	Mushrooms and truffles, preserved	0.93	Low RCA
2004	Other vegetables preserved other than by vinegar, frozen	0.15	Weak RCA
2005	Other vegetables preserved other than by vinegar, not frozen	0.11	Weak RCA
2006	Fruit, nuts, fruit-peel and other parts of plants	0.16	Weak RCA
2007	Jams, fruit jellies, marmalades, etc.	1.54	High RCA

2008	Fruit, nuts and other parts of plants	0.30	Weak RCA
2009	Fruit juices (including grape must) and vegetable juices	0.06	Weak RCA

Source: Computed from WITS data

Table 3.21 shows that India's overall RCA in prepared vegetables, fruits, nuts, and other plant parts is weak at 0.39, indicating limited global competitiveness. Vinegar-preserved vegetables (HS-2001) record a strong RCA of 4.68, reflecting notable niche export strength. Jams, jellies, and marmalades (HS-2007) and preserved mushrooms and truffles (HS-2003) show moderate competitiveness with RCAs of 1.54 and 0.93, respectively. Other products, including prepared tomatoes, frozen vegetables, fruit-peel, and juices (HS-2002, 2004–2006, 2008–2009), record RCAs below 0.5. Overall, India's comparative advantage is concentrated in niche preserved products, highlighting opportunities for value addition, diversification, and targeted export promotion.

21) Miscellaneous Preparations

Table 3.22: India's RCA Ranks for HS-4 Classification for Miscellaneous Preparations:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
21	Miscellaneous edible preparations	0.66	Low RCA
2101	Extracts and preparations of coffee, tea or mate	3.57	Strong RCA
2102	Yeasts; other single-cell micro-organisms, dead	0.17	Weak RCA
2103	Sauces and sauce preparations; mixed condiments	0.13	Weak RCA
2104	Soups and preparations therefor; homogenised	0.08	Weak RCA
2105	Ice cream and other edible ice	0.02	Weak RCA
2106	Food preparations not elsewhere specified	0.30	Weak RCA

Source: Computed from WITS data

Table 3.22 shows that India's overall RCA in miscellaneous edible preparations is low at 0.66, indicating limited global competitiveness. Extracts and preparations of coffee, tea, or mate (HS-2101) stand out with a strong RCA of 3.57, reflecting niche export strength. Other subcategories, including yeasts (HS-2102), sauces (HS-2103), soups (HS-2104), ice cream (HS-2105), and other food preparations (HS-2106), record RCAs below 0.5, showing weak international presence. India's comparative advantage is thus concentrated in coffee and tea extracts, suggesting scope for targeted value addition, product development, and market diversification to boost exports.

22) Beverages

Table 3.23: India's RCA Ranks for HS-4 Classification for Beverages:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
22	Beverages, spirits and vinegar	0.14	Weak RCA
2201	Waters (including mineral waters and aerated water)	0.01	Weak RCA
2202	Waters (including mineral and aerated), with added	0.03	Weak RCA
2203	Beer made from malt	0.10	Weak RCA
2204	Wine of fresh grapes (including fortified wines)	0.01	Weak RCA
2205	Vermouth and other wine of fresh grapes	0.02	Weak RCA
2206	Other fermented beverages (e.g., cider)	0.03	Weak RCA
2207	Ethyl alcohol, undenatured of $\geq 80\%$ alcohol	1.15	High RCA
2208	Undenatured ethyl alcohol of an alcoholic strength	0.24	Weak RCA
2209	Vinegar and substitutes for vinegar obtained from acetic acid	0.07	Weak RCA

Source: Computed from WITS data

Table 3.23 shows that India's overall RCA in beverages, spirits, and vinegar is very weak at 0.14, indicating limited global competitiveness. Only other fermented beverages, such as ethyl alcohol $\geq 80\%$ (HS 2207), show niche strength with an RCA of 1.15. All other

subcategories—including waters (HS 2201–2202), beer (HS 2203), wine (HS 2204–2205), cider (HS-2206), lower-strength ethyl alcohol (HS-2208), and vinegar (HS-2209), record RCAs below 0.5. India’s comparative advantage is thus restricted to high-strength spirits, while most beverages remain non-competitive, highlighting the need for quality improvements, branding, and market development.

23) Residues

Table 3.24 shows that India’s overall RCA in residues and waste from the food industry, including prepared animal fodder, is strong at 3.17, indicating notable global competitiveness. Oil-cake and other solid residues of groundnut (HS-2305) lead with an RCA of 41.41, reflecting India’s dominant position. Other strong subcategories include soya-bean residues (HS 2304, RCA 6.65), vegetable residues (HS-2306, RCA 6.03), and cereal brans and sharps (HS-2302, RCA 3.32). Minor residues, flours of meat/fish unfit for human consumption (HS-2301), and wine lees (HS-2307) have RCAs below 0.5. Competitiveness is concentrated in oil-cakes, highlighting opportunities for value addition and export growth in animal feed.

Table 3.24: India’s RCA Ranks for HS-4 Classification for Residues:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
23	Residues & waste from the food industry; prepared animal fodder	3.17	Strong RCA
2301	Flours, etc., of meat, fish, etc., unfit for human consumption	0.23	Weak RCA
2302	Brans, sharps and other residues, derived from	3.32	Strong RCA
2303	Residues of starch manufacture, beet-pulp, etc.	0.06	Weak RCA
2304	Oil-cake and other solid residues, of soya-bean	6.65	Strong RCA

2305	Oil-cake and other solid residues, of ground-nut	41.41	Strong RCA
2306	Oil-cake and other solid residues, of vegetable	6.03	Strong RCA
2307	Wine lees; argol	0.09	Weak RCA
2308	Vegetable materials, waste, residues, etc. used	0.03	Weak RCA
2309	Preparations of a kind used in animal feeding	0.24	Weak RCA

Source: Computed from WITS data

24) Tobacco

Table 3.25 shows that India's overall RCA in tobacco and manufactured tobacco substitutes is 1.39, indicating moderate competitiveness. Unmanufactured tobacco and tobacco refuse (HS 2401) lead with a strong RCA of 3.69, reflecting India's global strength in raw tobacco exports. Manufactured tobacco and substitutes (HS-2403) have an RCA of 1.95, showing moderate competitiveness, while cigars, cigarillos, and cigarettes (HS-2402) record a weak RCA of 0.26, indicating limited presence. India's comparative advantage is thus concentrated in raw tobacco, with scope for value addition and quality improvements in processed tobacco products to enhance export performance.

Table 3.25: India's RCA Ranks for HS-4 Classification for Tobacco:

HS-Code	Commodity Classification	Mean RCA Value	RCA Rank
24	Tobacco and manufactured tobacco substitutes	1.39	High RCA
2401	Unmanufactured tobacco; tobacco refuse	3.69	Strong RCA
2402	Cigars, cigarillos, cigarettes, etc. of tobacco	0.26	Weak RCA
2403	Other manufactured tobacco and substitutes	1.95	High RCA

Source: Computed from WITS data

3.3.3. Mean RCA for Regional Groupings for HS-2 Classification:

To gain a deeper understanding of India's export competitiveness across different regions, the study examines the mean Revealed Comparative Advantage (RCA) of India's

agricultural exports with five key regional groupings: South Asia, East Asia Pacific, EU-27, Latin America, and Least Developed Countries (LDCs). These regional classifications were derived from the World Integrated Trade Solution (WITS) database. By calculating the mean RCA values for each HS-2 product category across these regions, it becomes possible to identify the areas in which India exhibits comparative strength or weakness relative to its trading partners in each region.

Table 3.26 presents the mean RCA values of India's agricultural exports across five regional groupings: EU-27, East Asia Pacific, South Asia, Latin America, and LDCs. The table highlights that India has a strong comparative advantage in exporting live animals, dairy products, edible vegetables, sugar, and cocoa to South Asia, reflecting its regional specialisation in staple and high-demand agricultural commodities.

Table 3.26: India's Mean RCA for Regional Groupings

Commodity Classification	Major Regional Groupings				
	EU27	East Asia Pacific	South Asia	Latin America	LDC's
HS-01 Live Animals	0.19	0.01	10.04	0.05	0.28
HS-02 Meat	0.03	5.22	0.13	0.01	10.92
HS-03 Fish	4.86	3.98	0.14	0.20	0.05
HS-04 Dairy Products	0.05	0.23	4.27	0.05	5.50
HS-05 Products of Animal Origin	1.40	2.25	0.10	0.23	1.21
HS-06 Live Tree	0.38	2.04	0.18	0.03	0.08
HS-07 Edible Vegetable	0.60	1.23	6.11	0.11	1.91
HS-08 Edible Fruit	2.01	1.14	0.81	0.04	1.09
HS-09 Coffee, Tea, Mate & Spices	11.71	4.77	0.92	0.30	0.33
HS-10 Cereals	1.65	2.47	2.41	2.05	15.72
HS-11 Production Mill	0.18	1.43	1.51	0.03	1.61
HS-12 Oil Seeds	2.78	8.45	1.05	0.36	0.51
HS-13 Lac, Gums, Resins & Vegetable Saps	11.20	15.01	1.84	14.30	0.93
HS-14 Vegetable Plaiting Materials & Vegetable Product	4.86	7.00	6.07	0.68	0.37
HS-15 Animal Veg Fat Oils	1.79	0.85	0.32	0.64	0.32

HS-16 Preparations of Meat/ Fish	0.51	0.20	0.27	0.04	0.39
HS-17 Sugars	0.59	2.39	6.28	0.02	3.74
HS-18 Cocoa	0.03	0.24	6.04	0.05	0.36
HS-19 Preparation of Cereal/ Flour	0.18	0.34	4.07	0.30	6.28
HS-20 Preparation of Vegetable Fruit Nut	0.46	0.35	0.44	0.03	1.16
HS-21 Miscellaneous Edible	0.41	0.57	0.88	0.09	2.27
HS-22 Beverages	0.03	0.28	1.10	0.17	1.39
HS-23 Residues	1.24	20.01	2.98	0.06	7.09
HS-24 Tobacco	1.78	1.85	1.33	0.53	0.80

Source: Computed from WITS data

In contrast, India's exports to LDCs show high RCA values in cereals, meat, dairy products, and residues, suggesting a competitive position in supplying essential food and agro-processed products. For East Asia Pacific, India exhibits notable comparative strength in oil seeds, lac, gums, resins, and vegetable plaiting materials, indicating competitive advantages in plant-based and industrially significant products. Exports to EU-27 and Latin America generally show lower RCA values, except in specific categories such as coffee, tea, spices, and lac/gums/resins, which indicate niche export opportunities. Thus, the regional RCA analysis demonstrates India's diverse export capabilities, with strong comparative advantages concentrated in neighbouring regions and LDCs, while selective strengths exist in distant markets.

3.3.4. Ranks based on Mean RCA for Regional Groupings for HS-2 Classification:

To complement the analysis of mean RCA values, this section examines India's comparative advantage ranks for its agricultural exports across five regional groupings: South Asia, East Asia Pacific, EU-27, Latin America, and LDCs. The ranking is based on the mean RCA for each HS-2 product category, where RCA values are classified into four levels: weak ($RCA < 0.5$), low ($0.5 \leq RCA < 1$), high ($1 \leq RCA \leq 2$), and strong ($RCA > 2$). This ranking approach helps identify not only the products in which India holds a

comparative advantage but also the relative intensity of that advantage across different regions.

Table 3.27 presents India's RCA ranks for agricultural exports across five regional groupings, highlighting both the intensity and pattern of comparative advantage.

Table 3.27: India's RCA Ranks for Regional Groupings

Commodity Classification	Weak RCA RCA<0.5	Low RCA RCA >0.5 to <1	High RCA RCA 1 to 2	Strong RCA RCA > 2
HS-01 Live Animals	EU-27, East Asia Pacific, Latin America, LDC's			South Asia
HS-02 Meat	EU-27, South Asia, Latin America			LDC's, East Asia Pacific
HS-03 Fish	South Asia, Latin America, LDC's			EU-27, East Asia Pacific,
HS-04 Dairy Products	EU-27, East Asia Pacific, Latin America			LDC's, South Asia
HS-05 Products of Animal Origin	South Asia, Latin America		EU-27, LDC's	East Asia Pacific,
HS-06 Live Tree	EU-27, South Asia, Latin America, LDC's			East Asia Pacific
HS-07 Edible Vegetable	Latin America	EU-27,	LDC's, East Asia Pacific	South Asia
HS-08 Edible Fruit	Latin America	South Asia	LDC's	EU-27, East Asia Pacific
HS-09 Coffee, Tea, Mate & Spices	Latin America, LDC's		South Asia	EU-27, East Asia Pacific
HS-10 Cereals	Latin America		EU-27	LDC's, East Asia Pacific, South Asia,
HS-11 Production Mill	EU-27, Latin America		East Asia Pacific, South Asia	LDC's
HS-12 Oil Seeds	Latin America, LDC's		South Asia	East Asia Pacific, EU-

				27
HS-13 Lac, Gums, Resins & Vegetable Saps		LDC's		East Asia Pacific, EU- 27, Latin America, South Asia
HS-14 Vegetable Plaiting Materials & Vegetable Product	LDC's	Latin America		South Asia, EU-27, East Asia Pacific
HS-15 Animal Veg Fat Oils	South Asia, LDC's, Latin America	East Asia Pacific	EU-27	
HS-16 Preparations of Meat/ Fish	LDC's , EU-27, East Asia Pacific, South Asia, Latin America,			
HS-17 Sugars	Latin America	EU-27		South Asia, East Asia Pacific, LDC's
HS-18 Cocoa	EU-27, East Asia Pacific, LDC's, Latin America			South Asia
HS-19 Preparation of Cereal/ Flour	EU-27, East Asia Pacific, Latin America			LDC's , South Asia,
HS-20 Preparation of Vegetable Fruit Nut	East Asia Pacific, South Asia, Latin America	EU-27, LDC's		
HS-21 Miscellaneous Edible	EU-27, Latin America	East Asia Pacific,	South Asia	LDC's
HS-22 Beverages	EU-27, East Asia Pacific, Latin America		South Asia, LDC's	
HS-23 Residues	Latin America	EU-27		East Asia Pacific, South Asia, LDC's
HS-24 Tobacco	LDC's	Latin America	EU-27, East Asia Pacific, South Asia	

Source: Computed from WITS data

South Asia emerges as India's strongest regional market, with strong RCA in staples and

processed commodities such as live animals, dairy products, edible vegetables, cereals, lac, gums & resins, vegetable plaiting materials, sugar, cocoa, prep cereal/flour, and residues, and high RCA in coffee, tea, spices, production mill products, oil seeds, miscellaneous edible items, beverages, and tobacco. This pattern reflects geographic proximity, lower transportation costs, and shared dietary preferences, allowing India to maintain dominance in regional markets and support food security and trade revenues. East Asia Pacific shows strong RCA in meat, fish, products of animal origin, live trees, edible fruits, coffee, tea, spices, cereals, oil seeds, lac/gums/resins, vegetable plaiting materials, sugar, and residues, with high RCA in edible vegetables, production mill products, and tobacco. This is driven by rising incomes, growing demand for processed and industrially significant agricultural products, and favourable trade agreements, indicating India's potential to expand exports in high-value commodities. EU-27 demonstrates strong RCA only in select products such as fish, edible fruits, coffee, tea, spices, oil seeds, lac/gums/resins, and vegetable plaiting materials, with high RCA in products of animal origin, cereals, animal/vegetable fat oils, and tobacco. The limited breadth of comparative advantage reflects stringent quality standards, high competition, and trade barriers, highlighting opportunities in niche, high-value markets rather than mass commodity exports. In LDCs, India exhibits strong RCA in meat, dairy products, cereals, production mill products, sugar, prep cereal/flour, miscellaneous edible items, and residues, with high RCA in products of animal origin, edible vegetables, edible fruits, and beverages. The pattern reflects demand for staple and agro-processed foods in low-income economies, positioning India as a key supplier and providing potential for sustained export growth. Overall, the table underscores the region-specific nature of India's agricultural comparative advantage, suggesting that policy interventions should focus on strengthening regional trade with South Asia and LDCs, expanding high-value exports to East Asia Pacific, and promoting niche products for

developed markets like the EU.

3.3.5. Regional Groupings with Highest Mean RCA for HS-2 Classification:

To further understand India's export competitiveness, this section identifies the regional groupings where India exhibits the highest mean RCA for each HS-2 product category. By highlighting the regions with the strongest comparative advantage, it is possible to pinpoint India's core markets and assess strategic opportunities for targeted trade promotion.

Table 3.28: India's Highest RCA Ranks for Regional Groupings

Commodity Classification	Regional Grouping with Highest RCA	Mean RCA
HS-01 Live Animals	South Asia	10.04
HS-02 Meat	LDC's	10.92
HS-03 Fish	EU27	4.86
HS-04 Dairy Products	LDC's	5.50
HS-05 Products of Animal Origin	East Asia Pacific	2.25
HS-06 Live Tree	East Asia Pacific	2.04
HS-07 Edible Vegetable	South Asia	6.11
HS-08 Edible Fruit	EU27	2.01
HS-09 Coffee, Tea, Mate & Spices	EU27	11.71
HS-10 Cereals	LDC's	15.72
HS-11 Production Mill	LDC's	1.61
HS-12 Oil Seeds	East Asia Pacific	8.45
HS-13 Lac, Gums, Resins & Vegetable Saps	East Asia Pacific	15.01
HS-14 Vegetable Plaiting Materials & Vegetable Product	East Asia Pacific	7.00
HS-15 Animal Veg Fat Oils	EU27	1.79
HS-16 Preparations of Meat/ Fish	EU27	0.51
HS-17 Sugars	South Asia	6.28
HS-18 Cocoa	South Asia	6.04
HS-19 Preparation of Cereal/ Flour	LDC's	6.28
HS-20 Preparation of Vegetable Fruit Nut	LDC's	1.16
HS-21 Miscellaneous Edible	LDC's	2.27
HS-22 Beverages	LDC's	1.39
HS-23 Residues	East Asia Pacific	20.10
HS-24 Tobacco	East Asia Pacific	1.85

Source: Computed from WITS data

Table 3.28 presents the highest RCA values for each commodity, reflecting India's relative strength in supplying specific products to different regions. The analysis reveals

several noteworthy patterns. East Asia Pacific leads with the highest mean RCA for several commodities, most prominently Residues (20.10), Lac, Gums, Resins & other Vegetable Saps (15.01), Oil Seeds (8.45), Vegetable Plaiting Materials & Vegetable Products (7.00), Products of Animal Origin (2.25), Live Trees (2.04), and Tobacco (1.85). This indicates that India holds a strong competitive position in plant-based industrial commodities, agro-processing inputs, and certain animal products, driven by rising regional demand for both primary and processed agricultural goods, and by trade agreements facilitating market access.

LDCs exhibit the highest RCA for Cereals (15.72), Meat (10.92), Dairy Products (5.50), Prep Cereal/Flour (6.28), Production Mill Products (1.61), Prep Vegetable Fruit Nut (1.16), Miscellaneous Edible (2.27), and Beverages (1.39). This pattern reflects India's role as a supplier of staple foods and processed agro-products to low-income countries, where demand is stable and India's cost-competitive production strengthens its export position. South Asia records the highest RCA in Live Animals (10.04), Edible Vegetables (6.11), Sugar (6.28), and Cocoa (6.04), highlighting the importance of geographic proximity, similar dietary patterns, and low trade costs in sustaining India's regional dominance. Meanwhile, EU-27 shows highest RCA in Fish (4.86), Edible Fruits (2.01), Coffee, Tea, Mati & Spices (11.71), Animal/Vegetable Fat Oils (1.79), and Prep of Meat/Fish (0.51), indicating that India's exports to developed markets are concentrated in niche, high-value products, often aligned with consumer preferences and quality standards in Europe.

Thus, the table emphasises India's region-specific comparative advantages, showing that while South Asia and LDCs are strong markets for staples and broadly consumed agricultural products, East Asia Pacific and EU-27 are key markets for industrial, processed, and high-value commodities. From a policy perspective, these insights suggest

that India should focus on consolidating regional trade in South Asia and LDCs, expand high-value exports to East Asia Pacific, and promote niche products in the EU-27 to maximise its global agricultural trade potential.

3.3.6. Country classification based on Mean RCA of HS-2 Commodities

Bilateral RCA analysis provides insights into India's relative competitiveness in agricultural products with specific trading partners. Unlike overall RCA, which measures comparative advantage at the global level, bilateral RCA captures country-specific strengths and weaknesses, enabling policymakers to identify markets where India is most competitive and where targeted trade promotion could yield the greatest benefits. This approach facilitates an understanding of regional patterns, partner-specific trade potential, and strategic export opportunities for both traditional and emerging agricultural commodities.

Table 3.29: India's RCA Ranks for Bilateral Exports

Commodity Classification	Weak RCA RCA<0.5	Low RCA RCA >0.5 to <1	High RCA RCA 1 to 2	Strong RCA RCA > 2
HS-01 Live Animals	Kuwait, Iran, Egypt, Thailand, Russia, Singapore, Malaysia, Vietnam, USA, Germany, China, UK, Indonesia, Netherlands,	UAE, Japan	Nepal, Hong Kong, Saudi Arabia,	Bangladesh
HS-02 Meat	China, Nepal, Germany, Netherlands, UK, USA			Kuwait, Malaysia, Egypt, Hong Kong, Vietnam, Iran, UAE, Indonesia, Saudi

				Arabia, Bangladesh, Russia, Thailand, Singapore, Japan
HS-03 Fish	Indonesia, Bangladesh	Iran		Kuwait, UAE, Japan, Nepal, Hong Kong, Singapore, Saudi Arabia, USA, China, Malaysia, Germany, UK, Egypt, Thailand, Netherlands, Vietnam, Russia,
HS-04 Dairy Products	Hong Kong, USA, Iran, Malaysia, Germany, Netherlands, UK,	Nepal, Indonesia, Saudi Arabia, Singapore, China, Vietnam	Thailand, Egypt, Russia,	Bangladesh, UAE, Japan, Kuwait
HS-05 Products of Animal Origin	Egypt, Netherlands, Bangladesh, USA, Nepal, Iran.	Thailand, Russia	Germany, China	Hong Kong, Japan, UAE, Kuwait, Singapore, Vietnam, Malaysia, UK, Indonesia, Saudi Arabia
HS-06 Live Tree	Vietnam, Netherlands, Thailand, Egypt, Indonesia, Bangladesh, Iran	China, Malaysia	Singapore, USA, Nepal,	Kuwait, Japan, Russia, UAE, Hong Kong, Saudi Arabia, UK, Germany,
HS-07 Edible Vegetable	Vietnam, Nepal, Thailand, Netherlands, Iran, China	Egypt, USA		Kuwait, Hong Kong, Bangladesh, UAE, Malaysia, Saudi Arabia, Russia, Singapore, Japan, UK, Germany, Indonesia
HS-08 Edible Fruit	Thailand, Indonesia, China, Vietnam, Iran	Egypt		Kuwait, Bangladesh, Hong Kong, Japan, UAE, Saudi Arabia, Russia, UK, Netherlands, Singapore, Germany, Nepal, Malaysia, USA
HS-09 Coffee, Tea, Mate & Spices		Vietnam, Nepal, Indonesia		Kuwait, Saudi Arabia, UAE, Russia, Japan, Malaysia, Thailand, USA, UK, Hong Kong, Germany, Netherlands, Egypt,

				Iran, Bangladesh, Singapore, China,
HS-10 Cereals	USA, Thailand	Germany, Vietnam		Kuwait, Nepal, Saudi Arabia, Bangladesh, Iran, UAE, Malaysia, Indonesia, Singapore, Hong Kong, Japan, Egypt, UK, Russia, Netherlands, China,
HS-11 Production Mill	Egypt, Vietnam, Netherlands, Germany, Thailand	Russia, China, Nepal, UK, USA	Japan, UAE, Iran, Hong Kong	Bangladesh, Saudi Arabia, Indonesia, Malaysia, Kuwait, Singapore
HS-12 Oil Seeds	USA, Nepal		China	Kuwait, Saudi Arabia, UAE, Hong Kong, Bangladesh, Malaysia, Indonesia, Vietnam, Iran, Japan, Russia, Thailand, UK, Singapore, Germany, Netherlands, Egypt
HS-13 Lac, Gums, Resins & Vegetable Saps				Hong Kong, Kuwait, Saudi Arabia, UAE, Bangladesh, Malaysia, Indonesia, Vietnam, Iran, Japan, Russia, Thailand, UK, Singapore, Germany, Netherlands, Egypt, China, USA, Nepal
HS-14 Vegetable Plaiting Materials & Vegetable Product	Iran, Indonesia	Thailand, Vietnam, Singapore	Egypt	Kuwait, UAE, Saudi Arabia, Japan, Russia, Hong Kong, Bangladesh, China, UK, Germany, Malaysia, Nepal, Netherlands, USA
HS-15 Animal Veg Fat Oils	Nepal, Egypt, Malaysia, Indonesia	Singapore, UAE, Hong Kong,	Vietnam, UK, USA, Germany	China, Japan, Kuwait, Bangladesh, Thailand, Russia, Iran, Netherlands, Saudi Arabia
HS-16 Preparations of Meat/ Fish	China, Netherlands, Germany, Iran, Vietnam, Thailand, Indonesia,	Malaysia, Saudi Arabia, UK,	Hong Kong, Singapore, USA,	Kuwait, Egypt, Russia, Japan, Nepal, Bangladesh, UAE
HS-17 Sugars	UK, USA,	Egypt	China,	Bangladesh, Kuwait,

	Germany, Hong Kong, Japan, Thailand		Vietnam, UAE, Netherlands,	Nepal, Malaysia, Saudi Arabia, Indonesia, Singapore, Iran, Russia,
HS-18 Cocoa	USA, Indonesia, Singapore, Japan, Egypt, Germany, Netherlands, Malaysia, UK, Russia, Iran	UAE	Saudi Arabia, Hong Kong, China, Thailand, Vietnam,	Nepal, Bangladesh, Kuwait
HS-19 Preparation of Cereal/ Flour	Singapore, Iran, Thailand, Japan, Egypt, Netherlands, Germany, Hong Kong, Indonesia, China, Vietnam.	Nepal, UK, Russia, Malaysia, USA	Saudi Arabia	Bangladesh, Kuwait, UAE,
HS-20 Preparation of Vegetable Fruit Nut	Iran, Hong Kong, Egypt, China, Thailand, Vietnam,	Singapore, Germany, USA, Netherlands,	Indonesia, UAE	Russia, Bangladesh, Japan, Kuwait, Nepal, Saudi Arabia, UK, Malaysia,
HS-21 Miscellaneous Edible	Indonesia, UK, USA, Germany China, Netherlands, Thailand, Hong Kong,	Malaysia, Singapore, Vietnam, Egypt	Japan,	Russia, Bangladesh, Kuwait, Saudi Arabia, UAE, Iran, Nepal
HS-22 Beverages	Thailand, Kuwait, Saudi Arabia, Malaysia, Singapore, Netherlands, Indonesia, China, Russia, USA, Hong Kong, UK, Egypt, Germany,	Vietnam	Iran	Nepal, Bangladesh, UAE, Japan
HS-23 Residues	Nepal, USA	UK, Netherlands	Germany, Hong Kong,	Kuwait, Saudi Arabia, Bangladesh, Vietnam, Japan, Iran, UAE, Singapore, Indonesia, China, Malaysia,

				Thailand, Egypt, Russia
HS-24 Tobacco	USA, China, Hong Kong	Netherlands, Japan, Indonesia,	UK, Germany, Singapore	Saudi Arabia, Kuwait, Egypt, Russia, Nepal, Iran, UAE, Bangladesh, Vietnam, Malaysia, Thailand

Source: Computed from WITS data

Table 3.29 highlights India's bilateral RCA across 24 HS-2 agricultural product categories with 20 major trading partners, emphasising the countries where India enjoys high (RCA 1–2) and strong (RCA >2) comparative advantage. The results indicate that India maintains strong and high RCA predominantly with Gulf countries (UAE, Saudi Arabia, Kuwait), South Asian neighbours (Bangladesh, Nepal), and select East Asian markets (Hong Kong, Japan, Singapore). For instance, products such as lac, gums, and resins, coffee, tea, and spices, cereals, meat, and fish consistently show strong RCA with these partners, reflecting India's entrenched trade linkages and competitive edge in traditional commodities.

The concentration of strong bilateral RCA in regional markets implies several economic advantages. First, proximity reduces transportation costs and logistics risks, improving India's price competitiveness. Second, cultural and dietary similarities in these regions create a stable demand for specific commodities such as spices, cereals, and lac products. Third, the presence of strong RCA in multiple countries for the same product indicates the potential for scale economies in production and exports. Furthermore, countries with high RCA offer opportunities for incremental growth through export diversification and value addition, for example, moving from raw cereals or spices to processed or packaged products, which could enhance export earnings.

From a policy perspective, focusing on countries with strong and high RCA can strengthen India's regional market dominance while also serving as a platform for gradually entering more challenging developed markets. Investments in quality standards, cold chain infrastructure, and marketing in these high-RCA regions could help India consolidate its

comparative advantage, improve market share, and increase resilience against external shocks in global agricultural trade.

3.3.7 Bilateral RCA Analysis-Highest Mean Rank:

Bilateral mean RCA analysis provides a clear perspective on the specific countries where India enjoys the strongest competitive advantage for each HS-2 agricultural product category. By identifying the country with the highest mean RCA for each commodity, this analysis highlights not only India's core markets but also its strategic partners where export potential is maximised. Such insights are crucial for export planning, trade negotiations, and prioritising market-specific interventions, particularly for products where India holds a dominant position.

Table 3.30: India's Highest RCA Ranks for Bilateral Exports

Commodity Classification	Country with the Highest RCA	Mean RCA
HS-01 Live Animals	Bangladesh	54.28
HS-02 Meat	Kuwait	96.81
HS-03 Fish	Kuwait	97.83
HS-04 Dairy Products	Bangladesh	63.61
HS-05 Products of Animal Origin	Hong Kong	83.63
HS-06 Live Tree	Kuwait	98.07
HS-07 Edible Vegetable	Kuwait	96.17
HS-08 Edible Fruit	Kuwait	98.97
HS-09 Coffee, Tea, Mate & Spices	Kuwait	92.64
HS-10 Cereals	Kuwait	99.23
HS-11 Production Mill	Bangladesh	73.40
HS-12 Oil Seeds	Kuwait	97.63
HS-13 Lac, Gums, Resins & Vegetable Saps	Hong Kong	97.97
HS-14 Vegetable Plaiting Materials & Vegetable Product	Kuwait	95.90
HS-15 Animal Veg Fat Oils	China	44.54
HS-16 Preparations of Meat/ Fish	Kuwait	21.43
HS-17 Sugars	Bangladesh	88.30
HS-18 Cocoa	Nepal	83.43
HS-19 Preparation of Cereal/ Flour	Bangladesh	16.44
HS-20 Preparation of Vegetable Fruit Nut	Russia	45.51

HS-21 Miscellaneous Edible	Russia	71.96
HS-22 Beverages	Nepal	11.27
HS-23 Residues	Kuwait	95.80
HS-24 Tobacco	Saudi Arabia	99.71

Source: Computed from WITS data

Table 3.30 presents India's highest RCA ranks across 24 HS-2 agricultural commodities, identifying the single trading partner with the maximum mean RCA for each product. The results reveal a strong concentration of India's competitive advantage in the Gulf region (Kuwait, Saudi Arabia), South Asian neighbours (Bangladesh, Nepal), East Asia (Hong Kong, China), and select Eastern European markets (Russia). For example, Kuwait emerges as the top destination for a range of products, including meat, fish, live trees, edible vegetables and fruits, cereals, coffee, tea, spices, oilseeds, vegetable plaiting materials, and residues, with mean RCA values often exceeding 95. This underscores Kuwait's importance as a key market for India's traditional agricultural exports, reflecting high demand, trade complementarity, and relatively low trade barriers. Similarly, Bangladesh excels in live animals, dairy products, sugar, and processed cereals, indicating strong regional integration in the South Asian region. Hong Kong shows maximum RCA for products of animal origin and lac/gums/resins, highlighting India's competitive niche in specialised commodities, while Russia and Nepal appear as top markets for prepared vegetables, fruits, nuts, cocoa, and beverages, reflecting India's ability to meet demand for select high-quality or culturally specific products. Saudi Arabia ranks highest for tobacco, indicating the concentration of Indian tobacco exports in high-demand markets.

The economic implications of these findings are significant. A high mean RCA with specific countries suggests potential for market consolidation, higher export revenues, and targeted policy support, such as trade facilitation, quality standard certification, and logistics improvement. Products with exceptionally high mean RCA, such as cereals and

edible fruits in Kuwait or dairy products in Bangladesh, offer opportunities for value addition and diversification within existing markets. Moreover, reliance on a few key markets for certain products signals both strength and vulnerability: while India enjoys strong market positions, external shocks, regulatory changes, or shifts in demand in these countries could disproportionately affect export performance. Therefore, strategies aimed at expanding into additional high-RCA markets and promoting product upgrading are crucial for enhancing resilience and sustaining long-term growth in agricultural exports.

3.4. Discussion

The analysis of India's Revealed Comparative Advantage (RCA) across HS-4 agricultural products, regional groupings, and bilateral trade partners provides a comprehensive picture of the country's export competitiveness. At the product level, India's RCA is concentrated in specific primary commodities and niche products, reflecting its traditional strengths and long-standing expertise in certain agricultural sectors. In the category of live animals and animal products, India shows a moderate RCA overall, but dairy products, particularly milk and milk derivatives, exhibit a strong comparative advantage, highlighting the country's global prominence in dairy production and exports (Pingali et al., 2019). Among horticultural products, coconuts, cashew nuts, and preserved fruits display exceptionally high RCA, while fresh grapes, dates, figs, and pineapples show strong competitiveness, indicating India's strength in tropical and subtropical fruit exports (Kumar & Singh, 2017). The coffee, tea, and spices sector consistently emerges as highly competitive, with products such as tea, pepper, cardamom, and nutmeg achieving strong RCA values, corroborating India's historical dominance in global spice markets (Joshi et al., 2018).

In cereals and related products, India demonstrates strong RCA in rice, buckwheat,

millets, maize, and sorghum, reflecting its crucial role in global cereal supply, particularly for Basmati rice. However, most processed cereal products show low RCA, except for flour and meals of dried legumes, suggesting that domestic consumption largely absorbs processed cereal production. In oilseeds and fats, groundnuts, other oilseeds, and copra show a strong comparative advantage, while vegetable fats and groundnut oil emerge as key export commodities, indicating scope for value addition (Rao & Sharma, 2020). Non-timber forest products, such as lac, natural gums, and resins, also record strong RCA, reflecting India's niche export strengths. Conversely, highly processed agricultural products, including cocoa preparations, cereal-based foods, beverages, and confectionery, exhibit weak RCA, highlighting limited global competitiveness in processed segments. Residues and waste products, notably oil-cakes from groundnuts and soybeans, demonstrate very strong RCA, underscoring India's leadership in agro-industrial by-products. Tobacco exports reveal a strong RCA for unmanufactured products, whereas manufactured items like cigarettes remain less competitive, indicating potential for expanding processed exports. Overall, these results suggest that India's comparative advantage is largely concentrated in primary and niche products, with processed items showing relatively lower global competitiveness, emphasising the importance of value addition and quality enhancement to strengthen export performance (Haque & Sharma, 2019; Joshi et al., 2018).

At the regional level, India's RCA exhibits context-specific patterns shaped by geographic proximity, trade policies, and market demand. South Asia emerges as India's strongest regional market, showing the highest RCA in live animals, dairy products, vegetables, cereals, sugar, lac, gums, vegetable plaiting materials, and residues, alongside a high RCA in coffee, tea, spices, production mill products, and

oilseeds. This dominance is likely driven by cultural consumption patterns, shared dietary preferences, and lower transportation costs, highlighting India's strategic advantage in neighbouring markets (Balassa, 1965; WITS, 2020). Least Developed Countries (LDCs) exhibit a high RCA in cereals, meat, dairy, prepared cereals, and mill products, reflecting India's role as a supplier of staple and essential agro-processed goods, supported by cost competitiveness and established trade relationships (FAO, 2019). In the East Asia Pacific region, India exhibits a comparative advantage in residues, lac, gums, oilseeds, vegetable plaiting materials, animal products, and tobacco, with high RCA also in edible vegetables and processed products. These findings suggest that India's export strategy in East Asia should emphasise high-value, industrially relevant products to align with rising incomes and demand for processed commodities (Hidalgo et al., 2007; Singh et al., 2018). In contrast, the EU-27 shows concentrated comparative advantages in niche and high-value items such as coffee, tea, spices, fish, edible fruits, and oils, while cereals and basic animal products demonstrate moderate RCA. Stringent quality standards, regulatory requirements, and strong competition constrain India's competitiveness in commodity exports to developed markets, indicating a need to focus on differentiated, value-added products (Balassa, 1986; UNCTAD, 2021). These regional patterns underscore the necessity of tailored trade strategies, export infrastructure development, and investment in value addition to maximise India's export potential.

Bilateral RCA analysis further refines the understanding of India's global competitiveness, identifying specific countries where India holds a strong comparative advantage in agricultural exports. High RCA values are observed with countries such as Kuwait, Bangladesh, and Hong Kong. For example, Kuwait exhibits high RCA across meat, fish, dairy, vegetables, fruits, coffee, tea, and spices, indicating India's

ability to meet specific market preferences effectively. Bangladesh shows strong RCA in live animals, dairy, and sugar, reflecting targeted production and supply capabilities, while Hong Kong demonstrates notable RCA in products of animal origin. These bilateral patterns highlight the strategic importance of established trade networks, economies of scale in sectors like dairy, and specialised supply chains that cater to the unique demands of partner countries. At the same time, reliance on specific export markets underscores the need for diversification to mitigate risks associated with market concentration. Overall, the bilateral RCA results provide actionable insights for designing export strategies, strengthening trade partnerships, and promoting targeted policy interventions to enhance India's position in the global agricultural trade landscape.

In summary, the findings of this chapter provide strong empirical support for the hypothesis that India's agricultural commodities exhibit a significant revealed comparative advantage in traditional and resource-based products. The RCA results across HS-4 commodities, regional groupings, and bilateral partners consistently highlight India's export strengths in sectors such as cereals, spices, oilseeds, and residues, products closely tied to natural resource endowments and long-established production systems. By contrast, processed and high-value-added agricultural goods display relatively weaker comparative advantage, indicating structural constraints in upgrading toward more technology-intensive segments. These outcomes confirm that India's agricultural competitiveness remains deeply rooted in its traditional and resource-based sectors, validating the initial hypothesis and emphasising the need for strategic policy interventions to enhance value addition and diversification.

3.5. Conclusions

This chapter concludes that India's Revealed Comparative Advantage (RCA) in agricultural exports exhibits a clear and differentiated pattern across HS-4 products, regional groupings, and bilateral trade partners, reflecting both long-standing strengths and areas that warrant strategic policy attention. At the product level, India demonstrates a strong and persistent comparative advantage in several traditional and niche agricultural commodities such as rice, spices, groundnuts, coconuts, cashew nuts, lac, and oil-cakes. These strengths are deeply rooted in favourable agro-climatic conditions, well-established production systems, and accumulated export experience developed over several decades. Such products continue to form the backbone of India's agricultural export basket and contribute significantly to its presence in global markets.

In contrast, highly processed and value-added agricultural products generally exhibit weaker RCA, pointing to structural constraints related to technological capabilities, scale economies, quality certification, and compliance with international standards. However, the analysis also reveals encouraging signs among certain semi-processed products, including vegetable oils, molasses, flours, and selected agro-industrial by-products, which display moderate to high RCA values. This suggests considerable untapped potential for export upgrading through value addition, processing, and diversification into higher segments of global value chains.

From a regional perspective, India's comparative advantage varies markedly across export destinations. South Asia and Least Developed Countries emerge as India's most competitive markets, with consistently strong RCA across a broad range of staple commodities and agro-processed products. This performance is largely driven by geographical proximity, historical trade linkages, shared dietary preferences, lower transport costs, and India's price competitiveness. Conversely, the East Asia Pacific

region and the EU-27 exhibit more selective and product-specific patterns of comparative advantage. These markets tend to demand high-value, niche, and industrially relevant agricultural products and are characterised by higher income levels, stringent quality and sanitary standards, and complex regulatory frameworks. While these factors pose significant challenges for Indian exporters, they also offer opportunities for product differentiation and value enhancement.

The bilateral RCA analysis further highlights India's strong competitiveness in partner countries such as Kuwait, Bangladesh, and Hong Kong, particularly across cereals, meat, fish, spices, coffee, and tea. Overall, the findings indicate that India's agricultural export competitiveness remains predominantly anchored in traditional and resource-based products. To strengthen its long-term position in global agricultural trade, India must prioritise value addition, diversify into processed and high-value segments, and adopt market-specific export strategies supported by targeted trade, infrastructure, and quality-enhancing policies.

CHAPTER IV

STABILITY, CONVERGENCE AND STRUCTURAL DYNAMICS OF INDIA'S AGRICULTURAL EXPORT COMPETITIVENESS

4.1. Introduction

The assessment of comparative advantage is central to understanding how developing countries integrate into global markets and sustain export-led growth. Exporting allows firms to achieve economies of scale, improve productivity, and access foreign capital inflows that create a virtuous cycle of investment, specialisation, and technological upgrading. For developing economies such as India, agricultural exports provide not only foreign exchange but also opportunities for employment generation, technology transfer, and resource reallocation in line with comparative advantage. Export-oriented industrialisation has been widely acknowledged to drive economic growth by expanding production and specialisation, supported by policies that enhance competitiveness through efficient use of factor endowments, favourable trade policies, and exchange rate management. In this context, the stability and convergence of comparative advantage become an important dimension for examining how India's agricultural commodities perform and evolve in the global market.

Although RCA-based measures (Balassa, Vollrath, RSCA) and the Trade Balance Index (TBI) are widely used to assess agricultural competitiveness, most studies remain static, providing snapshots of comparative advantage. Few examine the dynamic evolution of competitiveness, particularly the stability, convergence, and structural transformation of agricultural exports over time. Heterogeneity across subsectors, where some products show β -convergence while others diverge, is often overlooked. Limited research integrates RSCA and TBI into a Trade Competitiveness Index or links convergence patterns with

structural transformation and diversification. Using metrics such as density, distance, and Agri-Product Complexity Index (Agri-PCI), the study addresses these gaps by adopting an integrated framework combining RSCA, TBI, convergence analysis, Product Mapping, and Product Spacing methods to comprehensively evaluate the stability, convergence, and transformation of India's agricultural exports from 1991 to 2020.

A first step in this analysis is to evaluate the comparative advantage of Indian agricultural commodities using **alternative measures of Revealed Comparative Advantage (RCA)**. The RCA index, pioneered by Balassa (1965), has undergone methodological refinements to address its limitations in capturing specialisation across products. Adjusted forms such as the Revealed Symmetric Comparative Advantage (RSCA) (Vollrath, 1991; Laursen, 1998) and the Trade Balance Index (TBI) (Lafay, 1992) provide robust frameworks for assessing both the intensity of comparative advantage and the trade orientation of products. By employing these two measures together, this study tracks trends in India's agricultural exports at the HS-2 level to assess persistence, improvement, or decline in competitiveness across subsectors over time.

Export instability remains a major challenge for developing countries, driven by fluctuations in demand, supply constraints, exchange rate changes, or concentration in a few commodities, especially primary ones (Dalum et al., 1998). Understanding both the **stability and convergence** of India's agricultural exports is crucial to assess whether the trade performance of different subsectors is becoming more consistent and competitive over time. Convergence analysis, complemented by clustering techniques, enables the identification of "convergence clubs" of subsectors sharing similar dynamics, offering insights into whether weaker performers are catching up with stronger ones or whether disparities persist. This aligns with theoretical arguments that trade can foster convergence or divergence depending on technological absorptive capacity and innovation externalities

(Pasinetti, 1981; Beelen & Verspagen, 1994; Dosi et al., 1990). Accordingly, this study tests the following hypothesis,

H2: The comparative advantage of Indian agricultural exports demonstrates β -convergence over time.

While convergence analysis offers dynamic insights, it is equally important to map agricultural exports spatially across product categories. **Product mapping** at the HS-4 level identifies India's leading export products that command significant shares in domestic and global markets. The approach situates products by their revealed competitiveness and trade balance contribution, highlighting "winners" with high comparative advantage and specialisation (Widodo, 2009; Girik et al., 2017). This mapping captures commodities generating foreign exchange as well as potential vulnerabilities, incorporating dynamics as comparative advantage shifts over time due to productivity, technology, institutions, or trade costs (Harrigan, 1997; Redding, 2002; Venables, 2001).

To complement product mapping, this chapter employs **product spacing** analysis via the "product space" framework of Hidalgo and Hausmann. Network-based and dynamic, it illustrates the proximity of products in terms of shared capabilities and diversification potential. By analysing HS-4 agricultural exports, product spacing highlights feasible paths toward higher-value products, linking current exports with future opportunities. Mapping shows India's current position, while product space indicates realistic diversification strategies.

These four approaches, RCA measures, convergence and clustering, product mapping, and product spacing, offer a comprehensive assessment of the **stability and dynamics** of India's agricultural comparative advantage. By combining static, dynamic, and network-

based analyses, the study provides multidimensional insights for policymakers to enhance export diversification, reduce volatility, and strengthen India's global trade position.

4.2. Methodology

This study integrates multiple approaches to evaluate the competitiveness and structural dynamics of India's agricultural exports. First, RCA measures, including Balassa, Vollrath, RSCA, and the Trade Balance Index (TBI) assess comparative advantage and trade orientation. Second, stability and convergence are analysed using Galtonian regression, kernel density estimation, and convergence clubs to track competitiveness evolution. Third, product mapping (RSCA–TBI matrix and Trade Competitiveness Index) classifies products by specialisation and advantage. Finally, the Product Space methodology (Hausmann & Hidalgo) examines diversification, capability accumulation, and structural transformation via proximity, density, distance, and Agri-PCI. Together, these methods provide static and dynamic insights into India's agricultural trade from 1991 to 2020.

4.2.1. Other measures of revealed comparative advantage:

The Revealed Comparative Advantage (RCA) is used to assess India's export competitiveness, with indices developed by Balassa and Vollrath. RCA measures a country's potential to gain export shares in global markets by comparing product performance against world trade. Although simple, the Balassa-RCA has limitations: it is asymmetric and does not account for agricultural policies, overestimating strengths when above 1 and underestimating disadvantages below 1. To address this, Vollrath (1991) proposed alternative indices, including the symmetric Revealed Symmetric Comparative Advantage (RSCA) (Dalum et al., 1998), computed as $RSCA = (RCA - 1) / (RCA + 1)$. The RSCA ranges from -1 to +1, with positive values indicating a comparative export advantage and stability in competitiveness. Vollrath developed three additional indices—Relative Trade Advantage (RTA), Relative Export Advantage (REA), and Revealed

Competitiveness (RC), which incorporate both exports and imports relative to the world, providing a balanced measure of comparative advantage. The RTA is computed as $\mathbf{RTA} = \mathbf{RXA} - \mathbf{RMA}$. The REA is measured as the natural logarithm of RXA over RMA, $\mathbf{RCA} = \mathbf{log_RXA} - \mathbf{log_RMA}$. The RC is calculated as $\mathbf{RC} = \mathbf{log(RXA)} - \mathbf{log(RMA)}$. Together with the RSCA and RXA, these indices allow comparison of comparative advantage across countries and products, classifying them as Strong/Low Disadvantage or High/Strong Advantage, facilitating trade and intra-industry specialisation.

The Trade Balance Index (TBI) measures a country's international competitiveness by the proportion of net exports of a product relative to total trade: $\mathbf{TBI} = (\mathbf{X_{ij}} - \mathbf{M_{ij}}) / (\mathbf{X_{ij}} + \mathbf{M_{ij}})$ (Wei, 2005), where X_{ij} and M_{ij} are exports and imports of product j in country i . Higher TBI values indicate stronger export competitiveness.

4.2.2. Convergence Framework

To evaluate the dynamics of India's agricultural export competitiveness, the study applies the Galtonian regression framework, regressing trade indicators of a later period (t_2) on their earlier values (t_1). The slope coefficient (β) reveals convergence, divergence, or stability across subsectors: $\beta = 1$ indicates unchanged specialisation; $\beta > 1$ shows intensified specialisation (β -divergence); $0 < \beta < 1$ reflects broad-based growth (β -convergence); and $\beta < 0$ signals strong convergence, where weaker sectors catch up, promoting a diversified trade structure (Dalum et al.).

The general regression equations are:

$$\mathbf{RSCA_{ij} \text{ } t_2} = \alpha_i + \beta_i \mathbf{RSCA_{ij} \text{ } t_1} + \varepsilon_{ij}$$

$$\mathbf{TBI_{ij} \text{ } t_2} = \alpha_i + \beta_i \mathbf{TBI_{ij} \text{ } t_1} + \varepsilon_{ij}$$

Table 4.1: Classification and Growth of Trade Specialisation & Patterns:

β Value	Specialisation Trend	Trade Pattern Interpretation
$\beta = 1$ or $\beta = R$	No change	Stable trade structure with unchanged specialisation
$\beta > 1$ or $\beta > R$	Increased specialisation	Divergence — stronger sectors expand further

$0 < \beta < 1$ or $0 < \beta < R$	Broad-based growth	Convergence — inclusive growth and diversification
$\beta < 0$	Dynamic transformation	Strong convergence — catch-up by lagging sectors

Source: Dalum et al. (1998)

In addition to β -convergence, σ -convergence is analysed using kernel density distributions of RSCA and TBI, where narrowing distributions indicate reduced disparities. Kernel density plots visualise convergence clusters, while β -convergence quantifies catch-up dynamics. Heatmaps complement these analyses, illustrating the intensity and evolution of RSCA and TBI across subsectors. Trade balance orientation is similarly analysed through the TBI. Subsector convergence clubs based on β values identify products following similar specialisation trajectories over time.

4.2.3. Product Mapping Framework

According to Widodo (2008), the Trade Balance Index (TBI) and Revealed Symmetric Comparative Advantage (RSCA) are key tools for mapping products. RSCA, derived from Balassa's RCA, measures comparative advantage on a scale from -1 to $+1$, where positive values indicate relative gains in a product, and negative values signal disadvantage (Widodo, 2009). The TBI, developed by Lafay, evaluates whether a country is net-exporting or net-importing a product, ranging from -1 (sole importer) to $+1$ (sole exporter). Volrath (1991) proposed the Trade Competitiveness (TC) index by combining RSCA and TBI, where a positive TC reflects comparative advantage and export orientation, and a negative TC indicates disadvantage and import dependence. Product mapping uses RSCA and TBI to classify HS-4 products into four groups, as illustrated in the Product Mapping Matrix (Table 4.2):

Table 4.2: PRODUCT MAPPING MATRIX		

		Importer	Exporter
RSCA Comparative Advantage / Disadvantage)	RSCA > 0	Group B: Comparative Advantage Export Specialisation (CA>0, TBI<0)	Group A: Comparative Advantage Export Specialisation (CA>0, TBI>0)
	RSCA < 0	Group D: Comparative Disadvantage Export Specialisation (CA<0, TBI<0)	Group C: Comparative Disadvantage Export Specialisation (CA<0, TBI>0)
		TBI < 0	TBI > 0
		TBI (Net Importer/ Net Exporter)	

Group A contains products with both comparative advantage and export specialisation, representing India's leading exports. Group B products have a comparative advantage but lack export specialisation, while Group C is export-oriented despite a disadvantage. Group D has neither advantage nor specialisation. For India, RSCA and TBI were computed for 200 HS-4 agricultural products over 1991–2020, analysing select years. Using the product mapping matrix, top agricultural exports were identified based on high domestic and global export shares, with particular focus on products in Group A exhibiting positive RSCA and TBI. This classification enables a clearer understanding of India's export structure and

competitive positioning across products. It also helps identify products with potential for upgrading from comparative advantage to sustained export specialisation. Such mapping provides useful policy insights for prioritising sectoral support and export diversification strategies.

4.2.4. Product Spacing Framework

The Product Spacing methodology, developed by Hausmann & Hidalgo (2007), analyses the relatedness and complexity of products to identify export diversification potential. Unlike traditional RCA approaches, it highlights products that are "close" to a country's current exports, facilitating feasible diversification. For India's agricultural exports, the method prioritises products aligned with existing capabilities and avoids unrelated sectors.

A product proximity matrix is constructed from global co-export patterns at the HS-4 level, where nodes represent products and edges indicate high proximity. India's RCA data is overlaid to analyse the position and connectivity of its export basket. Product space networks are generated for two time periods to track changes in specialisation, diversification, and capability accumulation.

Three core indicators are used:

Density: This metric measures the average proximity of a non-exported product to India's current export basket and reflects how easily India can move into new products based on its existing capabilities. For non-exported products, $Density_p = \left(\frac{1}{|N(p)|} \right) \times$

$\sum_{q \in N(p)} \phi_{pq}$ ϕ_{pq} measures the average proximity to India's current exports ($RCA \geq 1$).

High values indicate easier transition.

Distance: Unlike proximity or density, which measure closeness to the current export

basket, distance is a **capability gap** indicator; it tells us how far a product is from India's existing strengths. For a non-exported product p , **distance** is defined as:

$$\text{Distance } p = 1 - \frac{\sum_{q \in N(p)} \phi_{pq} \cdot M_q}{\sum_{q \in N(p)} \phi_{pq}}$$

ϕ_{pq} quantifies capability gaps. Higher values indicate products far from current strengths.

Agri-Product Complexity Index (Agri-PCI): $\text{Agri-PCI}_p = v_{2p}$, derived from the dominant eigenvectors of the standardised proximity matrix Φ , where $\Phi_{pp}' = \sum_c M_{cp} \times M_{cp}' / \sum_p M_{cp}'$. High Agri-PCI indicates less ubiquitous, knowledge-intensive products that contribute to long-term economic upgrading and structural transformation in India's agricultural exports.

4.3. Results

4.3.1. RSCA, RCA's & TBI indexes for HS-2 classification of goods

This section presents India's trade competitiveness across 24 HS-2 agricultural product categories using multiple indicators, namely Revealed Symmetric Comparative Advantage (RSCA), several RCA measures (RXA, RTA, ln RXA, RC), and the Trade Balance Index (TBI). These indices collectively provide a clear picture of both comparative advantage and trade performance. The analysis covers the period from 1991 to 2020, highlighting patterns of structural strengths and weaknesses.

Table 4.3 represents the mean Revealed Comparative Advantage (RCA) of HS-2 Classification of goods of India for the select years of 1991, 1995, 2000, 2005, 2008, 2010, 2015 to 2020 for 24 agricultural product categories. The TBI results show that India enjoys strong trade competitiveness in 16 out of 24 agricultural product categories, including meat, fish, cereals, coffee/tea/spices, lac and vegetable saps, vegetable plaiting materials, sugar, residues, and tobacco. These sectors consistently register high and positive TBI values, confirming a surplus trade position. Conversely, categories such as edible vegetables, edible fruits, animal/vegetable oils, cocoa, and beverages record negative or

weak TBI values, indicating structural trade deficits. The RSCA results further confirm revealed comparative advantage in 12 categories, notably meat, fish, edible vegetables, edible fruits, coffee/tea/spices, cereals, oilseeds, lac, vegetable plaiting materials, sugar, residues, and tobacco.

Table 4.3: India's Consolidated Mean RSCA, RCA's & TBI indexes for HS-2 classification of goods:

Section / Category	RSCA	RCA 1 (RXA)	RCA 2 (RTA)	RCA 3 (ln RXA)	RCA 4 (RC)	TBI
1. Live Animals	-0.92	0.04	0.03	-1.43	0.32	0.30
2. Meat	0.10	1.34	1.34	0.08	3.06	1.00
3. Fish	0.49	3.10	3.07	0.49	2.24	0.97
4. Dairy Products	-0.61	0.26	0.21	-0.64	0.84	0.68
5. Products of Animal Origin	-0.09	1.02	0.84	-0.06	0.67	0.49
6. Live Tree	-0.56	0.29	0.25	-0.50	0.92	0.73
7. Edible Vegetable	0.07	1.18	-0.15	0.07	-0.02	- 0.28
8. Edible Fruit	0.10	1.50	0.43	0.12	0.08	- 0.09
9. Coffee, tea, mati & spices	0.65	5.43	4.90	0.71	1.03	0.69
10. Cereals	0.54	3.58	3.48	0.55	1.83	0.91
11. Prod. Mill.	-0.21	0.79	0.66	-0.22	0.86	0.60
12. Oil seed	0.10	1.28	1.11	0.11	0.90	0.69
13. Lac; gums, resins & other Vegetable saps	0.80	9.59	8.34	0.97	0.87	0.72
14. Vegetable Plaiting materials & Vegetable Product	0.61	4.53	3.51	0.63	0.79	0.54
15. Animal/Veg fat oils	-0.08	0.90	-3.41	-0.06	-0.67	- 0.77
16. Prep of Meat/Fish	-0.48	0.40	0.39	-0.58	2.03	0.96
17. Sugar	0.23	1.98	1.35	0.22	0.52	0.39
18. Cocoa	-0.78	0.13	-0.04	-1.07	-0.21	- 0.50
19. Prep Cereal/Flour	-0.44	0.39	0.19	-0.41	0.72	0.69
20. Prep Vegetable Fruit Nut	-0.38	0.45	0.40	-0.35	1.21	0.70
21. Miscellaneous Edible	-0.26	0.60	0.44	-0.23	0.68	0.63
22. Beverages	-0.75	0.15	-0.03	-0.89	0.00	- 0.19
23. Residues	0.28	2.42	2.19	0.29	0.98	0.70
24. Tobacco	0.16	1.40	1.36	0.12	1.60	0.91

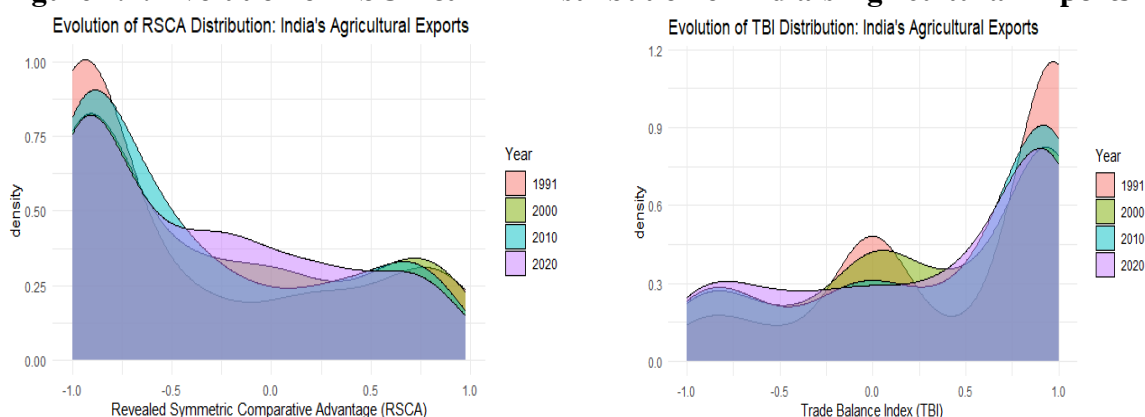
Source: Computed by author

Products like dairy, live trees, and products of animal origin show positive TBI values but negative RSCA, implying trade surpluses without a strong comparative advantage. Similarly, animal/vegetable oils remain weak on both measures, with negative TBI and RSCA values. The RCA (RXA) values reinforce these patterns, with lac, gums, and resins (9.58) recording the highest advantage, followed by coffee/tea/spices (5.42) and vegetable plaiting materials (4.53). In total, 13 of the 24 product categories have RXA values above 1, signifying comparative strength. Overall, India's agricultural exports reveal competitiveness concentrated in traditional and resource-based commodities, while perishables and processed products exhibit relatively weak performance.

4.3.2. Distribution Analysis

The distributional analysis of India's agricultural exports from 1991 to 2020 provides insights into the evolution of competitiveness and trade performance. Using the Revealed Symmetric Comparative Advantage (RSCA) and the Trade Balance Index (TBI), this section examines whether India's agricultural exports have become more competitive over time and how their trade orientation has shifted in response to liberalisation, policy reforms, and changing global market conditions.

Figure 4.1: Evolution of RSCA & TBI Distribution of India's Agricultural Exports



Source: Computed by author

Figure 4.1 presents the kernel density plots illustrating the evolution of RSCA and TBI

distributions for India's agricultural products from 1991 to 2020. In 1991, the RSCA distribution was unimodal and skewed to the left, indicating that most products exhibited comparative disadvantage. By 2000 and 2010, the distribution became flatter and shifted toward the centre, reflecting movement toward neutral competitiveness. By 2020, the RSCA curve displayed a bimodal pattern, with one peak remaining in the negative zone and a second emerging in the positive zone, showing that a group of products achieved higher comparative advantage while others continued to remain in disadvantage.

The TBI distribution in 1991 was unimodal and skewed slightly toward positive values, indicating that several agricultural products were already positioned as net exports. In 2000 and 2010, the TBI density became flatter, indicating wider dispersion among product-level trade balances. By 2020, the TBI distribution showed a sharper peak close to +1, suggesting that a larger share of agricultural products recorded strong trade surplus positions. Unlike RSCA, the TBI distribution did not develop a clear bimodal pattern and remained largely concentrated toward positive values throughout the study period.

A comparative view of both curves shows that RSCA values spread across positive and negative regions by 2020, while TBI values increasingly concentrated toward the export-oriented end of the scale. The combined results indicate that while export-surplus performance expanded across more products, comparative advantage evolved differently across product groups, resulting in a wider distribution pattern over time.

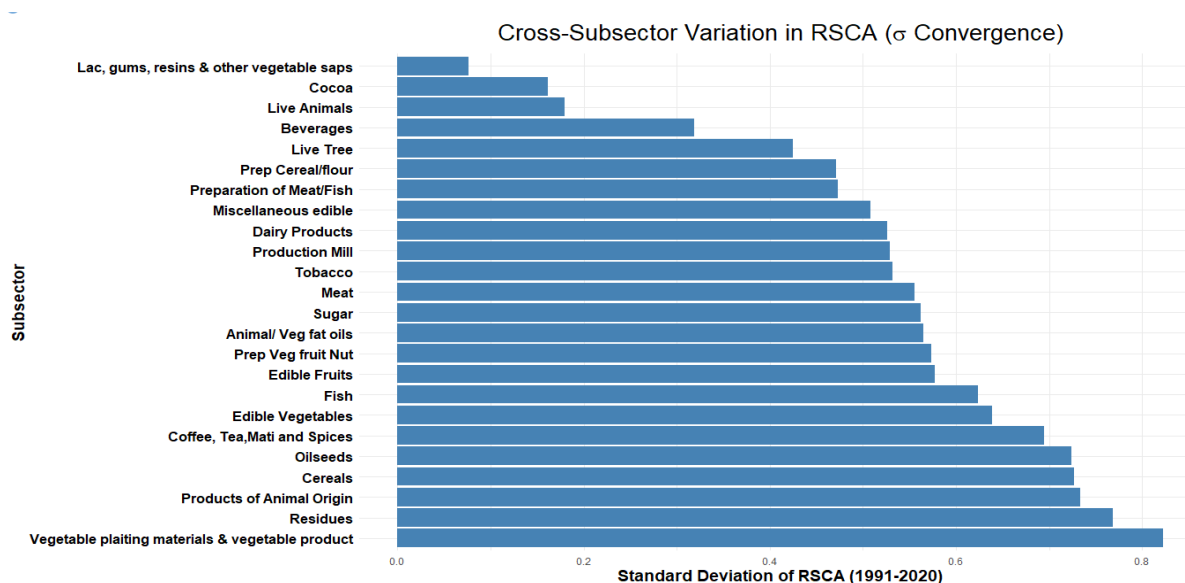
4.3.3. σ Convergence per Subsector

The σ -convergence analysis explores whether India's agricultural export subsectors have become more similar or more divergent in terms of competitiveness between 1991 and 2020. By examining the standard deviation of RSCA values across products within each subsector, this approach highlights the degree of internal variability: lower dispersion signals convergence (greater homogeneity in competitiveness), while higher dispersion

indicates divergence (a widening gap between strong and weak performers).

Figure 4.2 presents the cross-subsector variation in India's agricultural export competitiveness using the standard deviation (SD) of RSCA for the period 1991–2020. The SD reflects the level of dispersion in comparative advantage across products within each HS-2 subsector.

Figure 4.2: Cross-subsector variation in RSCA



Source: Computed by author

Subsectors with lower SD values indicate relatively uniform competitiveness among their constituent products. These include Lac, gums, resins and other vegetable saps, Cocoa, and Live Animals, which show low variability in RSCA values over time. Additional subsectors such as Beverages, Live Trees, Preparation of Cereals/Flour, and Preparation of Meat/Fish display moderate SD values, indicating limited divergence in competitiveness across products within those categories.

Higher SD values, on the other hand, indicate substantial variation among products within the same subsector. The subsectors with the highest RSCA dispersion include Vegetable plaiting materials and vegetable products, Residues, Products of Animal Origin, Cereals, and Oilseeds. In these groups, certain products achieved strong comparative advantages

while others remained weak, resulting in wide intra-group competitiveness gaps. Edible Vegetables, Fish, Edible Fruits, and Animal/Vegetable Fats and Oils show moderate dispersion, indicating the presence of both strengthening and declining products within the same subsector. Tobacco, Meat, and Sugar display slightly lower RSCA variation relative to high-dispersion groups, but do not fall into the category of low-variability subsectors.

Overall, the RSCA standard deviation results demonstrate differing patterns of competitiveness variation across subsectors, highlighting subsectors with relatively uniform performance and those exhibiting wide internal heterogeneity in export competitiveness across products during the 1991–2020 period.

4.3.4. Robustness Checks of Convergence

To ensure the reliability of the convergence of India’s agricultural exports, two additional analyses were performed, namely panel regressions with fixed effects and cross-sectional β -convergence regressions.

Table 4.4: Robustness Checks of Convergence in India’s Agricultural Exports

Method	Variable	Coefficient	P-value	Strength/ Interpretation
Panel Fixed Effects	RSCA	0.2920	0.000	Strong persistence within products (high coefficient)
	TBI	0.1176	0.000	Weak persistence within products (small coefficient)
Cross-Sectional β -Convergence	RSCA	-0.0143	0.000	Convergence across products (lagging products catch up)
	TBI	-0.0185	0.000	Convergence across products (lagging products catch up)

Source: Computed by author

Panel Fixed Effects Regression: The panel regressions of RSCA and TBI on their respective lagged values account for unobserved heterogeneity across HS-4 products. For RSCA, the lag coefficient is 0.2920 ($p < 0.01$), indicating that products with higher previous comparative advantage tend to maintain their relative position over time.

Similarly, TBI exhibits a positive lag coefficient of 0.1176 ($p < 0.01$), though smaller in magnitude, suggesting weak persistence in trade balance positions. In both cases, the F-tests for poolability are highly significant, confirming the necessity of fixed effects. These results highlight that past export performance exerts a persistent influence on current RSCA and TBI, reflecting the “stickiness” of comparative advantage and partial inertia in trade balances.

Cross-Sectional β -Convergence Regression: Complementing the panel analysis, cross-sectional regressions were conducted to test whether lagging products catch up with initially stronger products. For RSCA, the initial value coefficient (RSCA_start) is -0.0143 ($t = -9.353$, $p < 0.01$), indicating that products with lower initial RSCA grew faster than high-RSCA products over 1991–2020, demonstrating strong convergence. For TBI, the coefficient (TBI_start) is -0.0185 ($t = -7.956$, $p < 0.01$), also negative and significant, showing convergence in trade balance indices, although with greater variability across products. These results confirm that, across products, initially weaker exporters are catching up to stronger ones, providing a systematic and statistically significant pattern of convergence.

The robustness checks show that RSCA displays strong persistence over time within products and clear convergence across products, while TBI exhibits weaker but still noticeable persistence and catch-up. This aligns with economic theory, which explains that comparative advantage tends to be stable, whereas trade balance outcomes are more sensitive to short-term shocks, external demand, and policy changes. Thus, weaker TBI persistence is reasonable and does not weaken the analysis. Overall, the findings confirm reliable convergence patterns, with important policy scope for enhancing RSCA and managing TBI responsiveness.

4.3.5. β -Convergence per Subsector

In the β -convergence framework, the slope coefficient (β) captures whether lagging subsectors are catching up with leading ones. Following the β -convergence methodology of Barro and Sala-i-Martin (1992, 2004), a negative β indicates convergence, meaning that sectors with initially low specialisation improve relatively faster than those with high specialisation. Conversely, a positive β would signal divergence, where stronger sectors continue to expand while weaker ones lag further behind.

Consistent with empirical applications (e.g., Herrera-Idárraga et al., 2013; Monfort, 2008), the strength of convergence is interpreted by the magnitude of the coefficient. To interpret the strength of convergence, threshold values are applied to the β coefficient. When ' β ' is less than -0.40 , it reflects strong convergence, suggesting rapid catch-up by lagging subsectors. Values between -0.40 and -0.15 represent moderate convergence, while coefficients closer to zero (-0.15 to 0) indicate weak convergence, reflecting slower and less uniform adjustment. A ' β ' equal to 1 implies no structural change in specialisation (stable trade pattern), while ' β ' greater than 1 indicates divergence and growing inequality between subsectors.

Tables 4.5 and 4.6 present the OLS Galtonian regression results for India's agricultural exports from 1991 to 2020, confirming strong evidence of β -convergence in both Revealed Symmetric Comparative Advantage (RSCA) and the Trade Balance Index (TBI). Across all estimated models, the ' β ' coefficients are negative and statistically significant, indicating that products with initially weak competitiveness or negative trade balances have progressively improved relative to initially stronger products. No signs of divergence are observed, suggesting a systematic process of catch-up across agricultural sub periods. For RSCA, the strongest convergence appears in the full period (1991–2020), where the ' β ' coefficient is -0.40770 ($p < 0.001$, $R^2 = 0.2809$), indicating strong convergence. When

shorter horizons are examined, the magnitude of the ' β ' coefficient gradually reduces and explanatory power declines, reflecting weaker convergence intensity. Mid-term periods (1995–2010) display moderate convergence, while the most recent period (2015–2020) shows weak convergence, with ' β ' = -0.05798 ($p = 0.026$). This implies that structural realignment in comparative advantage was more active in earlier decades, with competitiveness stabilising in later years.

The TBI estimates reveal an even stronger convergence pattern. For 1991–2020, the ' β ' coefficient is -0.53526 ($p < 0.001$, $R^2 = 0.2250$), indicating strong convergence. Early- and mid-period regressions (starting in 1995 and 2000) also display strong convergence, while later periods (2005–2015) show moderate convergence, with ' β ' values ranging from approximately -0.30 to -0.22 . This reflects the gradual narrowing of trade imbalances, although the adjustment speed has slowed. Overall, the consistently negative and significant ' β ' values validate Hypothesis H_2 and demonstrate that weaker subsectors have systematically caught up, showing diversified and resilient export growth. However, the slowdown in recent years signals the need for renewed policy focus on productivity, value addition, logistics, innovation, and market diversification to maintain upward momentum (Hummels and Klenow, 2005 and Hausmann et al., 2007).

Table 4.5: RSCA β Convergence for different Sub periods:

End Year	Start Year	B	R ²	p-value	Convergence level
RSCA_2020	RSCA_1991	-0.40770	0.2809	0.001***	Strong Convergence
	RSCA_1995	-0.31658	0.2258	0.001***	Moderate Convergence
	RSCA_2000	-0.3368	0.2197	0.001***	Moderate Convergence
	RSCA_2005	-0.25750	0.1664	0.001***	Moderate Convergence
	RSCA_2010	-0.16048	0.0990	0.001***	Weak Convergence
	RSCA_2015	-0.057977	0.02196	0.026*	Weak Convergence

Source: Computed by author

Table 4.6: TBI β Convergence for different Sub periods:

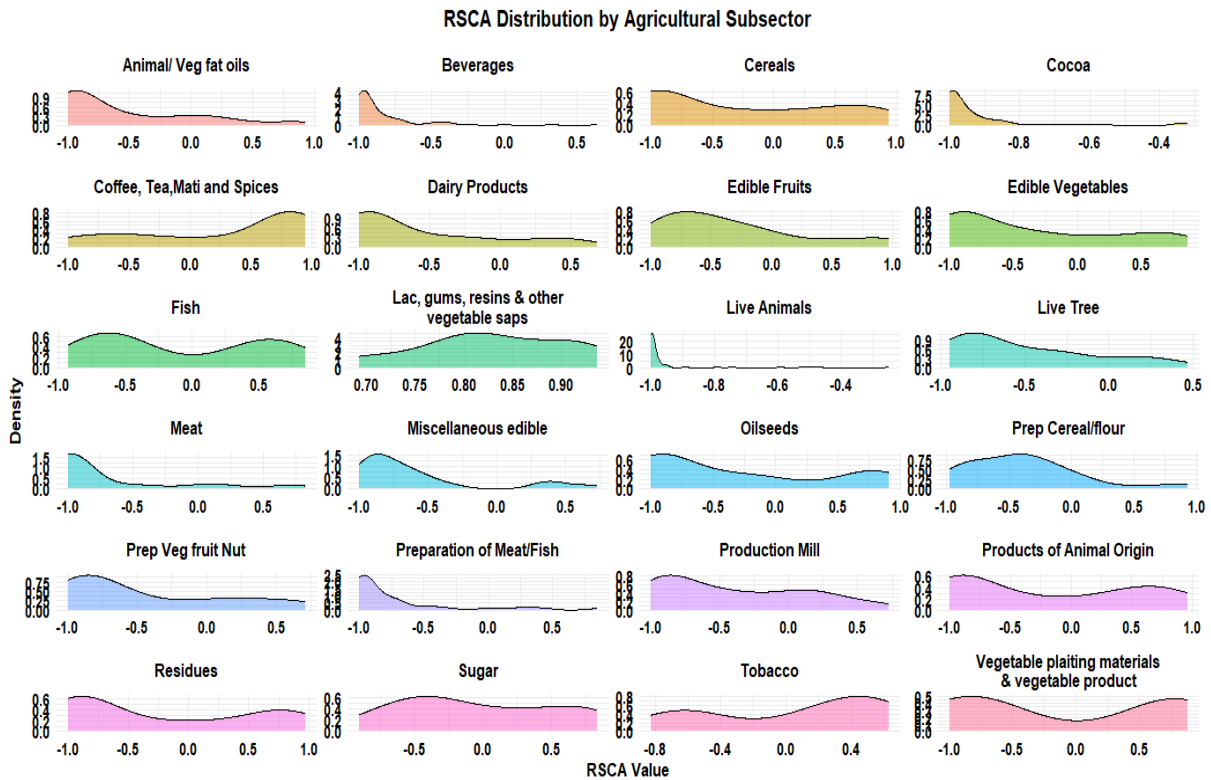
End Year	Start Year	B	R ²	p-value	Convergence level
TBI_2020	TBI_1991	-0.53526	0.2250	0.001***	Strong Convergence
	TBI_1995	-0.46031	0.1972	0.001***	Strong Convergence
	TBI_2000	-0.44924	0.2087	0.001***	Strong Convergence
	TBI_2005	-0.30013	0.1379	0.001***	Moderate Convergence
	TBI_2010	-0.25722	0.1244	0.001***	Moderate Convergence
	TBI_2015	-0.22297	0.1160	0.001***	Moderate Convergence

Source: Computed by author

4.3.6. Density Plots by Subsector

The density plots provide a visual representation of India's Revealed Symmetric Comparative Advantage (RSCA) across 24 agricultural subsectors between 1991 and 2020. By examining the distribution of RSCA values, these plots help identify whether specific subsectors consistently maintain a comparative advantage, persistently struggle with disadvantages, or exhibit transitional dynamics over time. This approach adds depth to the analysis by going beyond averages, capturing the frequency and stability of competitiveness across different product categories.

Figure 4.3: RSCA distribution by Agricultural Subsector



Source: Computed by author

Figure 4.3 presents Kernel Density plots showing the distribution of India's Revealed Symmetric Comparative Advantage (RSCA) across 24 agricultural subsectors from 1991 to 2020. The x-axis reflects RSCA values (−1 to 1), while the y-axis shows their density, which represents the frequency with which RSCA values occurred over the years. A higher density at any point indicates that a subsector recorded RSCA values in that range more often. Positive RSCA values indicate comparative advantage, while negative values reflect disadvantage. Many subsectors show higher density on the negative side because they experienced disadvantage for a larger number of years, whereas consistently strong sectors display density concentrated in the positive range. The smooth shapes arise from the kernel estimation, which captures the underlying distribution of RSCA over time.

The plots reveal that sectors such as Cereals, Coffee/Tea/Spices, and Edible Vegetables are concentrated on the positive side, indicating sustained competitiveness. In contrast, Animal/Vegetable Fats & Oils, Beverages, and Live Animals remain largely in the negative range, reflecting persistent disadvantages. Sub-sectors like Edible Fruits,

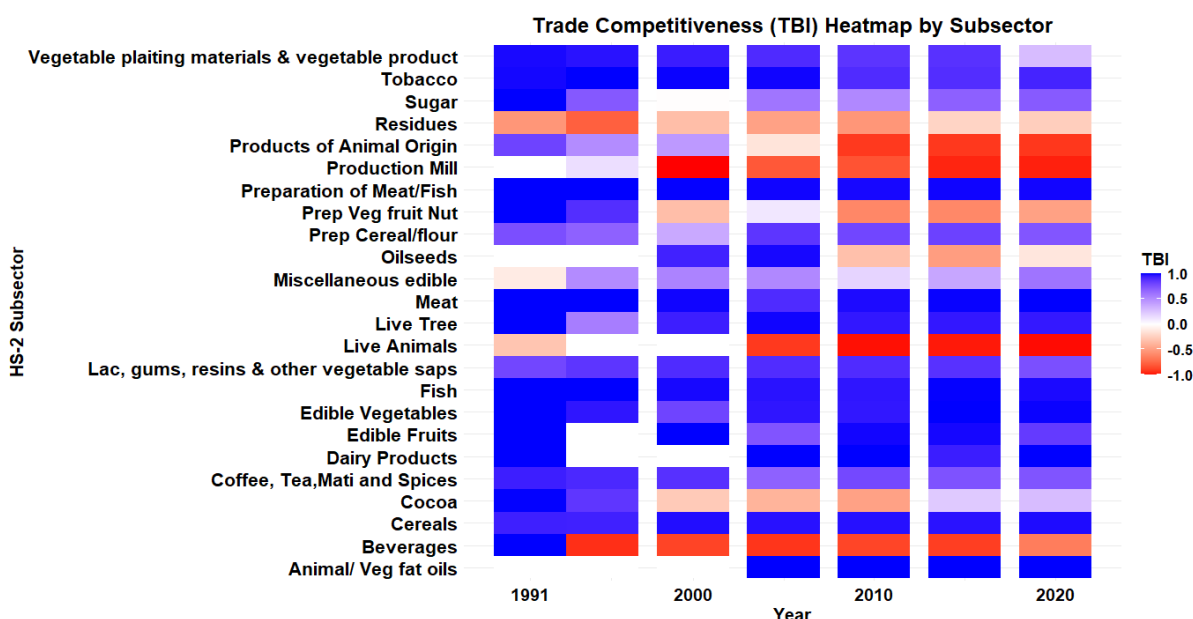
Oilseeds, and Processed Meat/Fish show mixed or bimodal patterns, reflecting periods of both strength and weakness. Products such as Lac, Gums & Resins display narrow, stable distributions, indicating little fluctuation. Economically, the results suggest uneven competitiveness across products, requiring differentiated policy support focused on value addition, certification, logistics, and market-specific promotion, especially for mid-performing and disadvantaged sectors.

4.3.7. TBI Heatmap by Subsector

The Trade Balance Index (TBI) heatmap offers a clear visual representation of India's agricultural trade dynamics across 24 subsectors from 1991 to 2020. Unlike RSCA, which captures underlying competitiveness, TBI highlights realised trade surpluses and deficits. By visualising these trends over three decades, the heatmap allows us to distinguish consistently strong export performers, structurally import-dependent sectors, and subsectors undergoing gradual shifts in trade orientation.

Figure 4.4 presents the Trade Balance Index (TBI) heatmap for India's agricultural subsectors from 1991 to 2020, illustrating the direction and intensity of net trade positions over time. Products such as Edible Fruits, Edible Vegetables, Fish, and Coffee, Tea, Maté & Spices consistently display deep blue shades across all reference years, reflecting strong and sustained export surpluses. These products form the core of India's agricultural export basket and demonstrate long-term stability and competitiveness in global markets.

Figure 4.4: TBI Heatmap of HS-2 digit Agricultural Products



Source: Computed by author

Dairy Products and Preparation of Meat/Fish show a gradual transition from neutral or slightly negative trade balances in the early 1990s to stronger blue shades post-2000, indicating emerging strengths supported by improvements in processing, safety standards, and production systems. This suggests a structural shift from traditional crop-dominated exports toward processed and high-value agriculture. In contrast, subsectors such as Beverages and Animal/Vegetable Fats & Oils remain predominantly red throughout the period, signalling persistent import dependence, especially in edible oils. Tobacco and Sugar maintain overall positive TBI values but with lighter bluish shades in later years, indicating a gradual weakening of trade surpluses.

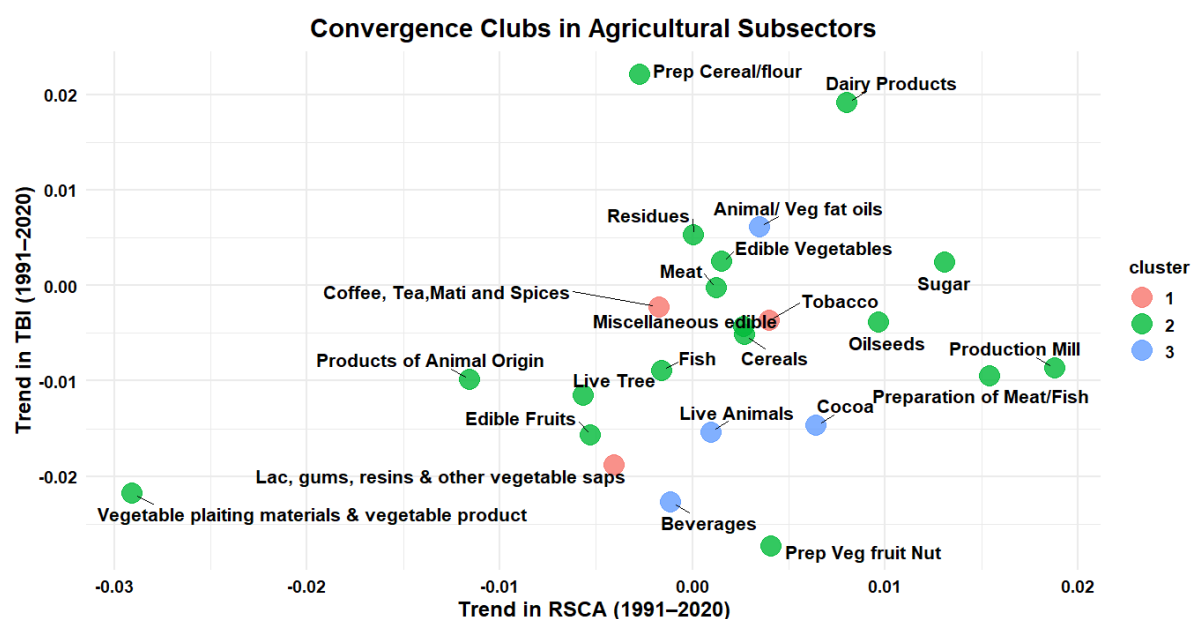
When viewed alongside the RSCA Kernel Density results, the heatmap confirms alignment between competitiveness and actual export performance, i.e. high-RSCA sectors correspond to strong TBI outcomes, while consistently negative RSCA sectors reflect long-term trade deficits. Emerging improvements in dairy and meat indicate evolving comparative potential, whereas persistent red zones highlight structurally vulnerable subsectors.

4.3.8. Clustering of Subsectors into Convergence Clubs

The clustering of agricultural subsectors into convergence clubs provides a dynamic lens for understanding India's trade competitiveness between 1991 and 2020. By jointly examining β -convergence in Revealed Symmetric Comparative Advantage (RSCA) and the Trade Balance Index (TBI), subsectors can be grouped into high-growth, declining, and stable trajectories. This approach highlights structural shifts in India's agricultural trade, moving beyond static measures to capture long-term performance dynamics and patterns of specialisation.

Figure 4.5 presents a β -convergence analysis by plotting the trend in RSCA against the trend in Trade Balance Index (TBI) for India's agricultural subsectors from 1991 to 2020. The subsectors are grouped into three performance clusters, high-growth, declining, and stable/mixed, allowing clear visual interpretation of long-term competitiveness dynamics. The high-growth cluster (green) includes subsectors with positive trends in both RSCA and TBI, indicating a strengthening comparative advantage combined with rising net exports. This group consists of Preparation of Meat/Fish, Dairy Products, Sugars, Edible Vegetables, Oilseeds, Edible Fruits, and Preparation of Cereal/Flour, reflecting a shift toward high-value, processed, and horticultural products. These gains align with improved technology, quality certification, and evolving global demand favouring nutrition-rich and minimally processed foods. The declining cluster (red) includes Cereals, Tobacco, and Coffee, Tea, Maté & Spices, which show stagnant or negative competitiveness and weakening trade surpluses. Although these products historically dominated India's export profile, factors such as stronger global competition, stricter regulations, domestic demand pressures, and episodic export restrictions have reduced their export momentum. The stable/mixed cluster (blue) contains Animal/Vegetable Fats & Oils, Live Animals, Cocoa, Beverages, and Lac, Gums & Resins, which show marginal, flat, or mixed movements in RSCA and TBI, suggesting niche, steady, or non-transformative roles in the export basket.

Figure 4.5: Convergence clubs in Agricultural Subsectors



Source: Computed by author

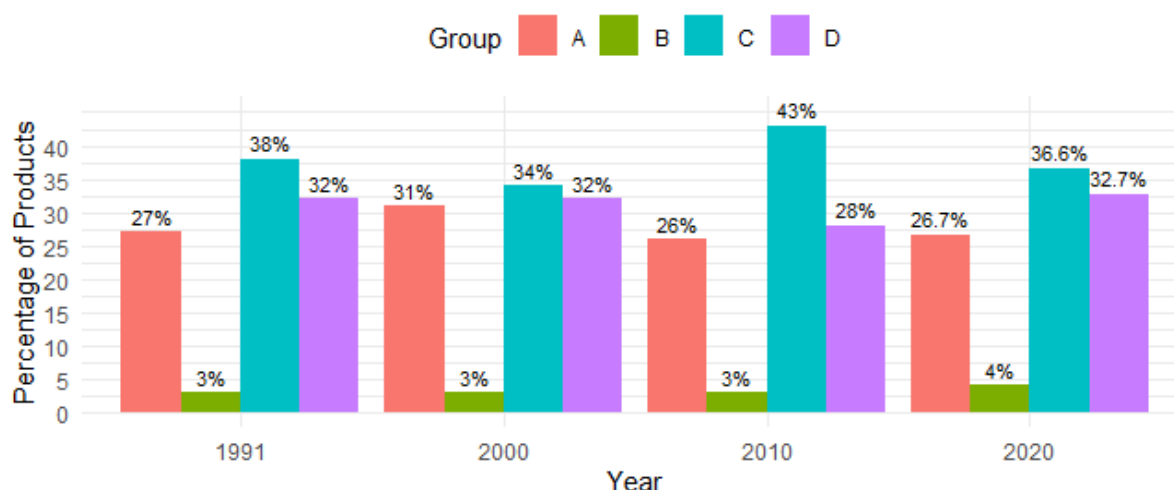
Overall, the results suggest that structural transformation of India's agricultural export growth is increasingly driven by processed, value-added, and horticultural categories rather than traditional bulk commodities. Strengthening emerging winners while repositioning or upgrading declining sectors will be crucial to sustaining long-term competitiveness and export diversification.

4.3.9. Product Mapping of India's Agricultural Products, 1991-2020

The product mapping class groups of A, B, C, and D of India's HS-4 agricultural products for select years are explained in Table 4.5.

Figure 4.6: Product Mapping of India's Agricultural Products (in percentage)

Product Mapping Groups, 1991–2020



Source: Computed by author

Figure 4.6 illustrates the product mapping groups (A, B, C, and D) of India's agricultural exports across select years, categorising products by their comparative advantage and export specialisation. Group A, combining both comparative advantage and specialisation, reflects India's most competitive exports, accounting for 26–32% over the years, with a peak of 31% in 2000 and 26.7% in 2020. Group B, with a comparative advantage but no specialisation, remained the smallest share (3–4%), representing untapped potential that requires branding and infrastructure support. Group C, showing specialisation without comparative advantage, consistently dominated, peaking at 43% in 2010 and still comprising 36.6% in 2020, indicating reliance on products well-integrated into export markets but not globally competitive. Group D, with neither advantage nor specialisation, accounted for 28–33%, rising to 32.7% in 2020, highlighting persistent structural weaknesses. Overall, the trends suggest four key takeaways: (i) Group A's stability calls for reinforcing strong exports; (ii) Group C's dominance signals the need to improve competitiveness through value addition and certification; (iii) Group D's growth points to deep-rooted inefficiencies requiring structural reforms; and (iv) Group B's small share represents an opportunity to develop underutilised but promising products. A targeted product-specific strategy focusing on trade policy, market diversification, and

competitiveness enhancement is essential to strengthen India's agricultural export performance.

4.3.10. India's Core Agro-Export Strengths: Long-Term Competitiveness and Specialisation in Group A Products (1991–2020)

The products that have maintained a Revealed Symmetric Comparative Advantage (RSCA > 0) and a Trade Balance Index (TBI > 0) consistently from 1991 to 2020 include fresh or chilled fish (0300), frozen fish (0303), frozen crustaceans (0306), preserved molluscs and aquatic invertebrates (0307), horsehair (0501), bones and horn-cores (0506), ivory and similar materials (0507), onions and garlic (0703), provisionally preserved vegetables (0711), dried vegetables (0712), coffee (0900), tea (0902), pepper and capsicum (0904), nutmeg and cardamoms (0908), anise and fennel seeds (0909), spices like ginger and turmeric (0910), rice (1006), buckwheat, millet, and canary seed (1008), wheat and meslin (1000), rye (1200), groundnuts (1202), other oil seeds and oleaginous fruits (1207), medicinal and aromatic plants (1211), barley (1300), natural gums and resins (1302), vegetable products not elsewhere specified (1404), fixed vegetable oils (1515), cane or beet sugar (1703), jams and fruit pastes (2007), coffee and tea extracts (2101), residues from food industries (2300), soya-bean oil (2304), groundnut oil (2305), other vegetable oils (2306), unmanufactured tobacco (2401), manufactured tobacco products (2403), and vegetable materials for plaiting (2400).

The sustained competitiveness of 39 agricultural products in Group A (RSCA > 0 and TBI > 0) from 1991 to 2020 highlights India's enduring strengths in key agro-export sectors. This stability is underpinned by multiple factors: diverse agro-climatic conditions that enable the cultivation of a wide variety of crops such as rice, spices, oilseeds, and medicinal plants; traditional expertise and long-established practices in products like tea, turmeric, and pepper that enhance quality and global reputation; and consistent global

demand for staples like rice as well as high-demand products such as spices, fish, and oils. Added to this are policy support, low labour costs, and improvements in infrastructure, which together have bolstered India's global competitiveness, securing stable export revenues, generating rural employment, and strengthening the long-term resilience of its agricultural trade sector.

4.3.11. Product Mapping of Top-Ten Agricultural Products from 1991 to 2020

Figure 4.7: Product Mapping- 1991

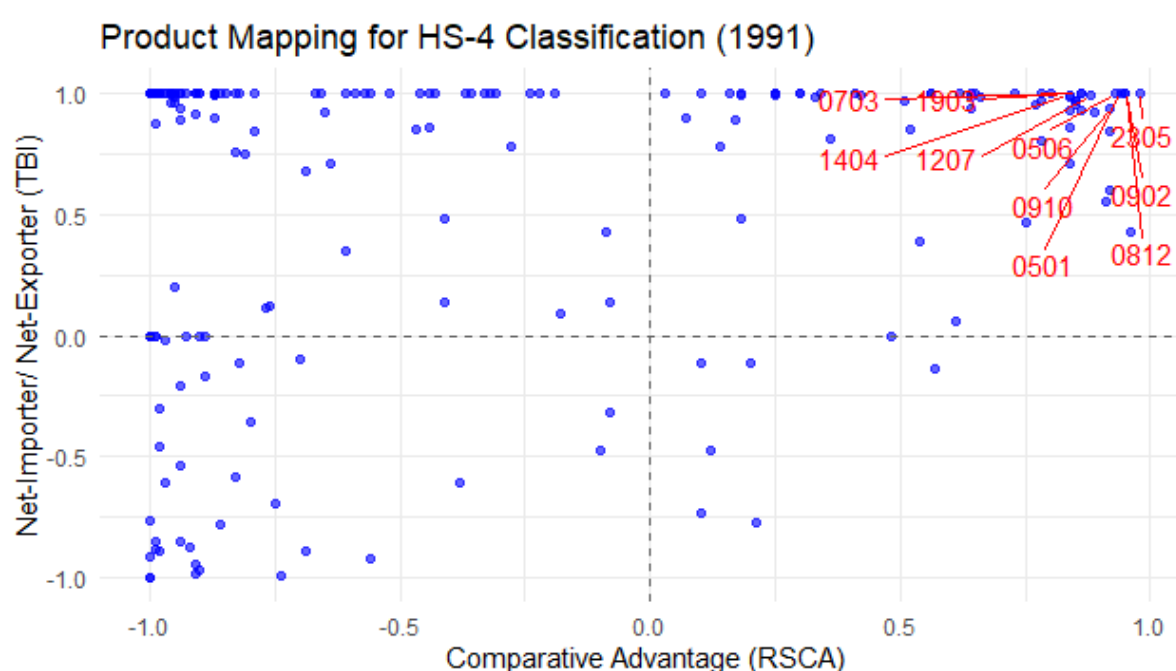


Table 4.7: Top 10 leading export products- 1991

Sr. No.	HS-4 Code	Commodity Description	RSCA	TBI	TC
1	2305	Oil-cake and other solid residues of ground-nut	0.98	1.00	1.98
2	0812	Fruit and nuts, provisionally preserved	0.95	1.00	1.95
3	0902	Tea, whether or not flavoured	0.95	1.00	1.95
4	0501	Human hair and waste	0.94	1.00	1.94
5	0506	Bones and horn-cores, unworked, defatted, simply prepared	0.93	1.00	1.93

6	1207	Other oil seeds and oleaginous fruits	0.88	0.99	1.87
7	1903	Tapioca and substitutes prepared from starch	0.86	1.00	1.86
8	0703	Onions, garlic, shallots, leeks	0.86	1.00	1.86
9	0910	Ginger, saffron, turmeric, thyme, bay leaves, curry and other spices	0.92	0.94	1.86
10	1404	Vegetable products not elsewhere specified or included	0.84	0.99	1.83

Source: Computed by author

Figure 4.8: Product Mapping- 2000

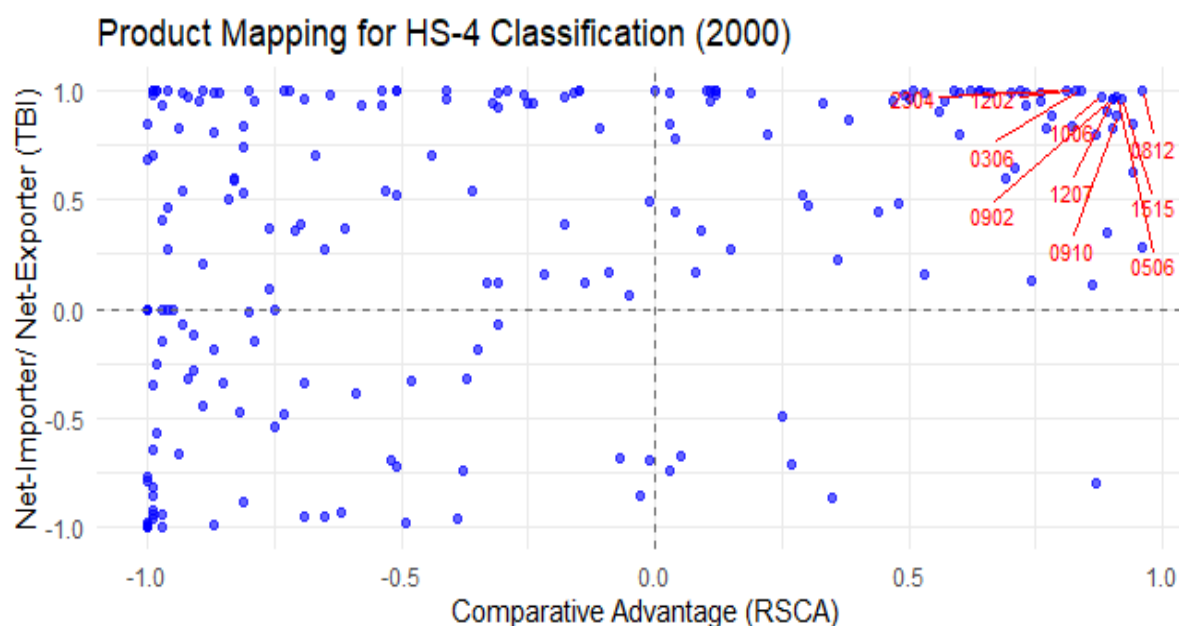


Table 4.8: Top 10 Leading export products- 2000

Sr. No.	HS-4 Code	Commodity Description	RSCA	TBI	TC
1	0812	Fruit and nuts provisionally preserved	0.96	1.00	1.96
2	0506	Bones and horn-cores, unworked, defatted, simply prepared	0.91	0.97	1.88
3	1515	Other fixed vegetable fats and oils (e.g., maize, rice bran oil)	0.92	0.96	1.88
4	0902	Tea	0.90	0.96	1.86
5	1207	Other oil seeds and oleaginous fruits	0.90	0.96	1.86
6	1006	Rice	0.88	0.97	1.85
7	0306	Crustaceans (e.g., shrimps, prawns), frozen, dried, salted	0.84	1.00	1.84
8	1202	Ground-nuts (peanuts), not roasted or cooked	0.83	1.00	1.83
9	2304	Oilcake and other solid residues of	0.81	1.00	1.81

		soyabean			
10	0910	Ginger, saffron, turmeric, thyme, bay leaves, curry, other spices	0.91	0.88	1.79

Source: Computed by author

Figure 4.9: Product Mapping- 2010

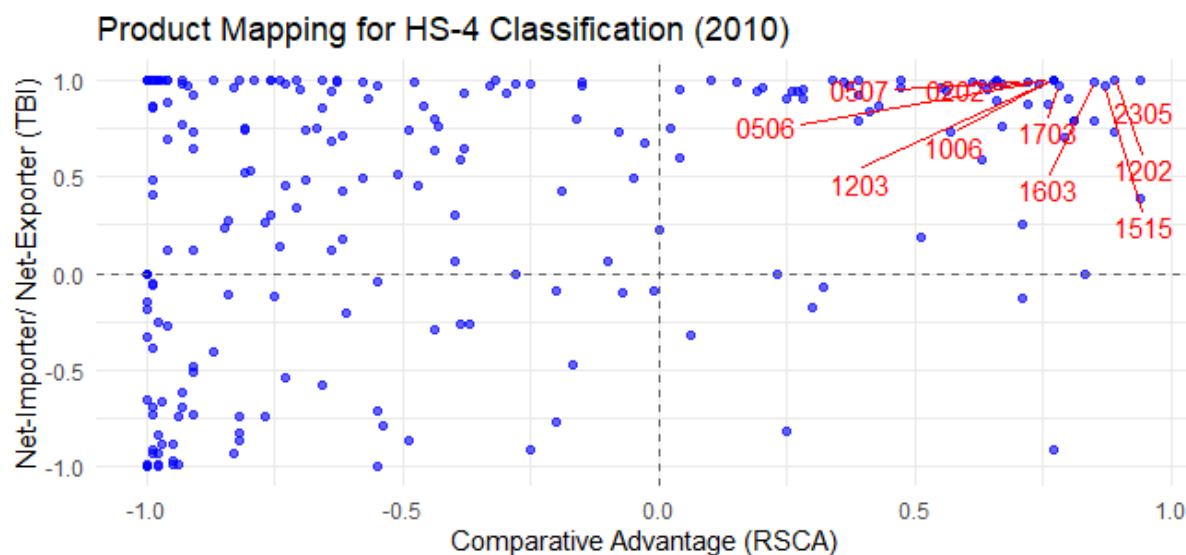


Table 4.9: Top 10 leading export products- 2010

Sr. No.	HS-4 Code	Commodity Description	RSCA	TBI	TC
1	2305	Oil-cake and other solid residues of ground-nut	0.94	1.00	1.94
2	1202	Ground-nuts, not roasted or cooked	0.89	1.00	1.89
3	1515	Other fixed vegetable fats and oils	0.87	0.97	1.84
4	1603	Extracts and juices of meat, fish, crustaceans	0.85	0.99	1.84
5	1006	Rice	0.77	1.00	1.77
6	1203	Copra	0.77	1.00	1.77
7	0202	Frozen bovine meat	0.77	1.00	1.77
8	1703	Molasses resulting from extraction or refining sugar	0.78	0.97	1.75
9	0506	Bones and horn-cores, unworked	0.74	0.98	1.72
10	0507	Ivory, animal teeth, unworked or simply prepared	0.72	0.99	1.71

Source: Computed by author

Figure 4.10: Product Mapping- 2020

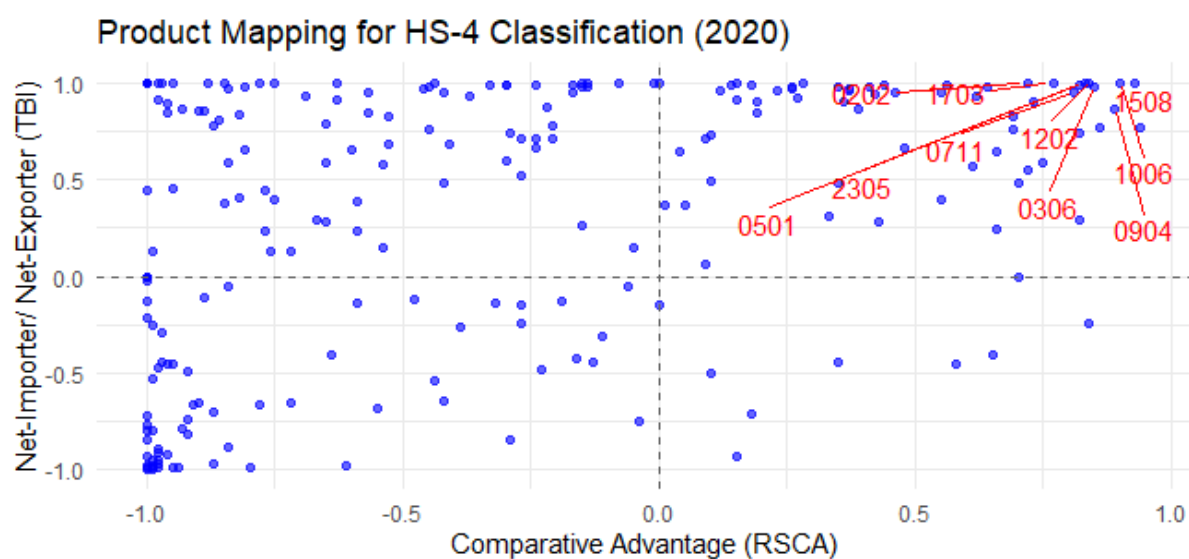


Table 4.10: Top 10 Leading export products- 2020

Sr. No.	HS-4 Code	Commodity Description	RSCA	TBI	TC
1	1508	Ground-nut oil and its fractions	0.93	1.00	1.93
2	1006	Rice	0.90	1.00	1.90
3	1202	Ground-nuts, not roasted or otherwise cooked	0.84	1.00	1.84
4	2305	Oil-cake and other solid residues of ground-nut	0.83	1.00	1.83
5	0306	Crustaceans (e.g., shrimp, prawns), frozen, dried, salted	0.85	0.98	1.83
6	0501	Human hair, unworked; waste of human hair	0.82	0.99	1.81
7	1703	Molasses resulting from the extraction or refining of sugar	0.77	1.00	1.77
8	0711	Vegetables provisionally preserved (e.g., in brine or sulphur)	0.81	0.95	1.76
9	0904	Pepper (black, white) and capsicum or pimento	0.89	0.86	1.75
10	0202	Frozen meat of bovine animals	0.72	1.00	1.72

Source: Computed by author

Tables 4.7–4.10 and Figures 4.7–4.10 present product mapping for 1991, 2000, 2010, and

2020 at the HS-4 level for India's agricultural exports. Product mapping (Widodo, 2008) combines comparative advantage (RSCA) and trade performance (TBI) to classify products into four groups (A–D). Group A contains products with both positive RSCA and TBI and is used to identify the top ten structurally competitive export products in each year. India's top-performing agricultural exports consistently reflect its natural endowments, traditional crop base, processing capabilities, and long-standing market linkages. Trade liberalisation, export incentives, infrastructure development, and targeted agricultural policies have supported competitiveness across decades. Market access through regional and multilateral agreements strengthened demand for several niche and value-added products.

In 1991, exports were dominated by traditional and resource-based items such as groundnut oil-cake (HS-2305), preserved fruits and nuts (HS-0812), tea (HS-0902), human hair (HS-0501), bones and horn-cores (HS-0506), other oilseeds (HS-1207), tapioca preparations (HS-1903), onions/garlic (HS-0703), spices (HS-0910), and miscellaneous plant products (HS-1404). These reflect strengths in plantation crops, livestock by-products, and semi-processed horticultural products. By 2000, export structure diversified towards value-added, marine, and processed products. Preserved fruits and nuts (HS-0812) remained strong, while bones and horn-cores (HS-0506), vegetable oils (HS-1515), rice (HS-1006), crustaceans (HS-0306), groundnuts (HS-1202), soybean oil-cake (HS-2304), and spices (HS-0910) expanded export presence, reflecting growth in edible oil processing and seafood industries. In 2010, processed and protein-rich items gained prominence alongside staples. Groundnut oil-cake (HS-2305) led, with groundnuts (HS-1202), vegetable oils (HS-1515), rice (HS-1006), meat and fish extracts (HS-1603), copra (HS-1203), frozen bovine meat (HS-0202), molasses (HS-1703), bones and horn-cores (HS-0506), and animal teeth (HS-0507), signalling deeper integration into processed food and

animal-based exports. By 2020, exports consolidated around high-demand staples and niche items, led by groundnut oil (HS-1508), rice (HS-1006), groundnuts (HS-1202), groundnut oil-cake (HS-2305), crustaceans (HS-0306), molasses (HS-1703), human hair (HS-0501), preserved vegetables (HS-0711), pepper/capsicum (HS-0904), and frozen bovine meat (HS-0202).

Across decades, recurring products, such as groundnut oil-cake, bones and horn-cores, groundnuts, rice, spices, human hair, crustaceans, and preserved fruits/nuts, indicate structural comparative advantage supported by climatic suitability, labour intensity, and supply chain continuity. India's export path shows gradual movement toward processing and value-addition, suggesting future policy focus on agro-processing, GI-based branding, quality upgrading, and strategic market penetration.

4.3.12. Product Spacing of India's Agricultural Products:

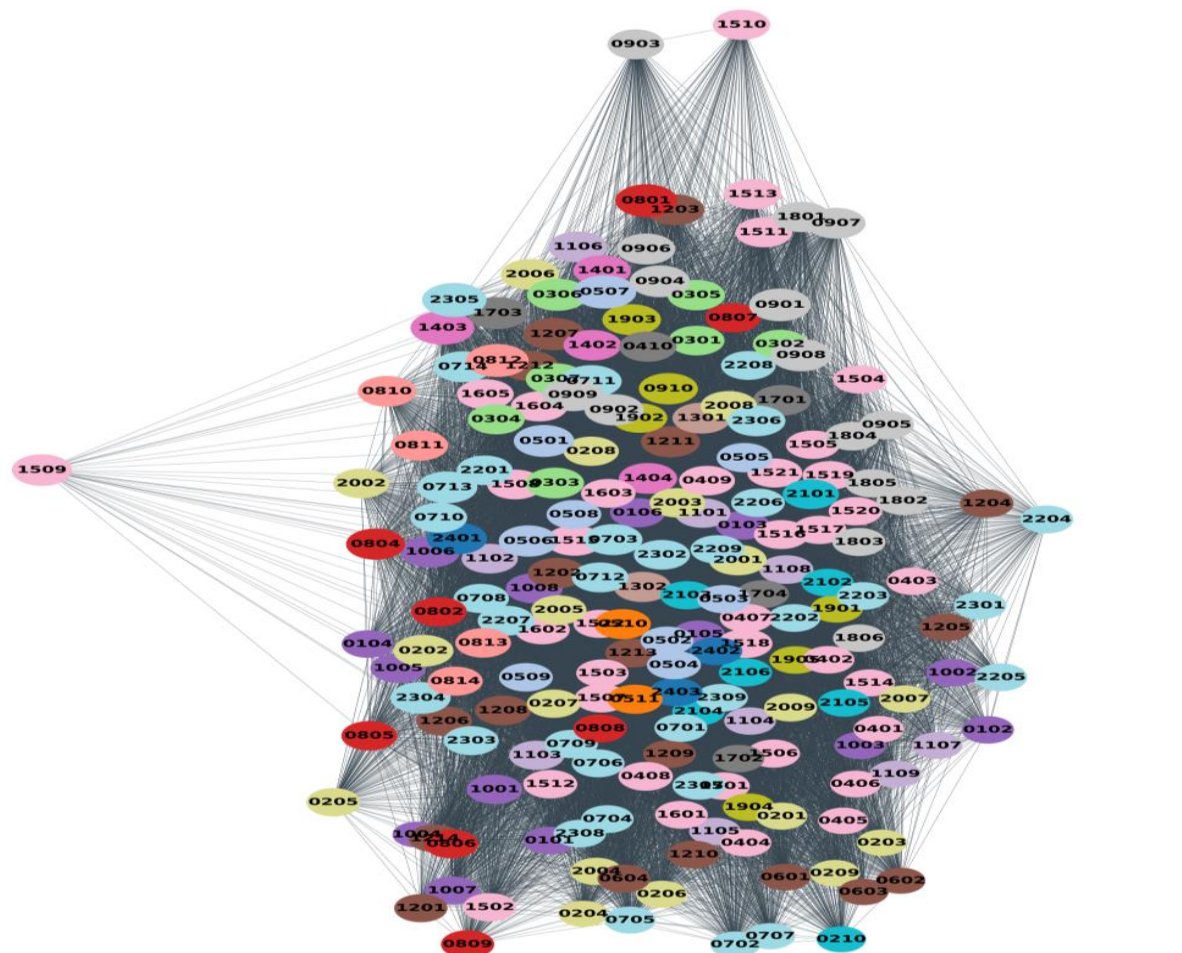
The product space diagrams for 1991–2005 and 2006–2020 map India's agricultural exports using RCA and product proximity to show structural transformation from early post-liberalisation to a more capability-driven phase. Each HS-4 product appears as a node, with links reflecting co-export relatedness. Core products are densely connected with strong RCA, while peripheral ones show weaker capabilities. Density indicates diversification ease, distance shows capability gaps, and Agri-PCI reflects product sophistication, revealing India's shift toward a more connected and complex export structure over time.

In Figure 4.11, the Product Space diagram for 1991–2005 reveals a vertically elongated structure with a sparse core, indicating a limited set of interconnected agricultural export products. The nodes representing individual HS-4 products are primarily concentrated in small, tight-knit clusters, while many peripheral products remain isolated or loosely connected to the main export basket. In terms of density, this period reflects India's narrow

capability set; most products with $RCA \geq 1$ are surrounded by a relatively low number of proximate products, limiting India's immediate diversification opportunities. India's export structure during this period was concentrated in traditional sectors such as sugars, cereal preparations, and select fruits and nuts, which formed the dense core of its product space, while many other categories remained peripheral and underdeveloped.

From a distance perspective, most potential diversification opportunities were located far from India's existing export capabilities, indicating that the country's capability infrastructure was insufficient to support a shift into more sophisticated agricultural products. As a result, the export basket remained focused on low-complexity commodities with few avenues for upgrading.

Figure 4.11: India's Product Space Map for Agricultural Products 1991-2005



Source: Computed by author

In terms of the Agricultural Product Complexity Index (Agri-PCI), the 1991–2005 product space was dominated by low- to medium-complexity products, while high-complexity goods such as beverages and miscellaneous edible preparations were positioned at the margins and weakly connected to the core, underscoring India’s limited integration into complex agri-food value chains during this period.

Top 10 Core Products 1991–2005

Table 4.11: RCA, Density, Distance & Agri-PCI of top 10 core products (1991-2005)

HS-Code	Product Name	RCA	Density	Distance	Agri-PCI
2305	Oil-Cake of Groundnuts	32.91	0.55	0.45	0.07
0801	Coconuts, Brazil Nuts and Cashews	27.37	0.46	0.54	0.24
0812	Apples, Pears and Quinces	18.36	0.47	0.53	0.04
0501	Horsehair and Waste of Horsehair	16.38	0.41	0.59	0.08
0909	Seeds of Fennel, Juniper and others	11.42	0.44	0.56	0.12
1006	Rice	9.83	0.39	0.61	0.18
0904	Pepper of the genus Piper	9.80	0.40	0.60	0.04
1207	Other Oil Seeds and Oleaginous Fruits	8.33	0.44	0.56	0.14
1403	Vegetable Materials for Brooms	7.31	0.52	0.48	0.09
0908	Nutmeg, Mace and Cardamoms	5.82	0.43	0.57	0.10

Source: Computed by author

During 1991–2005, India’s top core agricultural exports were dominated by primary commodities with strong trade competitiveness but limited diversification potential. Products like Oil-Cake of Groundnuts (HS-2305) and Coconuts, Brazil Nuts, and Cashews (HS-0801) showed very high RCA values (32.91 and 27.37), reflecting India's global strength in these sectors, yet their density scores were moderate (around 0.45 to 0.54),

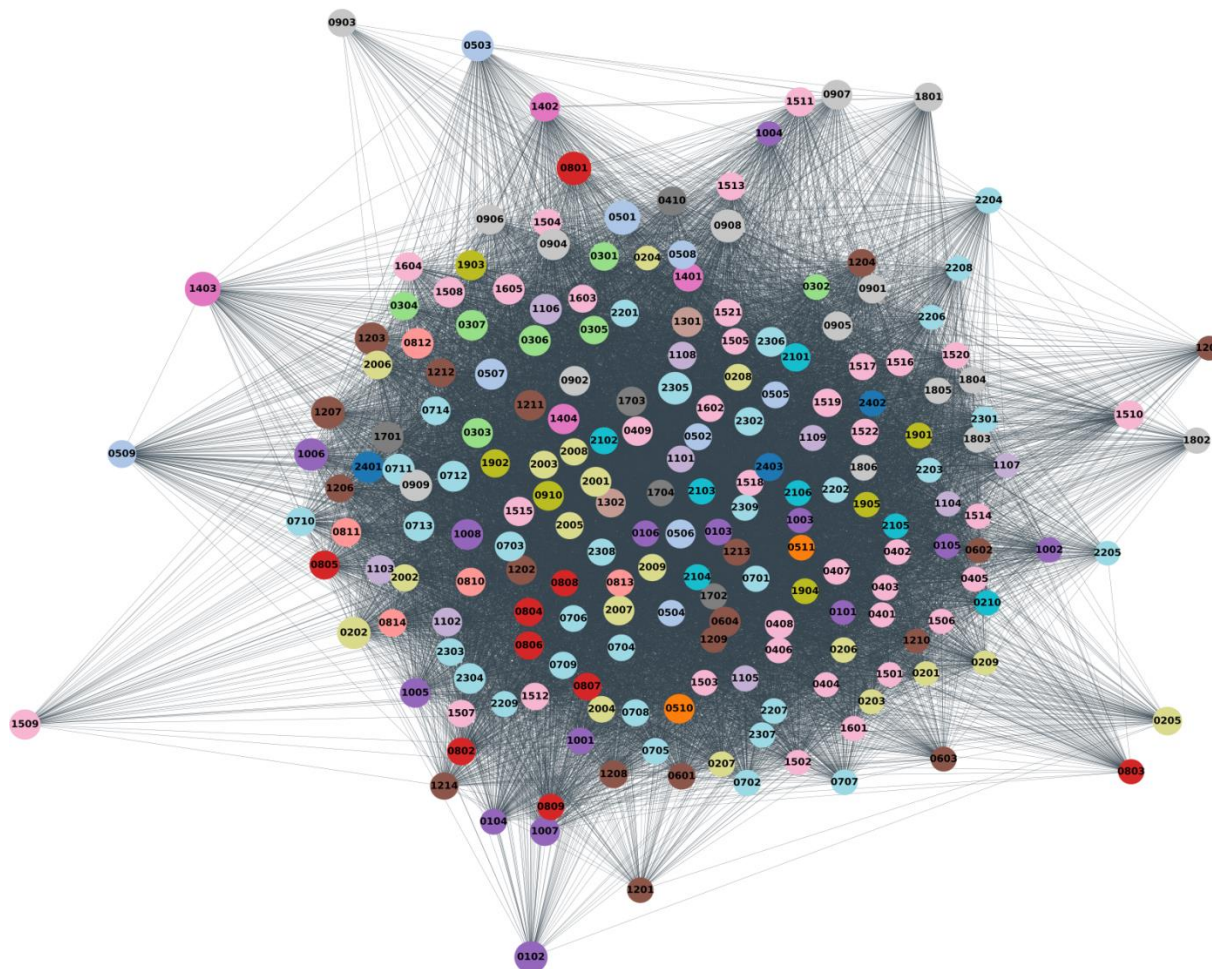
indicating only partial connectivity to other products within the export network. Most core products, including Rice (HS-1006) and Pepper (HS-0904), had high distance values (above 0.59), revealing their peripheral position in the product space and suggesting that India lacked the capability infrastructure to easily diversify into adjacent sectors. Furthermore, the Agri-PCI values were generally low (mostly below 0.15), signalling that India's export basket was concentrated in low-complexity, commodity-based products with minimal value addition. This combination of high RCA, moderate density, high distance, and low product complexity reflects a structurally constrained export profile, where India's agricultural export growth was heavily reliant on a narrow set of traditional commodities with limited pathways for upgrading into more sophisticated, value-added agri-products.

In Figure 4.12, the Product Space for 2006–2020 displays a significant structural evolution. The diagram takes on a radially expanded, circular shape with a dense and cohesive core, reflecting a significant rise in interconnectivity among India's agricultural exports. Nodes are more evenly distributed, and formerly peripheral products now show stronger links to the core, suggesting an enriched capability base. Export density has improved notably, as India's current products are surrounded by a wider range of proximate options, indicating greater ease of diversification into new agricultural sectors. The expansion of core clusters, particularly in vegetable preparations, edible preparations, and beverages, highlights this enhanced density and broader diversification potential. From a distance perspective, the 2006–2020 structure reveals a marked reduction in the average distance between existing exports and potential new products. Previously isolated items have moved closer to the core, pointing to the closing of capability gaps and greater feasibility of diversification.

The Agri-PCI dimension further underscores this progress, with a clear shift toward mid- to high-complexity products. Items such as beverages, lac & resins, and processed edibles, once peripheral, are now better integrated into India's export network. This demonstrates a

transition from basic commodities to more sophisticated, value-added exports, with the strengthened Agri-PCI distribution signalling a significant rise in India's agricultural export sophistication in the post-2005 period.

Figure 4.12: India's Product Space Map for Agricultural Products 2006-2020



Source: Computed by author

Top 10 Core Products 2006–2020

During the period 2006–2020, India's core agricultural export structure exhibited signs of gradual diversification and increased export sophistication compared to the earlier decade, though still rooted in traditional commodities. High RCA products like Vegetable Materials for Brooms (HS-1403) and Horsehair Waste (HS-0501) maintained their dominance with RCA values of 24.49 and 21.01, but their density scores improved to

above 0.58, indicating stronger integration within the product space and greater potential to facilitate diversification into adjacent sectors.

Table 4.12: RCA, Density, Distance & Agri-PCI of top 10 core products (2006-2020)

HS-Code	Product Name	RCA	Density	Distance	Agri-PCI
1403	Vegetable Materials for Brooms	24.49	0.58	0.42	0.03
0501	Horsehair and Waste of Horsehair	21.02	0.59	0.41	0.03
0909	Seeds of Fennel, Juniper and others	20.00	0.44	0.56	0.02
2305	Oil-Cake of Groundnuts	17.44	0.49	0.51	0.03
1006	Rice	10.49	0.48	0.52	1.23
0904	Pepper of the genus Piper	9.24	0.43	0.57	0.20
0503	Coconut Copra	8.98	0.42	0.58	0.03
1207	Other Oil Seeds and Oleaginous Fruits	7.08	0.49	0.51	0.53
0202	Meat of Bovine Animals	6.39	0.48	0.52	0.54
0908	Nutmeg, Mace and Cardamoms	5.61	0.51	0.49	0.03

Source: Computed by author

Unlike the previous period, the inclusion of products like Rice (HS-1006) with a remarkably high Agri-PCI of 1.23 and Meat of Bovine Animals (HS-0202) with 0.54 Agri-PCI suggests a shift towards more sophisticated, value-added exports. While some products, such as Pepper (HS-0904) and Other Oil Seeds (HS-1207), continued to have moderate density (around 0.48) and high RCA, their Agri-PCI values (0.20 and 0.53, respectively) highlight India's improved position in higher-complexity agricultural segments. However, a few core products, such as Coconut Copra (HS-0503) and Nutmeg, Mace, and Cardamoms (HS-0908), still exhibited low Agri-PCI values, indicating persistent reliance on certain low-complexity commodities. Between 1991 and 2005, and 2006 and 2020, India's agricultural export structure shifted from a narrow, low-complexity commodity base to a more diversified and interconnected product space. The latter period shows higher density, reduced distance, and rising Agri-PCI values, reflecting stronger capabilities and greater access to complex, value-added products. While traditional commodities remained important, exports such as rice (HS-1006) and bovine meat (HS-0202) gained prominence, signalling a shift toward sophistication. Overall, India's

agricultural exports have evolved from a dependence on primary goods to a more capability-driven and diversified structure, highlighting its readiness to expand into higher-value sectors with supportive policies.

4.4. Discussion:

The consolidated mean analysis of RSCA, RCA, and TBI across HS-2 agricultural categories indicates a consistent dual structure in India's export competitiveness. Traditional sectors such as meat, fish, cereals, coffee/tea/spices, lac and vegetable saps, and tobacco recorded persistently high RSCA and positive TBI values, confirming their long-standing role in driving agricultural exports. These findings align with earlier studies that highlighted India's structural strength in resource-based commodities like cereals and spices due to agro-climatic conditions and established global demand (Batra & Khan, 2005; Kumar & Rai, 2007). However, the analysis also revealed that several categories, notably edible vegetables, fruits, dairy products, and beverages, displayed negative or fluctuating competitiveness measures, reinforcing concerns about India's weak position in perishable and high-value-added products. Similar observations were made by Gulati and Juneja (2019), who argued that supply chain inefficiencies and inadequate cold storage infrastructure constrain India's ability to scale exports of perishables. Thus, while India has consolidated its comparative advantage in traditional commodities, the trend data suggest limited diversification toward processed and perishable categories.

The stability and convergence analysis of India's agricultural exports from 1991 to 2020 provides important insights into the sector's structural transformation. The distributional analysis shows a shift in RSCA distributions from unimodal disadvantage in 1991 to a bimodal structure by 2020, revealing a dual reality: strong leaders such as spices, cereals, and marine products on one hand, and persistent laggards on the other. In contrast, TBI

distributions consistently confirmed robust export surpluses, suggesting that aggregate trade performance masks uneven product-level competitiveness (Veeramani & Saini, 2011; Gulati & Juneja, 2019). This juxtaposition highlights a key tension in India's agricultural exports, the country has managed to sustain overall trade surpluses, but competitiveness remains highly concentrated in select subsectors.

At the sub-sectoral level, the results indicate mixed patterns of convergence and divergence. Certain niche groups, like lac, cocoa, and live animals, exhibited signs of convergence, while cereals, oilseeds, and vegetable products showed wide dispersion, often driven by the dominance of high-performing commodities, such as basmati rice. β -convergence analysis confirmed negative and statistically significant coefficients for both RSCA and TBI, implying that weaker products have gradually caught up with stronger ones, supporting the inclusiveness of export growth. However, the slowing pace of convergence in the most recent decade suggests diminishing returns to earlier reforms and the persistence of structural bottlenecks. These results are consistent with convergence theory, where early gains taper as sectors mature (Barro & Sala-i-Martin, 1995), and with findings on Indian agriculture that emphasise the constraints of diversification under current infrastructural and institutional settings (Veeramani & Saini, 2011; Birthal et al., 2015). Overall, the negative and statistically significant ' β ' coefficients for RSCA and TBI confirm that weaker agricultural subsectors have gradually caught up with stronger ones over the period 1991–2020. This empirical evidence supports Hypothesis H₂, indicating that the comparative advantage of India's agricultural exports demonstrates β -convergence over time.

The clustering analysis provides additional depth by showing how subsectors are regrouping into distinct convergence clubs. A high-growth cluster that includes dairy,

processed meat, fruits, vegetables, and oilseeds illustrates the rising competitiveness and the growing role of value-added and horticultural products. In contrast, cereals, tobacco, and spices fall into a declining cluster, while beverages, fats and oils, and niche products form a stable but stagnant group. This evidence supports the convergence club hypothesis (Phillips & Sul, 2007) and indicates a structural shift in India's agricultural exports from traditional commodities to processed and speciality goods (Gulati & Juneja, 2019; BIRTHAL et al., 2021). Together, the convergence and clustering results underline a dual narrative: while broad-based reforms have enabled weaker subsectors to catch up, persistent heterogeneity suggests that targeted, product-specific interventions are essential to sustain competitiveness and avoid entrenching low-growth trajectories.

The product mapping of India's agricultural exports reveals a dual narrative of structural persistence and gradual transformation. Group A products, combining both comparative advantage and specialisation, remained stable at around one-fourth of the export basket, with staples like rice (HS-1006), groundnut oil-cake (HS-2305), crustaceans (HS-0306), and spices (HS-0910) consistently featuring among the top ten. This stability underscores the resilience of India's agro-climatic strengths and traditional expertise in plantation crops, oilseeds, and marine exports. However, the dominance of Group C, products with specialisation but lacking comparative advantage, reflects a heavy reliance on markets for goods that are not globally competitive, highlighting India's limited ability to upgrade competitiveness across its full export spectrum. Similar patterns are noted by Widodo (2008), who emphasised that product mapping provides a diagnostic framework to identify where specialisation and advantage align or diverge, offering valuable guidance for targeted export strategies.

At the same time, the reappearance of several products across decades, such as rice, groundnuts, spices, tea, bones and horn-cores, and human hair, illustrates India's structural export strengths, comparable to Brazil's long-term dominance in soybeans or Thailand's in rice (Fugazza, 2004; Widodo, 2008). Yet, unlike these peers, India has been slower to scale up value addition and branding, as seen in the small share of Group B products (3–4%), which represent underexploited opportunities. The gradual emergence of processed items, such as frozen bovine meat (HS-0202), fixed vegetable oils (HS-1515), and molasses (HS-1703), indicates a movement up the value chain, supported by policy reforms, trade liberalisation, and infrastructure investment. These findings align with studies that highlight the importance of leveraging natural endowments and building capacity for value-added, niche, and branded products in sustaining competitiveness in agricultural exports (Balassa, 1965; Athukorala, 2012). Thus, India's product mapping results point to the need for a dual policy approach: reinforcing structurally competitive exports while enabling weaker but promising products to evolve into future drivers of trade.

Further, the comparison of India's product space between 1991–2005 and 2006–2020 reveals a clear structural transition from a sparse, commodity-dependent network toward a more cohesive and diversified agricultural export system. In the earlier period, India's export basket was heavily concentrated in low-complexity commodities such as oil-cake of groundnuts, coconuts, and rice, with high RCA values but low Agri-PCI scores. The elongated structure with weakly connected clusters reflected limited capability spillovers and constrained diversification opportunities, consistent with Hidalgo et al. (2007), who argue that countries locked into peripheral products face structural barriers to moving into more complex exports. Most core products exhibited high Distance values, suggesting that potential new exports were far from India's capability base. As a result, export growth

relied largely on traditional strengths in plantation crops, cereals, and oilseeds rather than on upgrading into high-value or sophisticated agricultural goods.

By contrast, the 2006–2020 period shows a denser, circular product space with stronger interconnections among export categories, indicating broader capability accumulation and reduced barriers to diversification. Higher density values for products like rice, meat of bovine animals, and other oilseeds, combined with rising Agri-PCI scores, point to India's gradual movement toward mid- and high-complexity exports. The integration of products such as beverages, edible preparations, and bovine meat into the core underscores India's emerging capacity to diversify into value-added and processed goods, echoing Hausmann and Klinger (2007), who highlight that capability expansion facilitates export sophistication. However, the persistence of low-complexity commodities, such as coconut copra and nutmeg, signals a continued structural dependence on traditional exports. Taken together, India's evolving product space reflects a dual dynamic, the resilience of historical export strengths alongside an increasing readiness to integrate into higher-value agricultural markets, provided that supportive policies in agro-processing, certification, and trade facilitation are sustained.

4.5. Conclusions

The analysis of India's agricultural export performance over the period 1991 to 2020, using a combination of competitiveness indicators, convergence dynamics, product mapping, and product spacing techniques, offers a comprehensive and multidimensional understanding of its long-term evolution. The results based on RSCA and TBI indicators reveal a significant transformation in India's export structure. In the early 1990s, India's agricultural exports were characterised by a largely unimodal distribution dominated by comparative disadvantage. By 2020, this structure had evolved into a more balanced and

dispersed distribution, reflecting increased integration into global agricultural markets. However, competitive and non-competitive subsectors continue to coexist, highlighting a persistent duality within India's export basket. Strong traditional commodities such as rice, spices, oilseeds, and groundnut products coexist alongside structurally weaker segments, indicating uneven progress across subsectors.

The stability and convergence analysis further underscores both persistence and gradual adjustment in export competitiveness. The β -convergence results confirm that subsectors with initially weaker comparative advantage have experienced improvement over time, leading to a partial narrowing of competitiveness gaps. At the same time, products with historically strong export performance, such as rice, spices, and groundnut-based products, exhibit high stability and structural resilience. This persistence reflects path dependence in India's agricultural export structure and suggests that while leading sectors remain robust, targeted policy interventions are necessary to accelerate progress in lagging subsectors.

Product mapping analysis reinforces these findings by revealing a steady presence of Group A products, which combine comparative advantage with export specialisation and represent India's core agricultural exports. However, the dominance of Group C products indicates a heavy reliance on export-oriented commodities that lack strong comparative advantage, raising concerns regarding long-term sustainability. The continued presence of Group D products points to inefficiencies and structural bottlenecks, while the relatively small share of Group B products highlights missed opportunities where comparative advantage exists but is not fully translated into export specialisation. These gaps signal the need for focused support in areas such as value addition, branding, quality upgrading, and logistics infrastructure.

Finally, product spacing analysis reveals a notable structural shift in India's agricultural product space. During the period 1991–2005, the product space was fragmented, sparsely

connected, and largely concentrated in low-complexity and resource-based products, limiting scope for diversification. In contrast, the 2006–2020 period exhibits a denser and more interconnected product space, with rising density and declining distance measures, indicating improved proximity to a wider range of agricultural products. This structural densification suggests that India has gradually accumulated productive capabilities that facilitate movement into related and higher-value agricultural products. It also reflects enhanced learning effects, spillovers, and complementarities across subsectors. The reduction in distance values implies lower entry barriers for diversification, making transition into new products more feasible. However, despite these improvements, the product space remains uneven, underscoring the need for sustained investments in technology, processing, quality infrastructure, and supply-chain integration to fully exploit emerging diversification opportunities.

CHAPTER V

CONSTANT MARKET SHARE AND TRADE MARGINS OF INDIA'S AGRICULTURAL EXPORTS

5.1. Introduction

India's agricultural sector has long been the backbone of its economy, contributing to food security, rural employment, income generation, and international trade. In recent decades, India has emerged as a leading global exporter of cereals, spices, fruits, vegetables, and processed foods, driven by improved production capacity, technological progress, trade liberalisation, and supportive policies such as minimum support prices, export incentives, and free trade agreements. Despite these gains, India's agricultural exports continue to face structural challenges arising from shifting global demand, stringent quality standards, and increasing competition from emerging economies. Understanding whether India's export growth stems from favourable external conditions or domestic competitiveness improvements remains essential for policy design.

Although previous research has examined India's agricultural exports using aggregate statistics, few studies have applied a disaggregated, long-term Constant Market Share (CMS) framework to identify the sources of export growth across multiple partners. Existing CMS studies are generally limited to short periods, broad product groups, or a narrow set of destinations, and rarely decompose growth into scale, competitive, and second-order effects over an extended horizon. Research on intensive and extensive margins is similarly limited, particularly regarding their determinants at the disaggregated HS-6 level over three decades. The influence of partner-country characteristics, trade agreements, and relative economic and agricultural factors on these dual margins remains underexplored. By applying a long-term CMS analysis and examining intensive and extensive margins separately, this study fills a methodological gap and offers a nuanced understanding of the drivers of India's agricultural export growth. Accordingly, the study

proposes the following hypothesis:

H3: Extensive margins contribute more significantly to export growth than intensive margins.

This hypothesis reflects the expectation that India's export expansion is driven primarily by diversification, consistent with findings by Besedes and Prusa (2011) and Kehoe and Ruhl (2013).

One of the most widely applied frameworks to analyse export performance is the **Constant Market Share** (CMS) analysis, originally developed by Tyszynski (1951) and later refined by others (Leamer & Stern, 1970; Ahmadi-Esfahani, 1995; Fagerberg & Sollie, 1987). CMS decomposes export growth into world trade, commodity composition, market distribution, and competitiveness effects, allowing researchers to distinguish growth driven by global demand from that stemming from domestic efficiency. Over time, refinements have added econometric formulations (Jepma, 1986), bilateral trade dimensions (Cheptea, et al., 2005), and gravity-model integration (Ahmadi-Esfahani, 2006). CMS has been applied across agricultural exporters, including China (Zhou & Diao, 2021), the EU (Smith et al., 2020), Vietnam (Nguyen et al., 2023), and South American economies (Pérez et al., 2022). For India, existing CMS studies remain limited to specific commodities or shorter periods (Singh, 2014; Kumar et al., 2023; Varalakshmi & Devatkal, 2017). This study fills these gaps by applying the refined CMS methodology of Ahmadi and Esfahani (2006) at the HS-6 level for India's agricultural exports to 20 partners from 1991 to 2020, offering a long-term, disaggregated view of structural change and competitiveness.

Alongside CMS, trade growth is also assessed through **trade margins**, distinguishing growth from existing flows (intensive) and from new products or markets (extensive). Classical theories stressed specialisation (Armington, 1969; Krugman, 1981), while newer ones emphasise firm heterogeneity (Melitz, 2003). Intensive margins reflect expansion of old products, whereas extensive margins capture diversification (Amurgo-Pacheco, 2006),

which stabilises developing economies (Hausmann et al., 2007; Agosin, 2008). Evidence shows developing countries rely more on extensive margins (Besedes & Prusa, 2011; Kehoe & Ruhl, 2013), influenced by trade agreements and restructuring (Dutt et al., 2008; Robinson et al., 2015).

A crucial aspect of the analysis lies in identifying the key **determinants** of export performance. Existing literature highlights that firm productivity, trade costs, market size (GDP), prevailing market conditions, and institutional quality significantly influence both the intensive and extensive margins of trade (Melitz, 2003; Anderson, 2007; Chaney, 2008). In addition, structural characteristics, free trade agreements, geographical proximity, and the presence of a common language are shown to play an important role in shaping export outcomes (Evenett & Venables, 2003; Feenstra et al., 2004). Against this backdrop, the present chapter combines Constant Market Share (CMS) analysis with trade margin decomposition to evaluate India's agricultural export performance during the period 1991–2020 and empirically investigates its underlying determinants using econometric techniques.

5.2. Methodology

5.2.1. Measurement of Constant Market Share

A quantitative research approach using the Constant Market Share (CMS) method of Ahmadi and Esfahani (2006) is applied to assess India's agricultural export competitiveness with 20 major bilateral partners from 1991 to 2020. HS-6 level trade data are sourced from UN COMTRADE for accuracy and global comparability. The 30-year period is divided into three decades—1991–2000, 2001–2010, and 2011–2020, to capture structural breaks, key policy phases, technological changes, and global shocks influencing trade, enabling clearer comparison of long-term shifts in competitiveness. This decadal division reflects India's transition from early liberalisation to WTO-driven reforms and

later integration into global value chains. The decomposition analysis, conducted using R software, evaluates scale, competitiveness, and second-order effects.

Table 5.1 classifies the factors driving changes in export values into three major effects—*Scale/Structural*, *Competitive/Residual*, and *Second Order*, each with specific sub-effects. The Scale/Structural Effect explains how shifts in the importing markets' demand influence export values. Its components include growth (change in overall demand), market (shift in demand across regions), commodity (demand for specific products), and interaction (combined regional and product effects). Together, these indicate how external demand shapes export performance. The Competitive/Residual Effect identifies changes arising from the exporting country's competitiveness. Static Residual captures competitiveness changes within specific markets, while Pure Residual reflects overall market-share gains or losses. Their subtotal shows the net role of competition. The Second Order Effect quantifies how competitiveness interacts with structural demand changes. Pure Second Order reflects competitiveness interacting with demand scale, while Dynamic Second Order captures its interaction with market and product demand shifts. Their subtotal shows the joint competitiveness-demand influence. The last row, Total (Change in Export Value), combines all effects to present the net shift in export values.

This decomposition provides a structured framework to analyse export performance by distinguishing Scale, Competitive, and Second Order influences. Unlike aggregate methods such as gravity models or RCA, CMS decomposes whether export growth arises from external demand changes or internal competitiveness gains.

Table 5.1: Formulas for Decomposition and Definitions of Key Components Driving Export Growth in Constant Market Share Analysis:

Main effect	Sub effect	Formula	Definition
Scale/ Structural	Growth	$S^0 \Delta X$	Captures the impact on export values from shifts in the overall scale of demand in the importing market.
	Market	$(\sum_i \sum_j S_{ij}^0 \Delta X_{ij} - \sum_i S_i^0 \Delta X_i)$	Measures changes in export values due to variations in demand across different importing regions.
	Commodity	$(\sum_i \sum_j S_{ij}^0 \Delta X_{ij} - \sum_j S_j^0 \Delta X_j)$	Reflects how export values adjust based on demand changes for specific products within the importing market.
	Interaction	$(\sum_i S_i^0 \Delta X_i - S^0 \Delta X) - (\sum_i \sum_j S_{ij}^0 \Delta X_{ij} - \sum_j S_j^0 \Delta X_j)$	Accounts for export value changes from the combined effects of market and product demand shifts.
	Sub total	$S_{kij} \times \Delta X_{kij}$	Total effect of demand structure changes in the importing market on export values.
Competitive/ Residual	Pure residual	$\Delta S X^0$	Measures export value changes stemming from shifts in the overall competitiveness (market share) of the exporting country.
	Static residual	$(\sum_i \sum_j \Delta S_{ij} X_{ij}^0 - \Delta S X^0)$	Indicates changes in export values related to adjustments in the exporting country's market share across specific target markets.
	Sub total	$\Delta S_{kij} \times X_{kij}^0$	Total impact of the exporting country's competitiveness changes on export values.
Second order	Pure second order	$(X^1/X^0 - 1) \sum_i \sum_j \Delta S_{ij}^0 X_{ij}^0$	Tracks export value shifts due to the combined effects of competitiveness and overall import market demand scale changes.
	Dynamic second order	$[\sum_i \sum_j \Delta S_{ij} \Delta X_{ij} - (X^1/X^0 - 1) \sum_i \sum_j \Delta S_{ij} X_{ij}^0]$	Captures export value shifts due to interaction between competitiveness changes and structural demand adjustments in the importing market.
	Sub total	$\Delta S_{kij} \times \Delta X_{kij}$	Total impact of interactions between competitiveness and demand scale/structure on export values.
Total (Change in export value)		Δx	Reflects the overall change in export values between countries, covering all components.

Source: Ahmadi-Esfahani, 2006

Importantly, Second Order effects capture the interaction between demand shifts and competitiveness, something traditional tools overlook, yielding a more comprehensive view of trade dynamics. Policymakers can use these insights to determine whether strategies should focus on improving competitiveness (cost efficiency, product differentiation) or enhancing market access (diversifying destinations, strengthening trade agreements). A positive Market or Commodity Effect identifies regions or products with

strong demand, guiding export promotion and production priorities. Thus, CMS decomposition enables more targeted trade strategies by separating demand-driven growth from competitiveness-driven growth while also analysing their interactions.

Table 5.2 presents the detailed definitions of variables employed to analyse India's agricultural export performance at both the commodity and national levels. At the commodity level, the variables measure India's export shares for specific agricultural products classified at the HS-6 digit level, relative to total global imports of the corresponding commodities. This approach enables an assessment of India's competitiveness and export orientation across individual agricultural products in the global market. At the national level, the variables capture India's agricultural exports to a selected group of 20 partner countries and compare these flows with each partner's total agricultural imports. This facilitates an evaluation of India's export performance and market penetration across different destination countries. By integrating commodity-level and country-level variables, the framework provides a comprehensive and multidimensional perspective on India's agricultural exports. Such an approach helps identify product-specific strengths, destination-specific opportunities, and structural patterns shaping India's overall export performance in international agricultural trade. Moreover, the use of these variables supports comparative analysis across time and regions, allowing for the identification of evolving export dynamics. It also aids in understanding the role of market size, demand structure, and trade orientation in influencing export outcomes. Overall, this variable framework strengthens the empirical analysis by linking product-level competitiveness with country-level trade performance.

Table 5.2: Comprehensive Variable Descriptions in Formulas:

Variables	Product Level	Country Level
S	The ratio of India's exports of	The ratio of India's agricultural

	select agricultural commodity i to global market in the total import of select agricultural commodity i by the globe.	exports to a select nation j in the total imports of all agricultural commodities by select nation j.
Si	The ratio of India's exports of select agricultural commodity i to global market in the total import of select agricultural commodity i by the globe.	The ratio of India's exports of agricultural commodity i to select nation j in the total imports of agricultural commodity i by select nation j.
Sj	The ratio of India's exports of select agricultural commodity i to nation j in the total imports of select agricultural commodity i by nation j.	The ratio of India's agricultural exports to a select nation j in the total imports of all agricultural commodities by select nation j.
Sij	The ratio of India's exports of select agricultural nation i to country j in the total imports of select agricultural nation i by country j.	The ratio of India's exports of agricultural commodity i to a select country j in the total imports of agricultural nation i by select country j
X	The total import value of select agricultural product i in global market.	The total import value of all agricultural commodities by select nation j.
Xi	The total import value of select agricultural commodity i in global market.	The total import value of agricultural commodity i by select nation j.
Xj	The total import value of select agricultural commodity i by nation j.	The total import value of all agricultural commodities by select nation j.
Xij	The total import value of agricultural commodity i by select nation j	The total import value of select agricultural commodity i by nation j.

Source: Zhu et al., 2024

5.2.2. Measurement of Extensive and Intensive Margins

The share of a nation's export in the world's aggregate export is a creation of the intensive and extensive margins of trade. The Extensive Margin (EM) refers to a fraction of a country's export product category within the global export market. The Intensive Margin (IM) refers to the expansion of export values of products that a country already exports to existing destinations.. The extensive trade margin measures the growth of trade due to an

increase in the number of product varieties exported to each destination country, focusing on the width of exports, i.e. whether a trading relationship exists. Intensive margin measures the average value of exports by variety, focusing on the depth of exports, i.e. how much is traded in the existing relationship. The intensive and extensive trade margin of a country can be formulated as: (Hummels & Klenow, 2005)

$$EM = \frac{\sum I^c P_i^w X_i^w}{\sum I^w P_i^w X_i^w}$$

$$IM = \frac{\sum I^c P_i^c X_i^c}{\sum I^c P_i^w X_i^w}$$

Where X_i^c and X_i^w and P_i^c and P_i^w are the export value and price value of country c's and world exports, respectively. I^c is the select range of positive export set of goods exported by country c, while I^w is the select range that contains all the goods exported in the world. Therefore, I^c is a subclass of I^w . The value of the extensive and intensive margins ranges from 0 to 1.

Equations (1) and (2) are used to relate a country's intensive and extensive margins for a given time period. On the other hand, a country's export growth can be subdivided between years t and $t + n$ to derive the extensive and intensive margins. (Kehoe and Ruhl, 2013) as;

$$g = g_{EM} + g_{IM}$$

where g is the export growth rate, g_{EM} is the growth rate of the extensive margin, and g_{IM} is the growth rate of the intensive margin.

5.2.3. Model of Determinants of Extensive and Intensive

A nation's export growth can be partially attributed to the expansion of global commerce, the specific trading partners the nation has chosen, or the items the nation sells most frequently. In addition, export growth depends upon the country's economic environment

and the performance of alternative factors supporting export growth. The growth strategies promoting exports have increasingly focused on identifying the key determinants of export performance. In this context, the present study analyses India's agricultural export performance through its intensive and extensive margins over the period 1991–2020.

The definition of significant variables that have been used to determine the intensive and extensive margins of trade in this study is explained as follows:

Table 5.3: Description of variables:

Variables	Source of Variable	Descriptions	Rationale
1. Relative economic size	World Bank	The proportion of the partner's GDP to India's GDP.	Larger economies generate greater production and demand, increasing bilateral trade potential. Hence, relative GDP captures how economic size differences influence India's trade margins.
2. Population	World Bank	Bilateral trade partners' population growth.	Population size shapes production capacity and consumer demand. Thus, population differences help explain variations in bilateral trade flows.
3. Relative Agriculture value added	World Bank	The proportion of the partner's agriculture value added to India's agriculture value added.	Higher agricultural value added indicates stronger processing capacity and competitiveness. The ratio shows how partner agricultural strength affects India's agricultural trade margins.
4. Relative Economic Freedom	World Bank	The proportion of the partner's economic freedom index to India's economic freedom index.	Higher economic freedom reduces regulatory and trade barriers. Thus, relative economic freedom captures policy differences affecting

			bilateral trade.
5. Distance	CEPII	The two-sided distance in kilometres between the partner and India.	Greater distance increases transport and transaction costs, reducing trade. Hence, distance serves as a core proxy for bilateral trade costs.
6. Relative Crop Production	FAO	The ratio of the partner's crop production index to India's crop production index.	Crop production reflects agricultural capacity and competitiveness. The relative index shows how production differences drive agricultural trade patterns.
7. Relative Purchasing Power	IMF	The ratio of the partner's net terms of trade index to India's net terms of trade index.	Terms of trade influence a country's ability to buy foreign goods and gain from trade. Thus, relative purchasing power explains how price competitiveness affects trade flows.
8. Trade Agreement	WTO	1 for the trade agreement in action.	Trade agreements reduce tariffs and barriers, promoting higher bilateral trade. A dummy variable captures this institutional advantage in shaping export flows.
9. Common Language	CEPII	1 for the presence of a common language.	A shared language lowers communication and transaction costs. Therefore, the common language facilitates easier trade relationships and higher bilateral exports.

5.2.4. Gravity Model of Trade

The gravity trade model is widely used to determine the important factors influencing trade for

the trading nation. The gravity model explains how a nation's trade results from the geographical space and remoteness between the two nations, which is a representation of transportation expenses, and the two nations' combined economic dimension, measured by the Gross Domestic Product (GDP). The model is expanded by incorporating variables that consider additional factors influencing trade, such as population of the partner country, relative agriculture value added, economic freedom, distance, relative crop production and relative purchasing power. Dummy variables representing trade agreements and common language have also been introduced to address other factors impacting trade levels over the basic model. The estimated equation of intensive and extensive trade margins is as follows:

$$EM_{jp} = \beta_0 + \beta_1 RES_{jp} + \beta_2 Pop_p + \beta_3 RAV_{jp} + \beta_4 REF_{jp} + \beta_5 LnDist_{jp} + \beta_6 RCP_{jp} + \beta_7 RPP_{jp} + \beta_8 D_{1_TA} + \beta_9 D_{2_CL} + \varepsilon_{jp}$$

$$IM_{jp} = \alpha_0 + \alpha_1 RES_{jp} + \alpha_2 Pop_p + \alpha_3 RAV_{jp} + \alpha_4 REF_{jp} + \alpha_5 LnDist_{jp} + \alpha_6 RCP_{jp} + \alpha_7 RPP_{jp} + \alpha_8 D_{1_TA} + \alpha_9 D_{2_CL} + \mu_{jp}$$

Where RES_{jp} is the relative economic size; Pop_p is the population of the partner country; RAV_{jp} is the relative agriculture value added; REF_{jp} is the relative economic freedom; $Dist_{jp}$ is the distance; RCP_{jp} is the relative crop production; RPP_{jp} is the relative purchasing power and D_{1_TA} and D_{2_CL} are dummy variables representing trade agreements and common language. The vectors of factors to be estimated are α and β . The stochastic error terms include ε_{jp} and μ_{jp} . The dependent variables are extensive and intensive trade margins of agricultural bilateral exports from India to 20 nations.

5.2.5. Gravity Model Estimation Methods: Feasible Generalised Least Squares (FGLS) and Poisson Pseudo Maximum Likelihood (PPML)

To ensure reliable and effective estimators, panel data were analysed using Feasible Generalised Least Squares (FGLS) and Poisson Pseudo Maximum Likelihood (PPML).

Both methods assume correct model specification and are widely used in trade analysis. FGLS is particularly useful for addressing heteroscedasticity and serial correlation when the exact form of heteroscedasticity is unknown. It assigns weights to observations based on the square root of their variances and accommodates disturbances with varying variances across panels. FGLS estimates regression coefficients and their covariance matrix even when the error structure is non-spherical, and its covariance matrix is unknown. PPML offers two major advantages: it provides consistent estimates under heteroscedasticity, common in trade data, and it allows inclusion of zero-trade observations, ensuring unbiased estimation even when zeros are present. PPML assigns equal weight to all observations and is widely recommended for gravity-type models.

To run FGLS, the process begins with estimating the model using OLS to obtain residuals, followed by testing for heteroscedasticity using tools like the Breusch–Pagan or White test. After detecting heteroscedasticity, the error variance is estimated from OLS residuals and used to transform the data by adjusting for variance patterns or autocorrelation. The transformed model is then re-estimated using GLS or FGLS, and robustness checks using robust standard errors help validate the results. For PPML, the procedure starts by specifying a log-linear gravity-type model suitable for trade flows, including zeros. The PPML estimation is then executed using software such as R. After estimation, convergence must be verified, followed by diagnostic checks, such as examining residual patterns or over-dispersion, to confirm that model assumptions hold and that the specification accurately captures trade dynamics.

5.3. Results

5.3.1. Analysis of CMS at the Product level and Country level

Results from the empirical analysis of India's agricultural exports at the product type level (HS-2 digit classification) as well as the partner country level are discussed in this section.

Agricultural export growth is decomposed into scale, competitive and second-order effects, which are estimated against 20 major trade partners for the three sub-periods: 1991-2000, 2001-2010, and 2011-2020. Table 5 provides the results of decomposition for the 24 HS-2 agricultural commodities for the period 1991-2000. The Total Scale Effect, which measures the impact of overall market growth, is positive for products like Live Animals (268.08) and Dairy Products (184.63), indicating they benefited from global demand, while Sugar (-1215.65) faced strong negative effects. The Total Competitive Effect, reflecting India's ability to compete, shows positive gains for Lac, Gums, Resins & Saps (20.27), Animal/Veg Fat Oils (23.35), and Fish (23.74), with Sugar (131.65) standing out despite its negative scale effect. Conversely, Beverages (-229.30) and Vegetable Plaiting Materials (-202.58) recorded major competitive losses. The Total Second Order Effect, which represents the interaction of structural changes and market performance, is negative for most products, suggesting weak responsiveness to demand shifts. However, Sugar (1184) exhibited the highest positive second-order effect, indicating that competitiveness improvements reinforced favourable market conditions, driving export growth. Animal/Veg Fat Oils (36.40) and Lac, Gums, Resins & Saps (15.47) also showed moderate reinforcement between competitiveness and demand.

Table 5.4: Product-level Decomposition of Export Growth using CMS for 1991-2000

Product Type	Total Scale effect (%)	Total Competitive effect (%)	Total Second order effect (%)
HS-01 Live Animals	268.08	-28.95	-139.13
HS-02 Meat	89.18	0.33	10.49
HS-03 Fish	69.34	23.74	6.92

HS-04 Dairy Products	184.63	-3.80	-80.83
HS-05 Products of Animal Origin	293.19	-20.90	-172.29
HS-06 Live Tree	115.37	30.09	-45.47
HS-07 Edible Vegetable	141.25	6.69	-47.94
HS-08 Edible Fruit	139.46	-10.18	-29.28
HS-09 Coffee, Tea, Mate & Spices	259.04	-81.59	-77.45
HS-10 Cereals	84.29	12.19	3.52
HS-11 Production Mill	105.45	4.45	-9.91
HS-12 Oil Seeds	208.32	-27.92	-80.40
HS-13 Lac, Gums, Resins & Vegetable Saps	64.26	20.27	15.47
HS-14 Vegetable Plaiting Materials & Vegetable Product	762.96	-202.58	-460.39
HS-15 Animal Veg Fat Oils	40.25	23.35	36.40
HS-16 Preparations of Meat/ Fish	405.32	-52.81	-252.51
HS-17 Sugars	-1215.65	131.65	1184.00
HS-18 Cocoa	1622.35	-409.91	-1112.44
HS-19 Preparation of Cereal/ Flour	306.99	-24.29	-182.70
HS-20 Preparation of Vegetable Fruit Nut	242.12	-20.75	-121.37
HS-21 Miscellaneous Edible	182.72	-2.95	-79.76
HS-22 Beverages	1417.85	-229.30	-1088.55
HS-23 Residues	650.94	-98.86	-452.08
HS-24 Tobacco	273.70	5.64	-179.34

Source: Compiled by the author

Overall, while some products benefited from market expansion, competitiveness played a key role in export performance, with second-order effects being largely insignificant except in a few cases.

Table 5.5: Country-wise Decomposition of Export Growth using CMS for 1991-2000

Country	Total Scale effect	Total	Total Second
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	(%)	Competitive effect (%)	order effect (%)
1. UAE	189.99	-4.17	-85.82
2. Bangladesh	37.94	0.62	61.44
3. China	996.48	-24.54	-871.94
4. Germany	320.48	-35.42	-185.06
5. Egypt	59.38	-52.58	93.20
6. UK	326.11	-94.20	-131.91
7. Hong Kong	-1301.34	453.16	948.17
8. Indonesia	481.35	-41.96	-339.40
9. Iran	75.11	74.98	-50.08
10. Japan	90.69	30.59	-21.28
11. Kuwait	118.11	-2.81	-15.31
12. Malaysia	161.72	3.00	-64.72
13. Netherlands	116.50	-33.19	16.69
14. Nepal	324.98	-59.36	-165.62
15. Russia	--	--	--
16. Saudi Arabia	100.38	8.17	-8.56
17. Singapore	175.41	-39.07	-36.34
18. Thailand	497.99	-29.60	-368.39
19. USA	78.22	12.64	9.14
20. Vietnam	-2313.49	106.15	2307.34

Source: Compiled by the author

Table 5.5 presents the CMS results at the country level for 1991–2000. The Total Scale Effect, which measures the impact of market and product growth in partner countries, is positive for UAE (189.99), Bangladesh (37.94), Germany (320.48), UK (326.11), and Indonesia (481.35), indicating favourable market conditions. However, Vietnam (-2313.49) and Hong Kong (-1301.34) faced significant negative scale effects, likely due to declining

demand or market contraction.

The Total Competitive Effect, reflecting India's ability to compete, shows notable gains in Hong Kong (453.16), Vietnam (106.15), and Japan (30.59), while Germany (-35.42), Nepal (-59.36), and the Netherlands (-33.19) recorded competitiveness declines. Vietnam's strong competitive gains helped offset its negative scale effect. The Total Second-Order Effect, measuring structural interactions, highlights Vietnam (2307.34) and Hong Kong (948.17) as markets where favourable shifts supported India's exports, whereas China (-871.94) and Germany (-185.06) faced structural challenges. Minor positive effects in the Netherlands (16.69) and Bangladesh (61.44) suggest modest interaction benefits. While competitiveness and market dynamics improved in Vietnam and Hong Kong, structural and scale-related challenges persisted in countries like Bangladesh, China, and Hong Kong.

Table 5.6 presents the CMS results at the product level for 2001–2010. Sugar (859.09) and Cocoa (103.40) maintained positive scale effects despite regional and product-level market contractions, while Miscellaneous Edible Products (304.90) and Live Tree (229.14) benefited from global market growth. However, Live Animals (-39.40) and Products of Animal Origin (-35.46) faced negative scale effects, indicating unfavourable market conditions. Edible Fruits (199.42) and Cereals (79.06) reflected strong demand-driven effects despite contractions at the product level.

Table 5.6: Product-level Decomposition of Export Growth using CMS for 2001-2010

Product Type	Total Scale effect (%)	Total Competitive effect (%)	Total Second order effect (%)
HS-01 Live Animals	-39.40	55.35	84.04
HS-02 Meat	76.94	2.12	20.94
HS-03 Fish	173.05	-12.08	-60.97
HS-04 Dairy Products	124.14	1.96	-26.09

HS-05 Products of Animal Origin	-35.46	50.19	85.27
HS-06 Live Tree	229.14	-4.56	-124.58
HS-07 Edible Vegetable	118.05	-4.18	-13.87
HS-08 Edible Fruit	199.42	-41.29	-58.12
HS-09 Coffee, Tea, Mate & Spices	137.07	-6.29	-30.78
HS-10 Cereals	79.06	1.09	19.85
HS-11 Production Mill	63.59	17.05	19.37
HS-12 Oil Seeds	116.96	-0.51	-16.45
HS-13 Lac, Gums, Resins & Vegetable Saps	78.01	1.81	20.19
HS-14 Vegetable Plaiting Materials & Vegetable Product	16.03	12.12	71.84
HS-15 Animal Veg Fat Oils	92.19	3.68	4.13
HS-16 Preparations of Meat/ Fish	15.93	33.86	50.21
HS-17 Sugars	859.09	-152.01	-607.08
HS-18 Cocoa	103.40	-15.99	12.58
HS-19 Preparation of Cereal/ Flour	41.75	17.86	40.39
HS-20 Preparation of Vegetable Fruit Nut	91.01	15.70	-6.71
HS-21 Miscellaneous Edible	304.90	-70.18	-134.72
HS-22 Beverages	58.06	16.95	24.99
HS-23 Residues	95.07	-1.75	6.68
HS-24 Tobacco	51.82	44.19	4.00

Source: Compiled by the author

In terms of competitiveness, Preparation of Cereal/Flour (17.86), Preparation of Meat/Fish (33.86), and tobacco (44.19) saw gains, while Live Animals (55.35) and Products of Animal Origin (50.19) offset scale challenges with strong competitive improvements. Conversely, Sugar (-152.01), Cocoa (-15.99), and Fish (-12.08) experienced competitiveness declines due to stronger competition, while Beverages (16.95) showed moderate competitive gains. The Second-Order Effect revealed structural gains for Live

Animals (84.04) and Products of Animal Origin (85.27), with Preparation of Meat/Fish (50.21) also benefiting from favourable trade shifts. Meanwhile, Sugar (-607.08) and Fish (-60.97) suffered from negative interaction effects, suggesting structural challenges. Cocoa (12.58) and Residues (6.68) recorded moderate positive effects, while Miscellaneous Edible Products (-134.72) experienced significant structural market losses.

Table 5.7 presents the CMS results at the country level for 2001–2010. Singapore (372.79), UAE (89.97), and Russia (510.16) recorded high scale effects due to strong market growth, while USA (135.20), Indonesia (153.07), and Bangladesh (152.57) benefited from demand-driven scale effects. Nepal (93.32) and Kuwait (107.59) showed moderate positive scale effects, reflecting favorable demand growth, whereas Germany (104.78) and the Netherlands (105.27) maintained positive effects despite product-level contractions. In terms of competitiveness, Singapore (-40.14), Russia (-183.88), and the USA (-8.87) experienced significant declines, suggesting increased competition from other suppliers, while UAE (2.54), Malaysia (4.43), and Nepal (0.25) showed minor competitive gains. Hong Kong (11.90), Iran (12.14), and Saudi Arabia (3.91) displayed small positive effects, indicating improved market performance, whereas Japan (0.36) saw negligible change. The Second-Order Effect revealed positive structural shifts in Hong Kong (44.63), Japan (60.38), and Vietnam (29.14), while Malaysia (14.85) and Saudi Arabia (9.73) had moderate gains. However, Russia (-226.28), Singapore (-232.65), and Germany (-27.52) faced structural challenges affecting exports, with USA (-26.33) and Indonesia (-34.76) also experiencing negative second-order effects, reflecting unfavourable market dynamics.

Table 5.7: Country-wise Decomposition of Export Growth using CMS for 2001-2010

Country	Total Scale effect (%)	Total Competitive	Total Second order effect
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		effect (%)	(%)
1. UAE	89.97	2.54	7.49
2. Bangladesh	152.57	-12.34	-40.23
3. China	148.27	-5.82	-42.45
4. Germany	104.78	22.74	-27.52
5. Egypt	105.66	7.63	-13.28
6. UK	135.65	-12.09	-23.56
7. Hong Kong	43.47	11.90	44.63
8. Indonesia	153.07	-18.31	-34.76
9. Iran	69.55	12.14	18.31
10. Japan	39.26	0.36	60.38
11. Kuwait	107.59	-0.30	-7.29
12. Malaysia	80.72	4.43	14.85
13. Netherlands	105.27	3.07	-8.33
14. Nepal	93.32	0.25	6.42
15. Russia	510.16	-183.88	-226.28
16. Saudi Arabia	86.36	3.91	9.73
17. Singapore	372.79	-40.14	-232.65
18. Thailand	90.82	-9.15	18.33
19. USA	135.20	-8.87	-26.33
20. Vietnam	71.01	-0.14	29.14

Source: Compiled by the author

Edible Fruit (2707.16), Sugar (289.20), and Live Tree (1182.62) experienced strong demand-driven growth despite product-specific challenges, indicating global market opportunities, while Cereals (208.54) and Edible Vegetables (223.87) also benefited from favourable demand conditions. Live Animals (174.75) and Meat (-35.34) exhibited weak or marginal demand-driven effects, whereas Oil Seeds (-325.04) and Tobacco (-58.38) faced negative scale effects due to unfavourable global demand. In terms of competitiveness, Live

Animals (-10789.42) and Sugar (-1901.03) suffered significant losses, while tobacco (527.27) was a rare exception with notable competitive gains.

Table 5.8 presents the CMS results at the product level for 2011–2020. Beverages (128.98), Oil Seeds (124.53), Cocoa (68.53), and Preparation of Meat/Fish (72.10) showed moderate improvements in niche markets. The Second-Order Effect revealed strong positive structural changes for Sugar (1711.82), Vegetable Plaiting Materials (339.28), and Live Animals (10714.67), indicating strong interaction effects despite weak competitiveness. Oil Seeds (300.51) also benefited from positive structural shifts. However, Edible Fruit (-3117.39), Preparation of Cereal/Flour (-39.63), and tobacco (-368.89) faced structural challenges that constrained their export performance.

Table 5.8: Product-level Decomposition of Export Growth using CMS for 2011-2020

Product Type	Total Scale effect (%)	Total Competitive effect (%)	Total Second order effect (%)
HS-01 Live Animals	174.75	-10789.42	10714.67
HS-02 Meat	-35.34	310.13	-174.79
HS-03 Fish	3.16	56.91	39.93
HS-04 Dairy Products	23.72	130.76	-54.48
HS-05 Products of Animal Origin	143.49	36.86	-80.35
HS-06 Live Tree	1182.62	-391.90	-690.72
HS-07 Edible Vegetable	223.87	15.56	-139.43
HS-08 Edible Fruit	2707.16	510.24	-3117.39
HS-09 Coffee, Tea, Mate & Spices	231.07	-49.87	-81.21
HS-10 Cereals	208.54	329.78	-438.32
HS-11 Production Mill	69.51	71.03	-40.54
HS-12 Oil Seeds	-325.04	124.53	300.51

HS-13 Lac, Gums, Resins & Vegetable Saps	99.01	-32.84	33.82
HS-14 Vegetable Plaiting Materials & Vegetable Product	151.56	-390.84	339.28
HS-15 Animal Veg Fat Oils	80.72	66.64	-47.36
HS-16 Preparations of Meat/ Fish	8.13	72.10	19.77
HS-17 Sugars	289.20	-1901.03	1711.82
HS-18 Cocoa	11.12	68.53	20.35
HS-19 Preparation of Cereal/ Flour	154.87	-15.24	-39.63
HS-20 Preparation of Vegetable Fruit Nut	71.03	57.51	-28.54
HS-21 Miscellaneous Edible	52.58	46.05	1.37
HS-22 Beverages	3.70	128.98	-32.69
HS-23 Residues	-25.53	117.35	8.19
HS-24 Tobacco	-58.38	527.27	-368.89

Source: Compiled by the author

Table 5.9 presents the CMS results at the country level for 2010-2020. While exports to Vietnam (-856.00), Singapore (-407.65), and Hong Kong (-252.18) faced unfavourable demand conditions, the USA (-25.48) and Russia (-28.10) only saw marginally negative scale effects, reflecting limited demand growth, while Bangladesh (7591.48) was the top-performing destination in terms of total scale effects, driven by strong global demand, followed by the UK (1360.03), Nepal (147.64), and Saudi Arabia (136.95).

India gained the most in Bangladesh (30816.69) in terms of competitiveness, greatly expanding its market share.

While the USA (131.29) and Nepal (142.31) showed modest increases despite negative scale effects, Hong Kong (229.32), Singapore (563.34), and the UAE (25.38) exhibited moderate competitive gains despite occasionally weaker demand.

Table 5.9: Country-wise Decomposition of export Growth using CMS for 2011-2020:

Country	Total Scale effect (%)	Total Competitive effect (%)	Total Second order effect (%)
1. UAE	52.38	25.38	22.24
2. Bangladesh	7591.48	30816.69	-38308.17
3. China	76.81	0.03	23.17
4. Germany	21.59	64.12	14.29
5. Egypt	93.76	217.46	-211.22
6. UK	1360.03	922.99	-2183.03
7. Hong Kong	-252.18	229.32	122.86
8. Indonesia	22.83	57.12	20.06
9. Iran	4.01	200.04	-104.05
10. Japan	60.26	23.86	15.88
11. Kuwait	76.23	-27.46	51.23
12. Malaysia	-12.29	114.94	-2.65
13. Netherlands	41.82	94.08	-35.90
14. Nepal	147.64	142.31	-189.95
15. Russia	-28.10	172.05	-43.95
16. Saudi Arabia	136.95	68.65	-105.60
17. Singapore	-407.65	563.34	-55.69
18. Thailand	108.67	-81.86	73.18
19. USA	-25.48	131.29	-5.82
20. Vietnam	-856.00	-188.45	1144.45

Source: Compiled by the author

However, significant demand-driven scale effects were offset by significant competitive losses for Vietnam (-188.45). The Netherlands (94.08) and Russia (172.05) also showed slight increases in competitiveness. In terms of second-order effects, despite difficulties with competition, Vietnam (1144.45) demonstrated significant positive structural changes, whereas Nepal (-189.95), Hong Kong (122.86), and Kuwait (51.23) underwent structural

adjustments that somewhat supported export growth. However, Bangladesh (-38308.17) had major structural issues that limited export gains despite its size and competitive consequences. Positive competitiveness was counterbalanced by structural restrictions in the UK (-2183.03) and Singapore (-55.69), but Germany (14.29) showed only slight structural effects.

5.3.2. Analysis of Trade Margins at the product level and the country level

The contribution of the growth of intensive and extensive margins to India's agricultural exports is presented in two parts. The first part discusses the trade margins for product-wise and destination-wise. This analysis is conducted at the HS-2 and HS-6 digit levels. The second section covers the identification of factors influencing the trade margins of India. It was found that the extensive margin is dominant than the intensive margin over the thirty period. The extensive margin serves as a growth factor for agricultural exports. Given its status as a productive agricultural economy, India possesses a wide range of agricultural products for global trade and has the potential to reach numerous destinations.

Table 5.10 represents the classification of HS-2 digit commodities (HS-6 is included in these broad categories of HS-2) along with their respective intensive margin (%) and extensive margin (%) across three decades: 1991–2000, 2001–2010 and 2011–2020.

Table 5.10: Share of intensive and extensive margin of India's agricultural products:

Product Type	Intensive Margin (%)			Extensive Margin (%)		
	1991-2000	2001-2010	2011-2020	1991-2000	2001-2010	2011-2020
HS-01 Live Animals	0.02	0.10	0.17	39.33	75.33	76.67
HS-02 Meat	0.62	1.13	4.72	46.12	65.03	54.38
HS-03 Fish	4.35	3.35	7.24	54.90	75.47	74.37
HS-04 Dairy Products	0.29	0.75	0.66	98.34	94.00	94.00

HS-05 Products of Animal Origin	3.93	1.38	1.54	92.37	81.33	98.19
HS-06 Live Tree	0.30	0.60	0.50	89.67	91.22	91.36
HS-07 Edible Vegetable	1.12	1.67	1.75	62.67	87.84	92.47
HS-08 Edible Fruit	3.44	2.51	2.08	69.10	88.82	95.09
HS-09 Coffee, Tea, Mate & Spices	7.68	6.63	8.51	94.18	97.23	92.84
HS-10 Cereals	4.52	7.45	9.77	63.75	96.25	98.75
HS-11 Production Mill	0.55	1.09	2.26	57.06	86.05	95.94
HS-12 Oil Seeds	1.46	1.54	1.86	49.45	80.53	82.95
HS-13 Lac, Gums, Resins & Vegetable Saps	15.59	17.88	33.76	67.50	84.09	90.00
HS-14 Vegetable Plaiting Materials & Vegetable Product	3.04	4.99	8.69	56.55	77.14	75.95
HS-15 Animal Veg Fat Oils	1.03	1.32	2.05	48.43	84.82	85.47
HS-16 Preparations of Meat/ Fish	0.04	0.47	0.87	27.6	65.20	61.20
HS-17 Sugars	0.64	2.21	2.65	66.00	94.67	99.33
HS-18 Cocoa	0.03	0.05	0.46	47.27	76.36	86.36
HS-19 Preparation of Cereal/ Flour	0.40	0.56	0.88	78.75	98.13	99.87
HS-20 Preparation of Vegetable Fruit Nut	0.28	0.59	1.15	50.89	81.83	88.69
HS-21 Miscellaneous Edible	1.02	1.02	1.32	80.7	97.00	99.12
HS-22 Beverages	0.13	0.11	0.27	71.43	93.59	93.00
HS-23 Residues	5.53	5.67	3.80	60.83	86.85	91.66
HS-24 Tobacco	1.39	2.24	2.90	83.33	95.56	98.89

Source: Compiled by the author

The intensive margin of Live Animals increased from 0.02% to 0.17%, showing a rise in production and trade interest. Meat rose significantly from 0.62% to 4.72%, indicating a growing market for meat products.

In the case of Fish the intensive margin fluctuated slightly, starting at 4.35%, dropping to 3.35%, and then increasing to 7.24%. This suggests variability in production but an overall upward trend. Dairy Products grew from 0.29% to 0.75%, and then slightly decreased to 0.66%, reflecting a stable market with minor fluctuations. Products of Animal Origin declined from 3.93% to 1.54%, indicating decreased production or market demand. Live Trees increased from 0.30% to 0.60%, showing growing interest in live tree production.

Edible Vegetables rose from 1.12% to 1.75%, indicating a growing market for these products. Edible Fruits decreased from 3.44% to 2.08%, suggesting challenges in production or market saturation. Coffee, Tea, Mati & Spices increased slightly from 7.68% to 8.51%, indicating stable production levels. Cereals grew from 4.52% to 9.77%, reflecting enhanced production capabilities and demand. Production Mill rose significantly from 0.55% to 2.26%, indicating major advancements in production processes. Oilseeds increased from 1.46% to 1.86%, showing stability in the oilseed market.

Lac, Gums, Resins & Other Vegetable Saps saw a major increase from 15.59% to 33.76%, indicating strong demand. Vegetable Plaiting Materials & Vegetable Products increased from 3.04% to 8.69%, reflecting a growing market. Animal/Veg Fat Oils rose from 1.03% to 2.05%, indicating increased market acceptance. Preparation of Meat/Fish increased from 0.04% to 0.87%, showing significant growth in prepared meat and fish products. Sugar grew from 0.64% to 2.65%, indicating a strong market potential. Cocoa increased from 0.03% to 0.46%, reflecting rising consumer interest. Preparation of Cereal/Flour rose from 0.40% to 0.88%, showing growth in processed cereals.

In the case of the extensive margin, Live Animals increased from 39.33% in 1991-2000 to 76.67% by 2011-2020, indicating a strong growth in the market for live animals, reflecting increased production and trade opportunities. Meat grew from 46.12% to 54.38%, showing a steady demand for meat products, although it saw a slight decrease in the last decade. Fish rose from 54.90% to 74.37%, indicating a robust and growing interest in fish products, particularly in the latter years. Dairy Products started at a high 98.34% and stabilised at 94.00% in both the 2001-2010 and 2011-2020 periods, reflecting a consistent presence in the market. Products of Animal Origin increased from 92.37% to 98.19%, suggesting a significant expansion in this category, highlighting strong market potential. Live Trees increased from 89.67% to 91.36%, showing stability and consistent interest in

live trees for trade and production. Edible Vegetables rose from 62.67% to 92.47%, reflecting increased market participation and demand for vegetables over the decades.

Edible Fruits increased from 69.10% to 95.09%, indicating a strong upward trend in the market for edible fruits. Coffee, Tea, Mati & Spices started at 94.18% and slightly declined to 92.84% by 2011-2020, indicating stable but slightly diminishing market saturation. Cereals grew significantly from 63.75% to 98.75%, indicating a strong increase in the demand and production of cereals. Production Mill increased from 57.06% to 95.94%, showing a strong growth trajectory in production capabilities. Oilseeds rose from 49.45% to 82.95%, indicating a growing market for oilseeds and their derivatives. Lac, Gums, Resins & Other Vegetable Saps increased from 67.50% to 90.00%, suggesting robust market growth in this niche category. Vegetable Plaiting Materials & Vegetable Products increased from 56.55% to 75.95%, indicating a steady growth in demand. Animal/Veg Fat Oils grew from 48.43% to 85.47%, reflecting a strong acceptance and growth in this market. Preparation of Meat/Fish increased from 27.6% to 61.20%, showing a significant increase in prepared products over time. Sugar rose from 66.00% to 99.33%, indicating a very high level of market participation and demand in the sugar category. Cocoa increased from 47.27% to 86.36%, indicating significant growth in this market.

Preparation of Cereal/Flour increased from 78.75% to 99.87%, showing near-total market coverage and acceptance for processed cereals. Preparation of Vegetable Fruit Nut increased from 50.89% to 88.69%, suggesting growing market demand for these products. Miscellaneous Edible increased from 80.7% to 99.12%, indicating a very high level of interest and production. Beverages increased from 71.43% to 93.00%, showing a solid growth trend in the beverage market. Residues increased from 60.83% to 91.66%, indicating a strong market for residues, which may reflect increasing efficiency in production processes. Tobacco increased from 83.33% to 98.89%, suggesting sustained

and growing interest in tobacco products.

Overall, many product types showed significant increases in the intensive margin, particularly meat, cereals, and lac products. However, some, like edible fruits and animal-origin products, showed declines. This highlights the dynamic nature of agricultural markets over the decades. The extensive margin percentages indicate a general trend of increasing market presence across many product categories, particularly in cereals, sugar, and animal products. Notably, the consistently high percentages in categories like dairy and animal products reflect their stable importance in the market. However, slight declines in products like meat and coffee indicate shifting consumer preferences or market saturation.

The data reveals varying trends in both intensive and extensive margins across product types. While some products show significant growth in market reach and production efficiency, others indicate fluctuations or declines, reflecting the dynamics of consumer preferences and market conditions over the three decades.

Product-wise Analysis-HS-6 digits

The following section presents an analysis of the top 20 products (HS-6) with a large share in the extensive margin and the intensive margin by comparing two time periods of 2011 and 2020.

Table 5.11 on major HS-6 agricultural products contributing to the extensive growth margin shows important changes in India's export structure between 2011 and 2020. In 2011, the extensive margin was largely driven by bulk agricultural commodities, particularly soybeans and wheat, which together accounted for the majority of the growth. Other cereals such as barley, rice, and maize also featured prominently, alongside products linked to the oilseed sector such as palm oil, crude soya-bean oil, and soya oilcake. Sugar, poultry meat, live sheep, and alcoholic beverages like wine, brandy, and whisky also

contributed, suggesting some degree of diversification beyond cereals but with a continued focus on raw or semi-processed products. By 2020, however, the structure of contributions had become more balanced. While soybeans and wheat remained important, their shares declined, and products such as milled rice, maize, and bovine meat emerged more strongly. At the same time, processed and value-added products such as food preparations, prepared bovine meat, beer, and other beverages entered the list, reflecting a shift towards diversification and gradual upgrading of the export basket. Traditional commodities such as sugar and tobacco continued to play a role, but with reduced weight compared to 2011.

Table 5.11: Major HS-6 Agricultural products contributing to Extensive growth margin:

2011			2020		
HS Code	Product Type (HS-6 digit classification)	Extensive margin (%)	HS Code	Product Type (HS-6 digit classification)	Extensive margin (%)
120100	Soya beans, whether or not broken	43.78	120100	Soya beans, whether or not broken	30.59
100190	Wheat and meslin (other than seed)	23.26	100190	Wheat and meslin (other than seed)	25.54
151190	Palm oil and its fractions, refined but not chemically modified	18.27	100590	Maize (corn), other than seed	21.46
100300	Barley	14.34	100630	Semi-milled or wholly milled rice, whether or not polished or glazed	20.24
100630	Semi-milled or wholly milled rice, whether or not polished or glazed	14.16	151190	Palm oil and its fractions, refined but not chemically modified	15.04
100590	Maize (corn), other than seed	14.09	230400	Oil-cake and other solid residues, of soya-bean	12.15

				oil	
230400	Oil-cake and other solid residues, of soya-bean oil	14.05	020230	Frozen, boneless meat of bovine animals	12.04
170111	Cane sugar, raw, in solid form, without added flavouring or colouring	13.97	170111	Cane sugar, raw, in solid form, without added flavouring or colouring	11.38
020741	Frozen cuts and edible offal of fowls of the species Gallus domesticus (chicken), cuts and offal	11.09	100300	Barley	09.37
020230	Frozen, boneless meat of bovine animals	10.82	100610	Rice in the husk (paddy or rough)	08.93
150710	Crude soya-bean oil, whether or not degummed	10.78	210690	Food preparations, not elsewhere specified or included	08.79
220421	Wine of fresh grapes, in containers ≤ 2 litres	09.00	150710	Crude soya-bean oil, whether or not degummed	07.77
020721	Frozen cuts and edible offal of turkeys, cuts and offal	08.98	020329	Frozen, boneless meat of swine	06.94
010410	Live sheep	08.23	220421	Wine of fresh grapes, in containers ≤ 2 litres	06.09
020329	Frozen, boneless meat of swine	07.24	180100	Cocoa beans, whole or broken, raw or roasted	05.73
220820	Spirits obtained by distilling grape wine or grape marc (brandy)	06.87	010410	Live sheep	05.68
240120	Tobacco, partly or wholly stemmed/stripped	06.72	220300	Beer made from malt	05.62
170199	Cane or beet sugar & chemically pure	06.67	220820	Spirits obtained by distilling grape wine or	05.61

	sucrose, in solid form (other than raw, without added flavouring or colouring)			grape marc (brandy)	
120750	Mustard seeds, whether or not broken	06.50	160239	Prepared or preserved meat of bovine animals, other than sausages, not elsewhere specified	05.25
220830	Whiskies	05.99	170199	Cane or beet sugar & chemically pure sucrose, in solid form (other than raw, without added flavouring or colouring)	05.18

Source: Compiled by the author

Overall, the comparison suggests a transition from a heavy reliance on bulk raw commodities in 2011 to a more varied combination of cereals, livestock, and processed agricultural products by 2020, indicating that India's agricultural exports have slowly moved towards greater diversification and value addition, even as cereals and oilseeds remain the backbone of extensive margin growth.

Table 5.12 of major HS-6 agricultural products contributing to the intensive growth margin highlights the products where India deepened its export presence by expanding the scale of existing trade lines rather than adding new ones. In 2011, intensive growth was concentrated in a narrow range of products dominated by natural gums and plant-based extracts such as mucilages and thickeners from guar seeds and locust bean seeds, along with copra, groundnuts, and cotton linters. Oilcakes from groundnut and cottonseed, castor oil, and groundnut oil also figured prominently, showing that residues and oils from India's oilseed sector were central to sustaining export growth. Traditional livestock-based products like live goats and frozen bovine meat cuts were present but had a smaller role compared to plant-based commodities.

Table 5.12: Major HS-6 Agricultural products contributing to Intensive growth margin:

2011			2020		
HS Code	Product Type (HS-6 digit classification)	Intensive margin (%)	HS Code	Product Type (HS-6 digit classification)	Intensive margin (%)
130211	Opium alkaloids and their derivatives (mucilage and thickeners of locust bean seeds, guar seeds, etc.)	74.74	020421	Frozen cuts of bovine animals, bone-in	81.08
130232	Mucilages and thickeners, of locust bean seeds (carob gum)	71.92	151530	Castor oil and its fractions	51.12
230500	Oilcake and other solid residues of ground-nut (peanut) oil	60.63	100610	Rice in the husk (paddy or rough)	44.38
151530	Castor oil and its fractions	42.25	120730	Castor beans	37.03
120300	Copra	31.11	130232	Mucilages and thickeners, of locust bean seeds (carob gum)	36.87
120220	Ground-nuts (peanuts), shelled, whether or not broken	24.91	010420	Live goats	33.72
010420	Live goats	23.98	110610	Flour and meal of the dried leguminous vegetables	24.11
130190	Other natural gums, resins, gum-resins and oleoresins	21.08	230690	Oilcake and other solid residues, of vegetable fats and oils, n.e.s.	17.99
020421	Frozen cuts of bovine animals, bone-in	18.84	100630	Semi-milled or wholly milled rice, whether polished or glazed	17.61
230690	Oilcake and other residues of vegetable fats and oils, n.e.s.	18.48	160540	Prepared or preserved liver of any animal	17.14
150890	Ground-nut oil and its fractions, refined but not chemically modified	16.77	140420	Cotton linters	15.98

140420	Cotton linters	16.59	130190	Other natural gums, resins, gum-resins and oleoresins	15.44
240399	Other manufactured tobacco, n.e.s.	15.30	130211	Opium alkaloids and derivatives; mucilage and thickeners of guar seeds	10.61
230610	Oilcake and other residues of cottonseed oil	14.90	240290	Cigars, cheroots, cigarillos containing tobacco	10.38
120750	Mustard seeds, whether or not broken	12.33	130219	Other vegetable saps and extracts, n.e.s.	10.30
200110	Cucumbers and gherkins, prepared or preserved by vinegar or acetic acid	11.55	020629	Frozen edible offal of bovine animals, n.e.s.	09.99
120799	Oilseeds and oleaginous fruits, n.e.s., whether or not broken	10.02	120750	Mustard seeds, whether or not broken	09.61
110610	Flour and meal of dried leguminous vegetables	09.92	230610	Oilcake and other residues of cottonseed oil	09.60
100610	Rice in the husk (paddy or rough)	09.76	210130	Roasted chicory and other coffee substitutes	09.42
120740	Sesamum (sesame) seeds, whether or not broken	09.40	120220	Ground-nuts (peanuts), shelled, whether or not broken	09.19

Source: Compiled by the author

By 2020, the structure of intensive growth shifted significantly, reflecting diversification towards cereals, animal products, and processed food. Frozen bovine meat cuts became the single largest contributor with more than 80 percent share, indicating India's growing strength in meat exports. Castor oil and castor beans continued to feature prominently, but rice (both paddy and milled) emerged strongly, reflecting sustained demand for Indian rice in global markets. Other contributors included prepared or preserved meat products, mustard seeds, coffee substitutes, and manufactured tobacco products, which suggest gradual expansion into value-added and processed goods. Oilcakes and vegetable residues

remained part of the mix, though with reduced importance compared to 2011.

Overall, the comparison between 2011 and 2020 shows that India's intensive margin growth moved from being heavily concentrated in plant-based gums, oils, and residues to a more diversified basket that included cereals, livestock, and processed foods. This shift reflects both changing patterns of global demand and India's capacity to strengthen its foothold in higher-value segments such as bovine meat, rice, and castor-based exports, while still retaining traditional strengths in oilseeds and natural extracts.

Table 5.13 represents the intensive margin (%) and extensive margin (%) in terms of India's bilateral exports across three decades: 1991–2000, 2001–2010 and 2011–2020. For intensive margin, countries like Nepal (from 24.35% to 65.02%) and Iran (from 1.56% to 8.46%) showed significant increases in productivity, indicating improved efficiency and output in agricultural sectors. Bangladesh, however, experienced a slight decline from 16.14% to 15.15%, reflecting challenges in enhancing productivity.

For the extensive margin, countries like Bangladesh (from 85.67% to 99.16%) and Egypt (from 82.66% to 98.08%) showcased significant growth in product diversity, highlighting successful efforts in expanding their agricultural portfolios. Most countries, including China (from 82.20% to 94.38%) and Saudi Arabia (from 82.72% to 98.32%), displayed strong trends in the extensive margin, indicating effective diversification strategies. Countries like Germany and Japan also showed consistent increases in extensive margin percentages, suggesting robust diversification in mature agricultural markets.

Table 5.13: Share of the intensive and extensive margin with respect to bilateral trade partners:

Country	Intensive Margin (%)			Extensive Margin (%)		
	1991-2000	2001-2010	2011-2020	1991-2000	2001-2010	2011-2020
1. Bangladesh	16.14	15.79	15.15	85.67	97.47	99.16
2. China	0.47	2.33	1.09	82.20	95.86	94.38
3. Egypt	1.37	2.55	4.00	82.66	94.37	98.08

4. Germany	0.63	0.52	0.78	84.86	95.61	96.53
5. Hong Kong	1.33	1.54	2.10	88.27	97.40	98.08
6. Indonesia	1.35	2.34	2.82	85.87	96.52	97.32
7. Iran	1.56	3.64	8.46	88.55	97.07	99.28
8. Japan	0.92	0.68	0.93	76.11	94.44	95.17
9. Kuwait	2.53	4.22	5.25	80.52	95.16	98.52
10. Malaysia	0.68	1.53	2.64	87.42	97.46	96.92
11. Nepal	24.35	51.28	65.02	84.39	96.92	99.42
12. Netherlands	0.46	0.79	1.38	81.68	95.09	92.47
13. Russia	2.08	0.77	0.98	76.07	94.56	98.14
14. Saudi Arabia	2.16	3.89	5.79	82.72	95.17	98.32
15. Singapore	0.91	2.72	4.03	84.46	96.47	96.62
16. Thailand	0.92	1.42	2.02	82.42	96.60	96.17
17. UAE	7.23	11.45	15.65	87.47	94.30	98.03
18. UK	0.85	0.99	1.52	82.64	94.99	95.51
19. USA	0.89	1.13	2.13	82.40	95.68	95.83
20. Vietnam	1.26	2.17	3.06	83.25	95.80	98.63

Source: Compiled by the author

Overall, for the intensive margin, some countries showed growth while others faced stagnation or slight declines. The extensive margin reflects a trend toward greater product diversification across most countries, enhancing resilience and market opportunities in agriculture. Countries like Nepal, Iran, and Bangladesh demonstrated particularly high growth rates in their extensive margins, indicating strong market dynamics. On the other hand, the intensive margin displayed more variability, with some countries like Nepal and UAE showing marked improvements in productivity, while others like Russia exhibited fluctuations. The data indicate a significant push toward diversifying agricultural products while also striving for productivity enhancements, crucial for economic stability and food security.

5.3.3. Determinants of Trade Margins: Panel Data Analysis

Summary statistics of variables

Table 5.14: Summary statistics of variables:

Variables (Unit of Measurement)	Mean	Maximum	Minimum	Standard Deviation

1. Intensive margin (ratio)	0.054	0.876	0	0.114
2. Extensive margin (ratio)	0.922	0.999	0	0.082
3. Relative economic size (ratio)	0.939	33.990	-8.855	2.213
4. Population (million)	1.449	19.052	-22.347	2.137
5. Relative Agriculture value added (ratio)	0.402	1.948	0.001	0.447
6. Relative Economic freedom (ratio)	0.783	1.598	0.609	0.523
7. Distance (Kilometres)	4430.85	13568	1012	2746
8. Relative Crop Production (ratio)	1.151	5.399	0.105	0.501
9. Relative Purchasing Power	0.946	2.425	0.622	0.319
10. Trade Agreement (dummy)	0.3	1	0	0.459
11. Common Language (dummy)	0.4	1	0	0.490

Table 5.14 summarises the core economic variables used in the statistical analyses. During the study period, the dependent variables of intensive and extensive margins had a mean of 0.054 and 0.922, respectively. The corresponding standard deviations of the intensive and extensive margins were 0.114 and 0.082. The gap between the minimum and maximum values of both margins implies that there has been an increase in the export volumes of agricultural goods during the period of study. The relative economic size mean value of 0.939, close to 1, suggests that, on average, the countries in the dataset have similar economic sizes relative to India. This implies a balanced economic context among trading partners. The population mean of 1.449 implies that, on average, the populations of the trading countries are larger than a baseline (likely India's population). This could influence agricultural demand and trade volumes. The economic freedom index, with a mean of 0.783, indicates moderate economic freedom. This can reflect the ability of countries to engage freely in trade and could be correlated with agricultural export volumes. The distance variable with a mean of 4430.85 indicates that trade partners are, on average, quite

far from India. This could impact transportation costs and trade dynamics.

5.3.4. Diagnostic Tests

In panel data, common issues such as heteroscedasticity and autocorrelation were encountered. The Breusch-Pagan test was employed to identify group-wise heteroscedasticity, assessing the hypothesis of homoscedasticity that assumes consistent variances of the error term across units. The test yielded a statistically significant result ($\chi^2(1) = 381.49$, $p < 0.05$ for the extensive margin and $\chi^2(1) = 142.12$, $p < 0.05$ for the intensive margin), leading to the rejection of the homoscedasticity assumption. This implies that the variances of residuals are not independent of explanatory variables, indicating the presence of heteroscedasticity. The White test, with a value of $\chi^2(52) = 104.66$ for the extensive margin and $\chi^2(52) = 351.32$ for the intensive margin, similarly rejects the null hypothesis ($p < 0.05$) that the variances of residuals are independent of explanatory variables, providing further evidence of heteroscedasticity. The Woolridge test was employed to detect serial correlation. According to the test results ($\chi^2(20) = 3315.19$, $p < 0.05$ for the extensive margin and $\chi^2(20) = 98.37$, $p < 0.05$ for the intensive margin), the null hypothesis was rejected, representing the existence of autocorrelation in the error term.

5.3.5. Results of Gravity Model Estimation-FGLS and PPML

Table 5.15 represents the FGLS and PPML results of the impact of variables such as relative economic size, population of the partner country, relative agriculture value added, relative economic freedom, distance, relative crop production, relative purchasing power, and dummy variables representing trade agreements and common language on the intensive and extensive trade margins. The FGLS results indicate that the relative economic size, relative agricultural value added, relative economic freedom, distance, relative purchasing power, trade agreements and common language significantly affect

India's export of extensive and intensive margins. The variable relative economic size is significant and negative, indicating that a large size of the economy would lead to a smaller amount of progression in India's export of extensive and intensive trade margins (Pacheco & Pierola, 2008; Veeramani et al., 2018; Elumalai & Kumar, 2022). An increase in the relative economic size relates to a decline of 0.019 per cent in the extensive trade margin and 0.005 per cent in the intensive trade margin in India's agricultural exports. The coefficient of the population yielded negative results for the intensive margin and positive results for the extensive margin (Elumalai & Kumar, 2022). This implies that an increase in a partner country's population encourages diversifying the range of products rather than the intensification of exporting existing agricultural products. This phenomenon could be attributed to the long-term trading relationships India has established with its partner countries, which primarily involve the export of diverse products. The relative agriculture value added has a significant and positive impact on the intensive and extensive margins of trade (Liapis, P., 2009).

The significant effects show that the intensive margin of India's agricultural exports will grow by 0.356 per cent, and the extensive margin of India's agricultural exports will grow by 0.647 per cent with an increase in relative agriculture value added.

Table 5.15: FGLS and PPML results for Intensive and Extensive Margins of India's Agricultural exports

Explanatory Variables	FGLS		PPML	
	Intensive Margin	Extensive Margin	Intensive Margin	Extensive Margin
Relative economic size	-0.001 (0.423)	-0.005 (0.000) ***	-0.043 (0.132)	-0.004 (0.151)
Population	0.001 (0.464)	0.001 (0.536)	0.023 (0.072)*	0.001 (0.632)
Relative agriculture	0.112	-0.016	0.152	-0.008

value added	(0.000)***	(0.092)*	(0.338)	(0.410)
Relative Economic freedom	0.040 (0.000)***	0.038 (0.000)***	0.242 (0.000)***	0.082 (0.000)***
Ln_ Distance	-0.059 (0.000)***	-0.023 (0.001)***	-1.588 (0.000)***	-0.273 (0.000)***
Relative crop production	0.007 (0.308)	-0.011 (0.026)**	0.787 (0.074)*	-0.115 (0.042)**
Relative purchasing power	-0.014 (0.049)**	0.522 (0.000)***	0.458 (0.000)***	0.537 (0.000)***
D1_Trade agreement	-0.009 (0.278)	0.0176 (0.016)**	0.421 (0.000)***	0.0147 (0.025)**
D2_Common language	0.064 (0.000)***	0.003 (0.561)	0.724 (0.000)***	0.007 (0.228)
Constant	0.453 (0.000)***	1.051 (0.000)***	8.148 (0.000)***	0.376 (0.510)
χ^2 (9)	741.22	353.94	12.17	3.156
Number of observations	600	600	600	600
Log-likelihood	692.74	911.47	-86.94	-579.75

Notes: *, **, and *** signify significance levels of 10%, 5%, and 1%, respectively.

Nonetheless, the relative economic freedom has a significant impact of 0.159 on the intensive margin and 0.272 on the extensive margin. Similarly, distance has significant undesirable impacts on trade margins. As anticipated, the coefficient for distance was negative and exhibited statistical significance (Pacheco & Pierola, 2008; Elumalai & Kumar, 2022; Lawless, M., 2010; Ngugi, T., 2015). As distance is considered a proxy for trade cost, an increase in trade cost results in a reduction of bilateral trade flows between the countries. The relative crop production has a positive impact of 0.017 per cent on extensive margins and 0.494 per cent on the intensive trade margin. The relative purchasing power has a negative but significant influence on the double margins of trade. Trade agreements bolster both the intensive and extensive margins of agricultural exports.

The coefficient of trade agreements has a positive and significant impact on the extensive and intensive trade margin (Pacheco & Pierola, 2008; Veeramani et al., 2018). Likewise, the language variable is conducive towards the dual margins of trade (Elumalai & Kumar, 2022; Ngugi T., 2015). The presence of a common language facilitates easy communication between nations and reduces the costs of trade.

Additionally, Table 5.15 represents the PPML results of the impact of variables on the intensive and extensive trade margins. The PPML results indicate that the relative economic size, relative agricultural value added, relative economic freedom, distance, relative crop production, relative purchasing power, trade agreements and common language significantly affect India's export of extensive and intensive margins. The variable relative economic size is negative for both margins, but only significant for the intensive margin of trade. The coefficient of the population yielded negative results for the intensive margin and positive results for the extensive margin (Elumalai & Kumar, 2022). The relative agriculture value added has a significant but negative impact on the extensive margin of trade (Liapis P., 2009). The relative economic freedom variable has a significant impact of 1.221 on the intensive margin. Similarly, distance has significant undesirable impacts on both trade margins. (Pacheco & Pierola, 2008; Elumalai & Kumar, 2022; Lawless M., 2010; Ngugi T., 2015). The relative crop production has a significant positive impact of 0.433 per cent on the intensive trade margin. The relative purchasing power has a negative but significant influence on the double margins of trade. The coefficient of trade agreements and language variables is conducive towards the dual margins of trade (Pacheco & Pierola, 2008; Veeramani et al., 2018; Elumalai & Kumar, 2022; Ngugi T., 2015). The statistically significant impact of distance, trade agreement, and common language in both models suggests that when trading partners are in closer proximity, share a trade agreement, or have a common language, they are more likely to engage in greater

trade compared to countries without close distance, trade agreements or a common language.

When the gravity model is estimated using the FGLS and PPML approaches, it was found that the PPML results for intensive and extensive margins are consistent and in agreement with the FGLS model. The PPML model has a significantly greater magnitude of coefficients of the independent variables than the FGLS model. The variables of relative economic freedom, distance, relative purchasing power, trade agreements and common language are significant in both estimation models. However, under the FGLS model, the relative economic size, relative agriculture value added, and relative economic freedom are significant for both the margins but under the PPML model, relative economic size is significant only for intensive margin, relative agriculture value added is significant only for extensive margin, relative economic freedom is significant for the intensive margin, and the relative crop production is significant only for the intensive margin.

Each variable has a significant impact on the twofold margins of export growth in agricultural products. The gravity model of trade flows is divided into intensive and extensive trade margins. Bilateral export growth can be maintained at a steady level by making necessary structural adjustments to promote India's exports.

5.4. Discussion

The Constant Market Share (CMS) decomposition of India's agricultural exports from 1991 to 2020 illustrates a clear transformation in the underlying sources of growth. In the first decade (1991–2000), India's export performance was predominantly driven by the 'scale effect', highlighting the role of rising global demand rather than domestic competitiveness. Products such as live animals, dairy, and coffee, tea and spices registered remarkable demand-led growth, yet most commodities displayed weak or negative competitive effects, suggesting limited capacity to translate global opportunities into

sustained advantage. Notable exceptions were modest competitive gains in fish, animal/vegetable oils, and gums and resins. The ‘second order’ effect was largely insignificant, except in a few cases such as sugar, where demand growth coincided with stronger competitive positioning. At the partner level, India demonstrated resilience in select Asian markets (Vietnam and Hong Kong), where positive competitive and second-order effects offset negative scale effects, while in traditional markets such as Germany and the UK, poor competitiveness constrained growth. These findings are consistent with Kumar (2022) and Singh (2014), who emphasise the dominance of demand-side factors in shaping India's agricultural export performance during the 1990s.

The second decade (2001–2010) reflected gradual structural adjustment, as competitiveness began to strengthen in several product categories. While the scale effect continued to underpin growth, especially in sugar, edible fruits, and live trees, the competitive effect improved notably in live animals, products of animal origin, tobacco, and processed meat/fish products, reflecting gains in efficiency and supply capacity. Positive second-order effects became more visible in this period, indicating that structural shifts were increasingly reinforcing competitiveness, particularly in animal-based exports. At the destination level, demand remained the main driver in Russia, Singapore, and Bangladesh, though competitiveness weakened in Russia and Singapore. Meanwhile, modest improvements were evident in Iran, Malaysia, and Hong Kong, pointing to a more diversified market orientation. These shifts align with Chaoudhari (2024) and Singh (2019), who attribute the post-reform strengthening of agricultural exports to liberalisation measures, diversification strategies, and rising integration with global value chains.

For the last decade (2011–2020), the competitive effect emerged as the dominant driver of export performance, marking a structural break from earlier demand-driven patterns. India recorded substantial competitive gains in tobacco, meat, cereals, and oilseeds, underscoring

the role of value addition, quality upgrading, and improved market targeting. The scale effect, while still relevant in products like edible fruits, sugar, and live trees, was less central than in previous decades. Interestingly, in some sectors (oilseeds, tobacco); India was able to record competitive gains despite negative scale effects, reflecting a more proactive export strategy. However, the second-order effect remained inconsistent, strongly positive in sugar, live animals, and plaiting materials, but significantly negative in products such as edible fruit and tobacco, where structural constraints continued to limit long-term gains. At the partner level, Bangladesh emerged as both a major demand and competitiveness driver, although its performance was undermined by a large negative second-order effect. Other partners, such as Singapore, the UK, and Hong Kong, showed moderate competitive improvements, while Vietnam benefited from favourable structural shifts despite declining competitiveness. These results both confirm and extend the findings of Kumar (2022), who stresses the enduring importance of demand, but also highlight a stronger competitive dimension in the 2010s than earlier studies suggest.

Taken together, the CMS results demonstrate that India's agricultural exports have evolved from being scale-driven in the 1990s to increasingly competitiveness-driven in the 2010s, with second-order effects playing only a limited supporting role. Sustaining this transition will require policy support to consolidate competitiveness in high-performing products such as tobacco, meat, and cereals, while addressing second-order structural weaknesses through investment in infrastructure, logistics, market intelligence, and innovation.

The decomposition of India's agricultural exports into intensive and extensive margins provides important insights into the sources of trade growth across products, destinations, and determinants. At the product level, the results indicate that while intensive margins have grown in selected categories, the extensive margin has been the dominant channel of expansion. Commodities such as meat, cereals, and lac products exhibited sharp increases

in intensive margins, reflecting improvements in production efficiency, value addition, and export capacity. By contrast, products like edible fruits and animal-origin products recorded declines, suggesting either market saturation or structural bottlenecks in competitiveness. The extensive margin, however, showed strong upward trends across most product categories, particularly in cereals, sugar, dairy, and oilseeds, highlighting that India's agricultural export growth has been largely driven by diversification into new products and market niches rather than intensification of existing ones. This finding is consistent with Besedes and Prusa (2011), who argued that export growth in developing countries tends to rely more on extensive margins through diversification, while intensive growth plays a relatively smaller role.

At the bilateral partner level, a similar pattern emerges. Countries such as Nepal and Iran experienced notable gains in intensive margins, indicating strengthened productivity and deeper export engagement. On the other hand, Bangladesh, despite a slight decline in intensive margins, registered one of the strongest gains in extensive margins, pointing toward diversification as the primary source of export growth. The majority of India's trading partners, including China, Saudi Arabia, Germany, and Japan, exhibited robust increases in extensive margins, reflecting India's ability to expand its product portfolio across both emerging and mature markets. These results suggest that India's agricultural trade integration has been characterised more by widening the scope of exports than by deepening existing flows. Similar patterns have been observed in other studies, such as Amiti and Freund (2010) and Hummels and Klenow (2005), who highlighted that extensive margins are critical in explaining the export growth trajectories of developing economies, especially in agriculture.

These findings provide clear empirical support for the study's hypothesis (H3), which posited that extensive margins contribute more significantly to export growth than

intensive margins. The observed predominance of extensive-margin expansion across products such as cereals, sugar, dairy, and oilseeds, as well as across major and emerging partner markets like Bangladesh, China, and Saudi Arabia, confirms that India's agricultural export growth has been primarily driven by diversification into new products and destinations rather than by deepening existing trade flows. While intensive margins have contributed to growth in select categories such as meat, cereals, and lac products, their overall impact remains secondary relative to the extensive margin. This aligns with prior empirical evidence for developing countries (Besedes & Prusa, 2011; Kehoe & Ruhl, 2013) and underscores the importance of export diversification as a structural driver of long-term competitiveness.

The econometric analysis of determinants further reinforces these dynamics. The gravity model results, using both FGLS and PPML estimations, show that relative agricultural value added, economic freedom, trade agreements, and common language are significant drivers of both intensive and extensive margins. Distance consistently exhibited a negative effect, underscoring the trade-cost disadvantages faced in geographically distant markets (Lawless, 2010; Pacheco & Pierola, 2008). Interestingly, the population of partner countries was found to have a positive impact on the extensive margin but a negative effect on the intensive margin, suggesting that larger populations encourage diversification into a broader product range rather than intensification of existing exports (Elumalai & Kumar, 2022). The findings also highlight the constraining role of relative economic size, where larger economies tend to dampen India's margins, possibly due to higher competition and stricter market requirements. These results resonate with Veeramani et al. (2018), who noted that structural and institutional factors, including trade agreements, play a pivotal role in shaping India's agricultural export margins.

Taken together, the trade margins analysis indicates that India's agricultural export growth

over the last three decades has been primarily extensive in nature, with gradual but uneven improvements in intensive margins. Product diversification and partner-market expansion have been central to sustaining growth, while structural factors such as agricultural value added, trade liberalisation, and institutional proximity (e.g., trade agreements and language) have enabled greater integration. However, the relatively weaker performance of intensive margins in certain categories underscores the need for policy interventions aimed at upgrading product quality, improving infrastructure, and fostering value addition to achieve sustained competitiveness. These findings are in line with Hummels and Klenow (2005) and Besedes and Prusa (2011), who emphasise that while diversification drives initial export expansion, long-term trade growth requires strengthening intensive margins through productivity and competitiveness gains.

5.5. Conclusions

The combined evidence from the Constant Market Share (CMS) decomposition and trade margin analysis provides a comprehensive understanding of India's agricultural export dynamics over the past three decades. The CMS results reveal a clear evolution in the sources of export growth. During the 1990s, India's agricultural exports were largely demand-driven, with the scale effect emerging as the dominant contributor. This indicates that export expansion in this period was mainly supported by favourable global demand conditions rather than improvements in India's relative competitiveness.

In the subsequent decades, particularly during the 2000s and 2010s, a gradual shift toward competitiveness-driven growth is observed in selected commodities such as tobacco, cereals, and meat products. These gains reflect improvements in productivity, quality upgrading, and enhanced market access. However, the uneven contribution of second-order

and interaction effects across products and periods points to persistent structural rigidities and uneven adjustment within the agricultural export sector.

At the partner-country level, the CMS analysis highlights India's relative resilience and growing presence in several Asian and developing markets. Proximity, lower transportation costs, and rising demand have enabled India to sustain or improve market shares in these destinations. In contrast, traditional high-income markets, particularly the European Union, remain challenging due to stringent sanitary and phytosanitary standards, complex regulatory requirements, and intense competition. India's agricultural export growth is largely driven by extensive margin diversification into new products and markets, while limited intensive gains and high trade costs constrain deeper market penetration.

CHAPTER VI

IMPACT OF EXCHANGE RATE ON AGRICULTURAL EXPORTS IN INDIA

6.1. Introduction

Exchange rates play a critical role in shaping a country's trade performance and overall macroeconomic stability. The exchange rate, defined as the price of one currency in terms of another, serves as a key determinant of a nation's external competitiveness, influencing both export and import dynamics. Movements in exchange rates can either stimulate or dampen trade flows: a depreciation of the domestic currency tends to make exports cheaper and more competitive abroad, while an appreciation renders them costlier and less attractive to foreign buyers. Hence, understanding the direction and magnitude of exchange rate movements becomes essential for evaluating their impact on a country's trade balance, particularly in a developing economy like India that relies heavily on exports of agricultural and agro-based commodities.

The stability of the exchange rate is closely tied to broader macroeconomic objectives such as growth, employment, and price stability. Volatile exchange rate movements can introduce uncertainty in trade transactions, affect producers' pricing strategies, and distort resource allocation between tradable and non-tradable sectors. For this reason, the exchange rate regime adopted by a country, whether fixed, floating, or managed, has significant implications for trade and investment decisions. India's experience reflects an evolving exchange rate management system. Until the early 1990s, India maintained a fixed exchange rate pegged to the US dollar. However, as part of its post-1991 liberalisation reforms, the country adopted a market-determined exchange rate system in 1993. Since then, the Reserve Bank of India (RBI) has followed a managed float regime, intervening periodically to curb excessive volatility while allowing market forces to determine the rupee's value.

Over the past three decades, India has witnessed distinct phases in its exchange rate behaviour. Between 2000 and 2004, the rupee faced pressure to appreciate due to capital inflows and strong economic growth momentum, prompting the RBI to intervene and accumulate reserves. The subsequent period (2004–2008) saw a similar trend of reserve build-up in response to foreign exchange inflows. The global financial crisis of 2008–2013 marked a reversal, with the rupee experiencing depreciation pressures due to global uncertainty and capital outflows. From 2013 to 2020, the RBI maintained active management in both spot and forward markets to prevent excessive fluctuations. These alternating phases highlight the balancing act between maintaining competitiveness and ensuring macroeconomic stability, two objectives that often move in opposite directions.

The relationship between exchange rates and trade has long been a subject of empirical inquiry. Classical and modern theories of international trade both acknowledge that relative prices shaped by exchange rate movements play a pivotal role in determining export performance. In the agricultural sector, this linkage is particularly strong due to the sector's sensitivity to price competitiveness and external demand. A stronger domestic currency can reduce export revenues by making agricultural commodities more expensive abroad, while a weaker currency can boost exports but may raise import costs of essential inputs such as fertilisers, machinery, and fuel. The net effect depends on the elasticity of supply and demand, the production structure, and the degree of integration into global value chains.

Historically, the role of exchange rates in agricultural trade was first articulated by Schuh (1974), who argued that an overvalued currency reduces farm profitability and export competitiveness by inflating domestic prices relative to world prices. Later studies expanded on this argument by incorporating exchange rate volatility as a critical factor influencing trade flows. High volatility introduces uncertainty in exporters' earnings,

detering long-term contracts and reducing the incentive to trade. However, the relationship is not always symmetric; under certain conditions, firms with access to hedging mechanisms or flexible production systems may still benefit from volatility by adjusting their output or pricing strategies.

Empirical research since the 1970s has produced mixed evidence on the effect of exchange rate volatility on trade flows. Early models, such as those of Ethier (1973) and Clark (1973), predicted a negative impact, arguing that uncertainty in future exchange rates discourages risk-averse exporters. Later studies, including De Grauwe (1988) and Franke (1991), suggested that some firms might increase exports in response to volatility to offset expected revenue losses. These contrasting findings underscore the complexity of exchange rate–trade dynamics, particularly when other macroeconomic and structural variables, such as income levels, tariffs, and production capacity, interact simultaneously.

In the Indian context, the agricultural export sector presents a compelling case for studying the exchange rate–trade nexus. Agriculture remains a cornerstone of India’s export basket, contributing substantially to rural employment and foreign exchange earnings. Yet, the sector’s export performance is often vulnerable to exchange rate fluctuations, changes in global demand, and domestic supply constraints. For instance, during periods of rupee appreciation such as 2006–2008, many exporters experienced reduced profit margins, consistent with evidence that real effective exchange-rate appreciation weakens the export performance of Indian firms (Cheung & Sengupta, 2012). Conversely, empirical studies show that rupee depreciation tends to stimulate agricultural trade, and Chand (2010) attributes part of the rise in India’s agricultural net exports during 2007–08 to the depreciation of the rupee.

This chapter analyses the impact of exchange rates on agricultural exports in India in the post-reform period. Based on the theoretical insights and empirical evidence observed, this

objective leads to the following hypothesis,

H4: Exchange rate depreciation positively influences India's agricultural exports in the long run.

This hypothesis is examined using disaggregated data at the HS-2 level across 24 agricultural product categories and the top trading partners for each product, enabling the identification of product-specific sensitivities to exchange rate fluctuations.

Given these dynamics, this chapter empirically investigates the relationship between the Exchange Rate (ER) and India's agricultural exports to its major trading partners from 1991 to 2020. The study employs a comprehensive panel dataset disaggregated at the HS-2 level across 24 agricultural product categories and the top 10 partner countries for each product. This disaggregation allows for the identification of commodity-specific sensitivities to exchange rate changes, recognising that the impact of currency fluctuations is unlikely to be uniform across products or markets. The subsequent sections of this chapter empirically examine these relationships for India's agricultural sector, focusing on how both exchange rate levels and volatility influence export performance across products and trading partners during the period 1991–2020.

While several studies have examined the determinants of India's agricultural exports, most have relied on aggregate trade data or short-term cross-sectional analyses, often ignoring product-level heterogeneity and dynamic interactions with trading partners. Specifically, the role of exchange rates has not been systematically analysed across a long-term, disaggregated panel spanning multiple HS-2 agricultural product categories and top trading partners. Previous studies have largely focused on OLS-based gravity models or examined trade flows at an aggregate level, which are incapable of capturing zero trade flows, endogeneity, and the distinction between short- and long-run dynamics. Moreover, the use of multi-method approaches, Poisson Pseudo Maximum Likelihood (PPML) gravity models, System Generalised Method of Moments (GMM), and Pooled Mean Group-

Autoregressive Distributed Lag (PMG-ARDL), to jointly address heterogeneity, dynamic effects, and co-integration relationships in India's agricultural exports remains scarce. Consequently, there is a need for a comprehensive, product-level, and long-term empirical investigation to rigorously quantify the short and long-run effects of exchange rates and their volatility on India's agricultural export performance in the post-reform period.

6.2. Methodology

6.2.1. Data and Variables

This study examines the determinants of India's agricultural exports to its top ten trading partners for each HS-2 product category from 1991 to 2020. The dataset is an unbalanced annual panel at the HS-2 digit product level, comprising country-product-year observations. In total, the sample comprises 24 agricultural product categories and the top 10 major partner countries for each category, resulting in over 7,000 panel observations. The dependent variable is India's agricultural exports, measured in US dollars.

The key explanatory variable is the Exchange Rate (ER) of partner countries. The bilateral exchange rate is derived by dividing the partner country's nominal exchange rate by India's nominal exchange rate to obtain the relative value of the partner country's currency against the Indian rupee. A higher value indicates a depreciation of the Indian rupee (or appreciation of the partner currency), while a lower value implies an appreciation of the rupee. The study employs nominal exchange rates rather than the Real Effective Exchange Rate (REER), as the nominal rate more directly captures the bilateral price relationship relevant for trade flows in gravity models. Several studies have emphasised the point that the nominal exchange rate is more appropriate in bilateral gravity frameworks, as it reflects the actual conversion rate affecting exporters and importers, whereas REER incorporates multilateral and price-level adjustments that may obscure bilateral effects (Majumdar & Basu, 2023; Kubendran et al., 2015; Bhanja et al., 2013; Rose, 2000; Baier & Bergstrand,

2001; Martínez-Zarzoso & Nowak-Lehmann, 2003). Based on the empirical tradition in both Indian and international contexts, this study employed the nominal bilateral exchange rate to assess its direct influence on India's agricultural export flows. Control variables are drawn from the standard gravity model framework. These include the Gross Domestic Product (GDP) of the partner country; India's Agricultural Production (IAP); the World Agricultural Price Index (WAP); partner countries' tariff rates on Indian agricultural exports; and geographical Distance. All continuous variables were log-transformed to reduce skewness and facilitate the interpretation of coefficients as elasticities. Data sources include the World Bank, IMF, FAO, WITS, and CEPII. The definitions of significant variables used in the study are presented in Table 6.1.

Table 6.1.: Description of variables:

Variables	Type of Variable	Descriptions	Source
1. Agricultural Exports	Dependent variable	India's agricultural exports to the top 10 partner countries, measured in US dollars, disaggregated by HS-2 digit products.	WITS
2. Exchange Rate (ER)	Main independent variable	The bilateral exchange rate is derived by dividing the partner country's official exchange rate by India's exchange rate to obtain the relative value of the partner country's currency against the Indian rupee.	IMF
3. Gross Domestic Product (GDP)	Control variable	GDP of the partner country, measured in constant US dollars, reflecting the economic size and market potential of the importing country.	World Bank
4. India's Agricultural Production (IAP)	Control variable	Total agricultural output in India, measured in physical quantity or value terms, for crops relevant to HS-2 agricultural products.	World Bank
5. World Agricultural	Control variable	Annual average of global food commodity prices, capturing overall trends in international	FAO

Price (WAP)		agricultural markets.	
6. Tariff	Control variable	The partner country's effective tariff rate on India's agricultural exports, expressed as a percentage of the export value, capturing both applied tariffs and trade-weighted adjustments.	WITS
7. Distance	Control variable	Geographical Distance between India and its trading partner countries, measured in kilometres; used as a proxy for transportation costs and trade frictions.	CEPII

1) **Exchange Rate (ER):** The bilateral exchange rate is derived by dividing the partner country's official exchange rate by India's exchange rate, both originally expressed against the US dollar, to obtain the relative value of the partner country's currency vis-à-vis the Indian rupee.. A higher bilateral exchange rate indicates a depreciation of the Indian rupee (or appreciation of the partner country's currency), making Indian agricultural exports relatively cheaper and more competitive in that market. Conversely, a lower rate implies an appreciation of the rupee, which can make exports more expensive and reduce competitiveness. This relationship is particularly important for agricultural products, which are generally price-sensitive and traded in highly competitive international markets. Fluctuations in bilateral exchange rates capture the price competitiveness effect and the potential pass-through of exchange rate movements to export prices. Empirical evidence (Choudhri & Khan, 2002; Krueger, 1983; Goldberg & Knetter, 1997) suggests that exchange rate dynamics have a significant influence on export volumes and trade balances, with the magnitude of the impact varying across products and trading partners. In India's case, such movements can affect the export performance of bulk commodities, such as rice or sugar, differently from high-value agricultural products, including spices, fruits, or processed goods, underscoring the diverse effects of currency changes across sectors.

2) **Gross Domestic Product (GDP):** The GDP of partner countries serves as a proxy for economic size, income levels, and market potential. A larger GDP indicates greater aggregate purchasing power, which is often associated with higher demand for imported goods, including food and agricultural commodities. This variable captures the demand-side effect: countries with higher GDP are more likely to import a diverse range of agricultural products, including higher-value items, whereas smaller economies may have more constrained demand. GDP growth in partner countries can also signal changes in consumer preferences, dietary diversification, and increased consumption of processed or speciality food products, thereby expanding export opportunities for India. The relationship between partner-country GDP and Indian agricultural exports aligns with the predictions of trade gravity models, which posit that larger economies trade more, *ceteris paribus* (Helpman, Melitz, & Rubinstein, 2008).

3) **India's Agricultural Production (IAP):** Domestic agricultural output is a key supply-side determinant of export capacity. Higher production enables India to generate a larger exportable surplus, supporting sustained or increased international trade. Conversely, low production levels, whether due to adverse weather, natural disasters, or structural constraints, can limit exports regardless of global demand conditions. IAP is critical for understanding supply responsiveness, as the ability to meet external demand depends on the adequacy of domestic production for different crop categories. Seasonal and annual fluctuations in production also impact price stability and export competitiveness, as high domestic output can depress domestic prices, making exports more attractive, while low output can restrict supply and increase domestic prices, potentially reducing the quantity of exports available (Baffes & Dennis, 2013).

4) **World Agricultural Price (WAP):** The global price index of agricultural commodities reflects prevailing trends in international markets, influencing both the revenue potential and competitiveness of Indian exports. Rising world prices increase the profitability of exports, making them more attractive to producers and exporters, while falling prices may discourage trade if domestic production costs are relatively high. WAP also captures terms-of-trade effects for India: favourable global prices improve export revenues and trade balance, whereas adverse price movements may reduce export earnings. Price fluctuations are particularly significant for commodities that are globally traded and exposed to demand shocks, policy changes, or speculative activity (FAO, 2020). Consequently, WAP serves as a critical indicator of India's integration into global agricultural markets and its exposure to international price volatility.

5) **Tariff:** The effective tariff rate imposed by partner countries on Indian agricultural products represents a policy-induced trade barrier. Higher tariffs increase the landed cost of Indian exports, reducing their price competitiveness relative to local or alternative foreign suppliers, which may potentially lower trade volumes. Conversely, tariff reductions through bilateral or multilateral trade agreements enhance market access and can stimulate exports. Tariffs also reflect regulatory, institutional, and protectionist tendencies in the partner country, making them an important factor in export strategy and trade negotiations. Empirical research indicates that tariff liberalisation often correlates with increased agricultural trade flows, emphasising the importance of policy measures in shaping export performance (Anderson & Nelgen, 2012).

6) **Distance:** Geographic Distance between India and its trading partners proxies for transportation costs, delivery times, and logistical complexity. Greater distances generally imply higher shipping costs, longer transit periods, and increased risk of spoilage for perishable agricultural goods, which can reduce trade volumes. Distance also reflects the practical constraints of trade, including the quality of infrastructure, port efficiency, and supply chain reliability. According to the gravity model of trade, Distance negatively affects trade flows, with more distant partners trading less, all else equal (Tinbergen, 1962). For India's agricultural exports, which comprise both perishable and non-perishable products, Distance interacts with transportation and storage technology to determine the actual feasibility and competitiveness of exports.

Interaction of Control Variables with ER: Collectively, the control variables (GDP, IAP, WAP, tariffs, and Distance) determine the broader context in which exchange rate movements operate. GDP and WAP capture demand-side potential, while IAP reflects supply-side capability. Tariffs and Distance act as trade frictions that influence how effectively changes in ER translate into export volumes. Understanding the interplay of these variables allows for a more nuanced assessment of India's agricultural export dynamics, highlighting the combined effects of domestic production, global market conditions, partner-country policies, and transportation constraints.

6.2.2. Econometric Model

This study employs a multi-method econometric approach to capture both short and long-term determinants of India's agricultural exports, addressing potential endogeneity, heterogeneity, and dynamic relationships in the panel data. The methods are chosen sequentially to ensure robustness and clarity in identifying the drivers of trade patterns.

1) Panel Unit Root and Co-integration Tests

To examine the stationarity properties of the panel data, panel unit root tests were conducted

for all time-varying variables. Stationarity in data is essential in panel data analysis to avoid spurious regression results. All variables were tested except for $\ln_Distance$, which was excluded as it is time-invariant across country pairs. Following standard practice in the literature, the Fisher-type panel unit root test was applied. This test combines the results of individual unit root tests across cross-sectional units and tests the null hypothesis that all panels contain a unit root (non-stationary) against the alternative that at least one panel is stationary.

To examine the long-run relationship among India's agricultural exports and the key explanatory variables, a panel co-integration test was conducted. This test determines whether a group of non-stationary and stationary variables share a stable long-run equilibrium relationship across cross-sectional units, thereby avoiding spurious regression results. The study employed the Kao residual-based test, which tests the null hypothesis of no co-integration against the alternative of co-integration.

2) Poisson Pseudo Maximum Likelihood (PPML) Gravity Model

To estimate the impact of bilateral trade determinants on India's agricultural exports, the PPML gravity model was employed. PPML is preferred over OLS because it accounts for heteroskedasticity and the presence of zero trade flows, which are common in disaggregated agricultural export data. The baseline model includes ER, GDP, IAP, WAP, tariffs, and Distance as explanatory variables. To account for product-specific heterogeneity, product-level PPML models were estimated for each HS-2 digit category. This approach allows capturing the differential responsiveness of agricultural exports across commodities to trade costs, production, and global prices.

The specification of the Poisson Pseudo Maximum Likelihood (PPML) gravity model is given below,

$$\ln Exports_{ijt} = \alpha + \beta \ln ER_{jt} + \gamma' X_{ijt} + \mu_i + \nu_j + \tau_t + \nu_{ij} + \epsilon_{ijt}$$

where $Exports_{ijt}$ is the export value of product iii from India to partner j in year t ; ER_{jt} is the real effective exchange rate of partner j ; X_{ijt} is a vector of control variables including GDP, India's agricultural production, world agricultural prices, tariffs, and Distance; μ_i , ν_j , τ_t , ν_{ij} represent product, partner, year, and country-pair fixed effects and ϵ_{ijt} is the error term.

3) System GMM Estimation

To address potential endogeneity among explanatory variables, particularly ER, the study applies the System Generalised Method of Moments (System GMM) estimator. Distance is used as an instrument, given its exogeneity and time-invariant nature. System GMM provides consistent estimates in the presence of endogenous regressors and dynamic panel structures.

$$\ln Exports_{ijt} = \alpha + \delta \ln Exports_{ijt-1} + \beta \ln ER_{jt} + \gamma' X_{ijt} + \mu_i + \nu_j + \tau_t + \epsilon_{ijt}$$

System GMM provides consistent and efficient estimates in the presence of endogenous regressors, unobserved country-specific effects, and dynamic panel structures. Robust standard errors are employed to correct for heteroskedasticity and autocorrelation.

4) PMG-ARDL Approach

The Pooled Mean Group (PMG) Autoregressive Distributed Lag (ARDL) model is employed to differentiate between short-run and long-run effects of determinants on agricultural exports. This method is particularly suitable for panels with a large time dimension and allows for heterogeneous short-run dynamics while imposing long-run homogeneity across countries.

$$\Delta \ln Exports_{ijt} = \lambda (\ln Exports_{ijt} - 1) - \theta_1 (ER_{ijt} - 1) - \phi' X_{ijt} - 1 + \sum \beta \Delta \ln (ER_{ijt}) + \sum \gamma \Delta X_{ijt} + \epsilon_{ijt}$$

Where, λ = speed of adjustment toward the long-run equilibrium; θ_1, ϕ = long-run coefficients of ER and other covariates X_{ijt} ; β_k, γ_k = short-run coefficients of ER and other covariates and ϵ_{ijt} = error term.

5) Robustness Checks: ER Volatility

To ensure the robustness of the results, the PPML model was augmented with a measure of exchange rate volatility to examine whether currency fluctuations affect India's agricultural exports.

$$\ln \text{Exports}_{ijt} = \alpha + \beta \ln \text{ER}_{jt} + \gamma' X_{ijt} + \delta \text{Volatility}_{jt} + \mu_i + \nu_j + \tau_t + \nu_{ij} + \epsilon_{ijt}$$

Where, Exports_{ijt} = value of agricultural exports of product iii from India to partner j in year t ; ER_{jt} = real effective exchange rate of partner j ; X_{ijt} = vector of control variables (GDP, India's agricultural production, world agricultural prices, tariffs, Distance); Volatility_{jt} = measure of ER volatility for partner j ; $\mu_i, \nu_j, \tau_t, \nu_{ij}$ = product, partner, year, and country-pair fixed effects and ϵ_{ijt} = error term

6.3. Results:

6.3.1 Summary statistics of variables:

Table 6.2: Descriptive statistics of variables:

Variables (Unit of Measurement)	Mean	Standard Deviation	Minimum	Maximum
Agricultural Exports (USD)	51766.18	155536.4	0.03	5250059
Exchange Rate (INR per partner currency)	157147.0	734106.0	0.002	4127608
Gross Domestic Product (USD)	2.12	4.04	0.000244	14235.40
India's Agricultural Production	77.26	21.20	49.3	120.12

(Index, 2015 = 100)				
World Agricultural Price World Agricultural Price (Index, 2014–2016 = 100)	88.78	14.95	67.1	118.80
Tariff (%)	7.37	9.34	0.01	91.27
Distance (Kilometres)	5052.21	3151.51	688.8	14235.4

Source: Computed by Author

Table 6.2 presents the descriptive statistics of the key variables used in the analysis of India's agricultural exports. The summary table provides the mean, standard deviation, the range, providing an overview of the data distribution and variability over the study period. India's agricultural exports average USD 51,766, with high variability across products and partners. The Exchange Rate (ER) shows a mean of 157,147, indicating substantial fluctuations in India's trade-weighted currency values over the period. Partner country GDP averages 2.12, reflecting diverse economic sizes. India's agricultural production and world agricultural prices exhibit moderate variation, with means of 77.26 and 88.78, respectively. Applied tariffs vary widely (0.01–91.27%), and the average geographical Distance to trading partners is 5,052 km. These statistics provide an overview of the scale, variation, and distribution of the variables used in the analysis.

6.3.2 Unit Root Test

Panel unit root tests were conducted using the Fisher test, which allows for heterogeneous dynamics across panels. The test combines information from all cross-sectional units to determine the overall stationarity of each variable. Only the Fisher panel unit root test is reported here, as it accommodates heterogeneous dynamics across cross-sections and provides robust results. The results indicate a mixed order of integration among the variables.

Table 6.3 presents the results of panel unit root tests for the key variables. Agricultural

exports (ln_Exports), the Exchange Rate (ln_ER), and tariffs (ln_Tariff) are stationary at level (I(0)), indicating that these variables do not exhibit persistent trends over time. In contrast, partner country GDP (ln_GDP), India's agricultural production (ln_IAP), and world agricultural prices (ln_WAP) are non-stationary at level and integrated of order one (I(1)), implying they contain stochastic trends. The geographical distance variable (ln_Distance) is excluded from the test due to its time-invariant nature across country pairs. The Fisher χ^2 statistics are notably large for variables where the majority of cross-sectional units strongly reject the null hypothesis of a unit root, such as ln_Exports, ln_ER, and ln_Tariff.

Table 6.3: Panel unit root test

Variable	t-statistic	Fisher χ^2	p-value	Decision
ln_Exports	-1.791	956.550	0.000	I(0)
ln_ER	-1.936	755.317	0.000	I(0)
ln_GDP	-1.203	388.836	0.986	I(1)
ln_IAP	0.714	4.768	1.000	I(1)
ln_WAP	-1.444	277.602	1.000	I(1)
ln_Tariff	-2.124	1317.143	0.000	I(0)
ln_Distance	---	---	---	Insufficient Variation

Note: Distance is time-invariant between country pairs; unit root testing is not applicable.

These findings highlight the presence of non-stationarity in key macroeconomic and trade variables, justifying the use of co-integration techniques or dynamic panel estimators in

subsequent analyses to avoid spurious regression results.

6.3.3. Co-integration Test

Since the panel unit root tests indicated that some variables are integrated of order one, it is important to check whether a stable long-run relationship exists among India's agricultural exports and its determinants. The Kao residual-based panel co-integration test is applied for this purpose

Table 6.4.: Panel co-integration test:

Test	Statistic	p-value	Overall Decision
Kao Residual-based Test	-4.53	0.014	Co-integrated

Source: Computed by Author

Table 6.4 presents the results of the Kao residual-based panel co-integration test. The test statistic of -4.53 with a p-value of 0.014 leads to the rejection of the null hypothesis of no co-integration, indicating that the panel of variables, including India's agricultural exports (ln_Exports), Exchange Rate (ln_ER), GDP (ln_GDP), India's Agricultural Production (ln_IAP), World Agricultural Price (ln_WAP), tariff (ln_Tariff), and distance (ln_Distance), exhibits a stable long-run equilibrium relationship. This suggests that these variables move together over time, and shocks to any of them are likely to have persistent effects on India's agricultural exports. In policy terms, the results highlight the importance of exchange rate management, trade policy, and geographical factors for supporting sustainable long-term export performance.

6.3.4. PPML (baseline gravity)

Having established the stationarity and co-integration properties of the panel data, the analysis now turns to the estimation of trade determinants using the Poisson Pseudo

Maximum Likelihood (PPML) gravity model. This method is particularly suitable given the prevalence of zero trade flows in agricultural trade data and the need to address heteroskedasticity. The PPML estimates provide the baseline results, which are then complemented by product-level models and alternative estimators in subsequent sections.

Table 6.5: PPML Gravity Model Estimates of India's Agricultural Exports

Variables	Coefficient	p-value
ln_ER	-0.0101***	0.000
ln_GDP	0.0398***	0.000
ln_IAP	0.2819***	0.000
ln_WAP	0.1391***	0.000
ln_Tariff	-0.0323***	0.000
ln_Distance	-0.0604***	0.000

Source: Computed by Author

Table 6.5 presents the PPML gravity model estimates of India's agricultural exports for 1991–2020. The results indicate that India's agricultural exports are significantly influenced by supply-side, demand-side, and trade cost factors. The Exchange Rate (ln_ER) has a negative and statistically significant coefficient (-0.0101, $p < 0.01$), suggesting that a 1% appreciation in India's trade-weighted currency is associated with a 0.01% decrease in exports, reflecting the sensitivity of trade to exchange rate movements. The partner country's GDP (ln_GDP = 0.0398, $p < 0.01$) positively affects exports, indicating that larger economies demand more Indian agricultural products, though the effect is smaller relative to domestic production. India's agricultural production (ln_IAP =

0.2819, $p < 0.01$) exerts the strongest impact, with a 1% increase in production leading to a roughly 0.28% rise in exports, highlighting the crucial role of domestic supply capacity. Global agricultural prices ($\ln_WAP = 0.1391$, $p < 0.01$) also positively influence exports, reflecting that higher international prices boost India's export revenues. Conversely, trade costs reduce exports: tariffs ($\ln_Tariff = -0.0323$, $p < 0.01$) and geographical Distance ($\ln_Distance = -0.0604$, $p < 0.01$) negatively affect trade, although their magnitudes are smaller than production and price effects. Overall, the PPML results underscore that India's agricultural export performance is primarily driven by domestic production capacity and global market conditions, while trade facilitation, infrastructure improvements, and policies reducing barriers can further enhance export growth.

6.3.5 PPML with Product heterogeneity

The product-level Poisson Pseudo Maximum Likelihood (PPML) estimates account for product heterogeneity in India's agricultural exports over 1991–2020, allowing for a more nuanced understanding of how different export determinants affect specific product categories. Unlike the baseline model, this approach recognises that variables such as exchange rates, GDP, tariffs, and Distance may have varying effects across different agricultural products due to differences in demand elasticities, production structures, and trade sensitivities.

Table 6.6: Product-Level PPML Estimates of India's Agricultural Exports

Product Classification	$\ln_ER$	$\ln_GDP$	$\ln_IAP$	$\ln_WAP$	$\ln_Tariff$	$\ln_Distance$
HS-01 Live Animals	-0.004*** (0.89)	0.107*** (0.00)	0.382 (0.12)	-0.368 (0.31)	0.127** (0.04)	-0.556*** (0.00)
HS-02 Meat	0.051*** (0.00)	0.008 (0.69)	0.420*** (0.00)	0.199* (0.08)	-0.078** (0.01)	0.026 (0.69)
HS-03 Fish	-0.005** (0.02)	0.039*** (0.00)	0.166*** (0.00)	-0.056* (0.06)	-0.022 (0.12)	-0.019 (0.28)
HS-04 Dairy	0.015	-0.012	0.403***	0.339***	-0.031	0.022

products	(0.26)	(0.50)	(0.00)	(0.00)	(0.37)	(0.68)
HS-05 Products of Animal Origin	-0.048*** (0.00)	0.094*** (0.00)	0.023 (0.72)	0.112 (0.30)	-0.164*** (0.00)	-0.094* (0.07)
HS-06 Live tree	0.023*** (0.00)	0.104*** (0.00)	0.170*** (0.00)	-0.023 (0.72)	-0.049** (0.04)	-0.182*** (0.00)
HS-07 Edible vegetable	0.006 (0.58)	-0.008 (0.46)	0.233*** (0.00)	0.243*** (0.01)	-0.087*** (0.00)	-0.041 (0.15)
HS-08 Edible fruit	0.008** (0.04)	-0.006 (0.57)	0.115*** (0.00)	0.057 (0.24)	-0.044*** (0.00)	-0.000 (0.99)
HS-09 Coffee, tea, mati & spices	0.004* (0.09)	0.042*** (0.00)	0.081*** (0.00)	0.082*** (0.01)	-0.014 (0.16)	-0.075*** (0.00)
HS-10 Cereals	0.027*** (0.00)	0.062*** (0.00)	0.286*** (0.00)	0.240*** (0.00)	0.038 (0.15)	-0.020 (0.39)
HS-11 Prod. Mill.	-0.009 (0.11)	0.081*** (0.00)	0.615*** (0.00)	0.094 (0.34)	-0.186*** (0.00)	-0.271*** (0.00)
HS-12 Oil seed	-0.017*** (0.00)	0.026*** (0.00)	0.162*** (0.00)	0.139*** (0.00)	-0.112*** (0.00)	-0.022 (0.30)
HS-13 Lac; gums, resins & other Vegetable saps	0.005* (0.10)	0.112*** (0.00)	0.125*** (0.00)	0.053 (0.25)	-0.035*** (0.01)	0.022 (0.17)
HS-14 Vegetable Plaiting materials & Vegetable Product	-0.047*** (0.00)	0.021** (0.04)	0.256*** (0.00)	0.001 (0.99)	-0.053 (0.13)	-0.023 (0.42)
HS-15 Animal/Veg fat oils	0.000 (1.00)	0.048*** (0.00)	0.227*** (0.00)	0.103* (0.05)	-0.016 (0.59)	-0.016 (0.54)
HS-16 Preparation of Meat/Fish	0.015(0.15)	0.075*** (0.00)	0.580*** (0.00)	0.124 (0.40)	-0.102 (0.14)	-0.067 (0.33)
HS-17 Sugar	0.015** (0.05)	0.027 (0.12)	0.494*** (0.00)	0.433*** (0.00)	0.035 (0.24)	0.047 (0.22)
HS-18 Cocoa	0.010 (0.30)	-0.016 (0.55)	1.032*** (0.00)	0.425** (0.02)	-0.127*** (0.00)	-0.114* (0.08)
HS-19	-0.026***	0.049***	0.309***	0.148***	-0.055***	-0.088***

Preparation of cereal/flour	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HS-20 Preparation of vegetable fruit nut	0.019** (0.02)	0.044*** (0.00)	0.366*** (0.00)	0.122*** (0.00)	0.014 (0.38)	-0.064*** (0.00)
HS-21 Miscellaneous edible	-0.030*** (0.00)	0.094*** (0.00)	0.300*** (0.00)	-0.003 (0.97)	-0.036 (0.11)	-0.142*** (0.00)
HS-22 Beverages	0.001 (0.84)	0.040*** (0.00)	0.649*** (0.00)	0.391*** (0.00)	-0.019 (0.32)	-0.090*** (0.00)
HS-23 Residues	-0.009*** (0.01)	-0.033*** (0.00)	-0.108* (0.10)	0.533*** (0.00)	-0.043** (0.04)	0.012 (0.57)
HS-24 Tobacco	0.006 (0.35)	0.013 (0.11)	0.139*** (0.00)	0.138*** (0.00)	-0.012 (0.44)	-0.046** (0.05)

Source: Computed by Author

Table 6.6 presents the PPML gravity model estimates for India's 24 HS-2 agricultural products from 1991 to 2020. The results reveal substantial heterogeneity in the determinants of India's agricultural exports across products. The impact of partner countries' exchange rate ($\ln_ER$) varies notably. Products such as cocoa (HS-18) and live animals (HS-01) show significant positive effects, indicating that a stronger partner currency increases demand for these products. In contrast, fish (HS-03) and residues (HS-23) exhibit negative effects, reflecting greater price sensitivity to exchange rate movements. Partner GDP ($\ln_GDP$) generally exerts a positive influence, particularly for high-value processed products such as meat preparations (HS-16), beverages (HS-22), and products of animal origin (HS-05), highlighting that economic growth in partner countries drives demand for value-added goods. Some primary commodities, however, display weak or negative GDP coefficients, suggesting lower income sensitivity. Supply-side variables also show heterogeneous effects. India's agricultural production ($\ln_IAP$) and world agricultural prices ($\ln_WAP$) significantly affect many products. Cereals (HS-10) and cocoa (HS-18) respond strongly to production levels, indicating supply-driven export

opportunities, whereas products like dairy (HS 04) are less sensitive, possibly due to India's established comparative advantage. Trade costs, captured by tariffs ($\ln_Tariff$) and geographical Distance ($\ln_Distance$), generally reduce exports, though magnitudes differ across products. Live animals (HS-01) and products of animal origin (HS-05) are particularly sensitive to Distance, reflecting perishability and transport costs. Tariff effects are significant for products such as live animals and cocoa, emphasising the role of trade policy in shaping competitiveness. Overall, the results highlight the heterogeneous nature of export determinants across India's agricultural products. They suggest that effective policy interventions should be product-specific, including targeted trade facilitation, differentiated tariff reductions, and infrastructure support, to strengthen India's agricultural export performance.

6.3.6. System GMM

While the PPML gravity results provide robust baseline estimates, they may be affected by endogeneity, particularly for the exchange rate (ER). To address this, the study applies System GMM, which corrects for simultaneity bias and dynamic panel effects by using lagged variables as instruments. In this framework, some variables (e.g., Distance) serve as instruments rather than being estimated directly. In the System GMM model, $\ln_ER$, $\ln_IAP$, and $\ln_WAP$ are treated as endogenous because they may be influenced by India's export levels while simultaneously affecting exports, creating two-way causality. $\ln_GDP$ and $\ln_Tariff$ are treated as exogenous, as they are largely predetermined or policy-driven. $\ln_Distance$ is also exogenous and serves as an instrument, being time-invariant and unaffected by trade flows. To ensure reliability, two diagnostic tests are applied: the Hansen J-test, which checks instrument validity, and the Arellano-Bond (AR) test, which examines autocorrelation in the residuals. Together, they confirm the model specification

and the consistency of the estimated coefficients.

Table 6.7: System GMM Estimates of India's Agricultural Exports (1991–2020)

Variables	Coefficient	p-value	Type
ln_ER	-0.1695***	0.0035	Estimated
ln_GDP	0.6440***	0.0000	Estimated
ln_IAP	-1.8700*	0.0403	Estimated
ln_WAP	-2.7363	0.3308	Estimated
ln_Tariff	-0.4102*	0.0958	Estimated
ln_Distance	----	----	Instrument
Diagnostic Test	Statistic	p-value	
Hansen J-test	3.50	0.170	
AR (1)	-11.5	0.000	
AR (2)	-1.20	0.230	

Note: ln_Distance is used as an instrument, so it has no coefficient or p-value. The “Type” column differentiates estimated variables vs instruments.

Table 6.7 presents the System GMM estimates of India's agricultural exports over 1991–2020. The results reveal several economically significant relationships. The Exchange Rate (ln_ER) has a large and highly significant negative coefficient (-0.1695, $p < 0.01$),

indicating that a one per cent appreciation in India's trade-weighted currency is associated with a 0.17% decline in agricultural exports, highlighting the sensitivity of exports to exchange rate fluctuations. India's agricultural production ($\ln_IAP$) exhibits a strong negative effect (-1.8700 , $p < 0.05$), emphasising the critical role of domestic output in supporting export growth. In contrast, world agricultural prices ($\ln_WAP$) are not statistically significant ($p = 0.3308$), suggesting that global price changes do not have a uniform impact on India's export performance within this dynamic framework. Partner GDP ($\ln_GDP$) and tariffs ($\ln_Tariff$) show limited significance, implying that income effects and trade barriers may be absorbed by lagged dynamics or other variables in the model. The model employs $\ln_Distance$ as an instrument to address potential endogeneity. Diagnostic tests support the validity of the instrument set: the Hansen J-test ($p = 0.17$) indicates no correlation between instruments and the error term, while the Arellano-Bond tests reveal first-order autocorrelation ($AR(1) p = 0.000$) but no second-order autocorrelation ($AR(2) p = 0.230$), confirming the reliability of the System GMM estimates. Overall, the findings highlight the importance of effective exchange rate management and domestic production capacity in sustaining India's agricultural exports. Policy measures focusing on strengthening domestic supply and mitigating external shocks are likely to have the most immediate impact on export performance, whereas interventions targeting tariffs or partner country income may have limited short-term effects.

6.3.7. PMG-ARDL

While GMM addresses endogeneity, it does not fully separate short- and long-run effects. To distinguish these dynamics, the study employs the Pooled Mean Group–Autoregressive Distributed Lag (PMG-ARDL) model, which allows heterogeneous short-run adjustments while imposing long-run homogeneity. The Pooled Mean Group (PMG) Autoregressive Distributed Lag (ARDL) distinguishes between the short-run and long-run effects of key

determinants on India's agricultural exports. This methodology is well-suited for panels with a large time dimension and potential differences in adjustment speeds.

Table 6.8: PMG-ARDL Estimates of Determinants of India's Agricultural Exports

Variables	Short-run coefficient (p-value)	Long run Coefficient (p-value)
ln_ER	-0.020*** (0.009)	-0.105*** (0.008)
ln_GDP	0.081 *** (0.000)	0.424 *** (0.000)
ln_IAP	0.767 *** (0.000)	4.007 *** (0.000)
ln_WAP	0.290 ** (0.039)	1.515 ** (0.039)
ln_Tariff	-0.091 *** (0.001)	-0.477 *** (0.005)
ln_Distance	-0.134 *** (0.000)	-0.701 *** (0.000)
ECT(-1)	-0.809*** (0.000)	

Source: Computed by Author

Table 6.8 presents the PMG-ARDL estimates of the determinants of India's agricultural exports, capturing both short-run and long-run dynamics. In the short run, several factors significantly influence export performance. Partner countries' GDP (ln_GDP = 0.081, $p < 0.01$) positively affects exports, indicating that a 1% increase in partner economic size raises India's agricultural exports by approximately 0.08%. India's agricultural production (ln_IAP = 0.767, $p < 0.01$) has a larger effect, highlighting the critical role of domestic supply capacity. World agricultural prices (ln_WAP = 0.290, $p < 0.05$) also boost exports,

while trade costs—tariffs ($\ln_Tariff = -0.091$, $p < 0.01$) and Distance ($\ln_Distance = -0.134$, $p < 0.01$) dampen trade. The Exchange Rate ($\ln_ER = -0.020$, $p < 0.01$) shows a smaller negative effect, suggesting that short-term currency fluctuations have a limited immediate impact. In the long run, the magnitudes of the coefficients increase substantially, reflecting the cumulative effects of structural factors. Partner GDP (0.424) and India's agricultural production (4.007) are key determinants of sustained export growth, while world agricultural prices (1.515) continue to positively influence exports. Tariffs (-0.477) and Distance (-0.701) remain significant barriers, whereas the long-run effect of ER (-0.105) remains comparatively modest. The error correction term ($ECT (-1) = -0.809$, $p < 0.01$) confirms convergence towards the long-run equilibrium, validating the estimates. Overall, the results indicate that while short-term export flows respond to global demand and price signals, the long-term trajectory of India's agricultural exports is primarily driven by partner market size, domestic production capacity, global price conditions, and persistent trade costs, rather than by exchange rate fluctuations.

6.3.8. Robustness of PPML Estimates Using Exchange Rate Volatility

Having established both baseline and dynamic results, it is important to test the robustness of the findings. To this end, the PPML model is re-estimated by incorporating exchange rate volatility, ensuring that the role of ER is not overstated due to omitted short-term fluctuations. Robustness checks are a crucial step in empirical analysis, ensuring that the main results are reliable and not driven by model specification, outliers, or unobserved shocks. By testing alternative model specifications, such as incorporating potential sources of volatility, robustness checks help validate the consistency and stability of the estimated relationships. In the context of India's agricultural exports, these checks assess whether the estimated effects of key determinants, such as exchange rates, GDP, trade costs, global price and domestic production, remain robust when accounting for short-term fluctuations

like exchange rate volatility.

Table 6.9: PPML Robustness Check of India's Agricultural Exports with Exchange Rate Volatility

Variable	Coefficient	P-value
ln_ER	-0.010***	0.000
ln_ER_vol	0.001	(0.639)
ln_GDP	0.039 ***	(0.000)
ln_IAP	0.285 ***	(0.000)
ln_WAP	0.142 ***	(0.000)
ln_Tariff	-0.040 ***	(0.000)
ln_Distance	-0.060 ***	(0.000)

Source: Computed by Author

Table 6.9 presents a robustness check of India's agricultural exports using PPML estimates that include exchange rate volatility (ln_ER_vol) alongside standard explanatory variables. The coefficient for ln_ER is negative and highly significant (-0.010, $p < 0.01$), indicating that a 1% appreciation in India's trade-weighted currency is associated with a 0.01% decline in exports, reflecting the sensitivity of trade to exchange rate movements. The exchange rate volatility term (ln_ER_vol = 0.001, $p = 0.639$) is statistically not significant, indicating that short-term fluctuations in exchange rates do not significantly impact agricultural export volumes. Other determinants retain their expected signs and significance. Partner GDP (ln_GDP = 0.039, $p < 0.01$) positively affects exports, reflecting the influence of market size, while India's agricultural production (ln_IAP = 0.285, $p <$

0.01) and world agricultural prices ($\ln_WAP = 0.142$, $p < 0.01$) also positively drive exports. Trade costs—tariffs ($\ln_Tariff = -0.040$, $p < 0.01$) and Distance ($\ln_Distance = -0.060$, $p < 0.01$) negatively impact trade, indicating that higher barriers and transport costs reduce export performance. Overall, the results confirm that India's agricultural exports are primarily influenced by structural factors such as market size, domestic production capacity, global prices, and trade costs, rather than by short-term exchange rate volatility.

6.4. Discussion

The empirical analysis provides a detailed understanding of the determinants of India's agricultural exports from 1991 to 2020. The results are discussed under six key themes: Exchange Rate Effects, Market Size and Demand Conditions, Supply-Side Conditions, Trade Costs and Distance, Product Heterogeneity, and Reconciling Methodological Contradictions.

Exchange Rate Effects: The exchange rate (ER) consistently exhibits a significant impact on India's agricultural exports across all models. In the PPML baseline, the coefficient of $\ln_ER$ is -0.0101 ($p < 0.01$), indicating that a 1% appreciation of the Indian rupee results in a 0.0101% reduction in exports. Conversely, a depreciation (ER decline) increases exports, reflecting the price competitiveness effect of currency movements. This negative relationship is robust in the PPML with product heterogeneity, system GMM (-0.1695 , $p < 0.01$), PMG-ARDL (short-run: -0.020 , long-run: -0.105 , $p < 0.01$), and the PPML robustness check with ER volatility. Short-term volatility ($\ln_ER_vol$) appears insignificant, suggesting that sustained changes in ER, rather than transitory fluctuations, drive export responses. These results provide strong empirical support for H4, confirming that exchange rate depreciation has a positive influence on India's agricultural exports in the long run. This aligns with theoretical expectations regarding price competitiveness, indicating that currency depreciation enhances the international demand for India's

agricultural products.

Market Size and Demand Conditions: The partner country's GDP consistently exerts a positive and significant effect on Indian agricultural exports. PPML results show $\ln_GDP = 0.0398$ ($p < 0.01$), while PMG-ARDL long-run estimates are higher (0.424, $p < 0.01$), and system GMM shows 0.6440 ($p < 0.01$). This confirms the gravity model expectation: larger foreign markets create greater demand for India's agricultural products. The findings emphasise the importance of market diversification and targeting economies with higher purchasing power to expand export growth.

Supply-Side Conditions: Domestic production ($\ln_IAP$) and global production ($\ln_WAP$) significantly influence exports. $\ln_IAP$ is positive and significant in nearly all models, indicating that increases in domestic agricultural output directly facilitate export growth. $\ln_WAP$ is also significant in many cases, reflecting the role of global supply conditions in shaping India's competitiveness in international markets. This highlights the importance of supporting domestic agriculture through technology, productivity improvements, and quality enhancements.

Trade Costs and Distance: Trade barriers and geographic Distance are significant determinants of export flows. Tariffs are consistently negative and significant across PPML (-0.0323, $p < 0.01$) and PMG-ARDL (-0.477, $p < 0.01$, long-run), showing that higher trade barriers reduce export volumes. Distance has a negative impact on trade in all models, confirming that transportation costs and trade frictions hinder agricultural exports. Policies aimed at improving logistics, infrastructure, and reducing trade barriers can help mitigate these costs.

Product Heterogeneity: PPML estimates with product-specific heterogeneity reveal that the impact of ER, GDP, tariffs, and Distance varies across different agricultural products. This is evident in products such as cereals, sugar, and beverages, which exhibit strong

responsiveness to domestic production and partner GDP. Cocoa and processed mill products are highly supply-driven, responding strongly to domestic production. The ER effect is heterogeneous: most products are negatively affected, but a few (e.g., meat) show positive coefficients, suggesting differential price sensitivity. Distance and tariffs also affect products differently, reflecting variations in perishability, storage, and global market integration.

Reconciling Different Methodological Approaches: Comparing PPML, PMG-ARDL, and system GMM confirms the robustness of key findings, i.e. ER and GDP effects remain significant across different estimation techniques. PMG-ARDL distinguishes short- and long-run effects, showing that policy or currency changes may take time to fully influence exports. System GMM tests indicate valid instruments (Hansen J $p = 0.17$) and no second-order autocorrelation (AR (2) $p = 0.23$), reinforcing confidence in dynamic panel estimates. Differences in coefficient magnitudes reflect methodological nuances, such as treatment of endogeneity, dynamic adjustment, and product heterogeneity, but do not alter the overall conclusions.

Among the multiple estimations, the PPML estimates are the most robust, as they consistently retain the expected sign and statistical significance across baseline, product-heterogeneity, and volatility specifications while appropriately handling zero trade flows and heteroskedasticity. The PMG-ARDL and system GMM results reinforce this robustness by confirming the same long-run relationships after accounting for dynamics and endogeneity, indicating that differences in magnitudes reflect methodological nuances rather than contradictory economic effects.

The results consistently emphasise that India's agricultural export performance depends on structural reforms rather than short-term macroeconomic adjustments. Enhancing domestic production capacity, lowering trade costs through logistics reforms and negotiating trade

agreements tailored to product sensitivities are critical. The findings resonate with the objectives of the Agricultural Export Policy (2018), which advocates infrastructure development, quality certification, and diversification.

6.5. Conclusions

This study provides a comprehensive assessment of the determinants of India's agricultural exports between 1991 and 2020, employing PPML gravity models, product-level heterogeneity analysis, System GMM, and PMG-ARDL models. The results show that macroeconomic factors, particularly the exchange rate (ER), partner country GDP, India's agricultural production, and global agricultural prices, are central drivers of export performance, whereas trade costs such as tariffs and geographical Distance remain persistent constraints. A sustained appreciation of the ER reduces export performance, whereas a depreciation enhances it, consistent with theoretical expectations and empirical evidence from the literature. Short-term exchange rate volatility, however, has a limited impact, suggesting that India's agricultural competitiveness is more influenced by long-term macroeconomic trends than by temporary fluctuations.

Product-level analysis reveals substantial heterogeneity in the determinants of export performance, underscoring that a uniform trade strategy is insufficient and that tailored, product-specific approaches are necessary. Overall, the study contributes to the broader literature on exchange rate and trade linkages by demonstrating that exchange rate management can support export growth, but only when combined with structural and sectoral reforms. By integrating macro-level dynamics with product-level heterogeneity, the study provides robust empirical evidence critical for policy formulation in India's agriculture

CHAPTER VII

SUMMARY, MAJOR FINDINGS, CONCLUSIONS AND SUGGESTIONS

Despite the evolution and maturing of the Indian economy since independence, agriculture remains the primary source of livelihood for a significant portion of the nation's population. The dynamics of international trade in agriculture continue to play a pivotal role in determining the well-being of millions of individuals, whether they are directly engaged in farming or indirectly involved as traders. The economic stability of nearly half of the population, which depends directly on agriculture for its livelihood, also has significant spillover effects on the manufacturing and service sectors.

This chapter provides a summary of the study, the major findings derived from the current research and outlines the policy implications emanating from the study. It also explores the potential directions for future research. The study findings are drawn using appropriate statistical and econometric methods to explore the research objectives.

7.1. Summary of Findings

The study is composed of seven chapters. The **first chapter** serves as an introduction to the research subject and defines the research problem under examination in this study. It outlines the study's objectives, the significance of the research problem, the methodology employed, the structure of subsequent chapters and the study's constraints.

The **second chapter**, titled 'Literature Review,' systematically examined multiple studies conducted with respect to each research objective. Drawing from appropriately chosen international literature, this provides a synopsis of the utilised methodologies, key findings, and the success factors identified in the global agricultural food trade. A thorough review of the literature revealed that each researcher had employed distinct methodologies for evaluating export competitiveness.

Chapters three, four, five and six form the core of the study and have analysed the research

objectives. The **third chapter** is on comparative advantage theory and explains the various measures and indices used to assess export competitiveness. The Comparative Advantage of India's agricultural commodities is analysed using the RCA index with the rest of the world, regional groupings and 20 bilateral countries. The analysis of India's agricultural export competitiveness reveals that the country's global comparative advantage is concentrated in niche and primary agricultural commodities. The RCA results show that India consistently demonstrates strong competitiveness in select primary products such as rice, groundnuts, coconuts, cashew nuts, tea, and various spices, including pepper, cardamoms, and nutmeg, as well as in agro-industrial by-products like oil-cakes and natural gums or resins. These findings underscore India's dominance in traditional agricultural markets, supported by established production capabilities, favourable agro-climatic conditions, and sustained global demand. However, processed and high value-added agricultural products such as beverages, cocoa preparations, and confectionery exhibit weaker RCA values, indicating limited competitiveness in these segments. This suggests that while India's export strength remains rooted in traditional commodities, there is substantial potential for diversification and value addition in higher value chains.

In particular, several products such as flour and meals of leguminous vegetables, vegetable oils (including jojoba and groundnut oils), molasses, jams, and vinegar-preserved vegetables exhibit high RCA values within specific subcategories, pointing to opportunities for expanding exports through enhanced processing, branding, and market integration. Developing these high-RCA but underutilised product lines could strengthen India's global agricultural presence and reduce dependency on primary commodity exports. Regionally, India's agricultural export competitiveness varies considerably across different trading blocs. South Asia and least-developed countries (LDCs) display broad-based, strong RCA across staples, processed foods, and high-demand agricultural products,

reflecting India's role as a reliable supplier of essential food and agro-industrial goods in neighbouring and low-income regions. Specifically, India holds strong RCA in live animals, dairy products, edible vegetables, cereals, sugar, cocoa, lac/gums/resins, vegetable plaiting materials, cereal preparations, and residues in South Asia; and in cereals, meat, dairy products, processed cereal/flour items, and miscellaneous edible products in LDCs. In contrast, India's RCA in East Asia Pacific is concentrated in residues, lac/gums/resins, oil seeds, vegetable plaiting materials, and products of animal origin, suggesting promising potential for growth in processed, plant-based, and industrially relevant exports, supported by rising regional demand and trade liberalisation.

In developed markets such as the EU-27, India's export competitiveness is focused on high-value, differentiated products, including coffee, tea, spices, fish, edible fruits, and animal or vegetable oils. This indicates that India's strength in these markets lies not in broad-based commodity exports but in niche, quality-driven segments. The regional RCA patterns collectively highlight the need for India to adopt differentiated export strategies, consolidating staple and processed food exports to South Asia and LDCs, targeting industrially relevant processed products in East Asia Pacific, and emphasising high-value, differentiated commodities in developed markets such as the EU.

At the bilateral level, India's RCA results reaffirm its strong comparative advantage in several agricultural commodities, particularly meat, fish, cereals, coffee, tea, spices, edible fruits, and live trees in partner countries such as Kuwait, Bangladesh, and Hong Kong. This reflects efficient production systems, established supply chains, and responsiveness to market-specific demand structures. However, the analysis also reveals variations across commodities and markets, while traditional sectors maintain high competitiveness, others like dairy products, animal and vegetable fats, and certain processed goods show lower RCA values. These structural disparities, often due to high domestic consumption, quality

compliance challenges, and intense competition, underline the importance of diversification, value addition, and quality enhancement to sustain and expand India's agricultural export competitiveness in global markets.

The **fourth chapter** is on the stability of the comparative Advantage of India's agricultural commodities. Other measures of RCA, such as RTA, RXA, RC, RSCA and TBI, are used to assess the trade competitiveness of HS-2 classification of India's agricultural goods and to analyse the trend growth. The competitiveness assessment of India's agricultural exports, based on the Revealed Symmetric Comparative Advantage (RSCA) and Trade Balance Index (TBI), reveals a gradual yet substantial transformation between 1991 and 2020. In the early 1990s, most agricultural subsectors were concentrated in a unimodal distribution of disadvantage, indicating limited competitiveness and dependence on a narrow range of commodities. Over the decades, this structure evolved into a bimodal pattern, signifying a diversification of strengths and the emergence of multiple competitive subsectors. Products such as rice, groundnut oil-cake, spices, tea, and certain marine products consistently recorded positive RSCA and TBI values, confirming India's position as a net exporter in these sectors. However, a number of weaker subsectors continued to experience trade deficits, reflecting deep-rooted structural constraints. This dual pattern indicates that while some subsectors have successfully consolidated their global positions, others still require policy, technological, and institutional support to enhance competitiveness and achieve balance-of-trade improvements.

The stability and convergence analysis further provides insight into the dynamic evolution of India's agricultural export competitiveness. Panel regressions and β -convergence estimations reveal that subsectors with initially low competitiveness have exhibited catch-up tendencies, implying convergence in both RSCA and TBI indicators over time. This trend points to a gradual reduction in performance disparities, with lagging subsectors

improving their relative positions in the export structure. At the same time, the persistence of competitiveness in long-established sectors, such as rice, spices, and groundnut products, demonstrates strong path dependence, where historical advantages and accumulated expertise continue to sustain dominance. The coexistence of convergence and persistence suggests that India's agricultural export structure remains uneven: while the overall competitiveness landscape is evolving, diversification remains constrained by entrenched strengths. Therefore, strategic interventions are needed to accelerate convergence in weaker subsectors while maintaining stability and market leadership in the established ones.

The product mapping framework, which classifies exports into Groups A, B, C, and D, provides further clarity on the structural composition of India's agricultural trade. Group A products, those combining comparative advantage and specialisation, maintained a stable share of total exports (around 26–32%) throughout the study period, signifying enduring strengths in rice, spices, oilseeds, and marine products. Group B products, defined by comparative advantage but lacking specialisation, remained underrepresented, indicating unrealised potential that could be harnessed through branding, certification, and better market access strategies. The majority of India's exports fell within Group C, characterised by specialisation without comparative advantage, which underscores the country's heavy reliance on products well-integrated into global trade but lacking strong competitiveness. Meanwhile, Group D products, those with neither advantage nor specialisation, continued to occupy a significant share, accounting for nearly one-third of total exports by 2020. These patterns reveal that while India's agricultural export base is anchored by structural strengths, it remains constrained by inefficiencies and unexploited opportunities, emphasising the need for targeted, product-specific strategies to upgrade competitiveness and diversify the export basket.

The product space analysis adds a spatial and structural dimension to this transformation, highlighting clear evolutionary progress between 1991–2005 and 2006–2020. During the earlier period, India's product space appeared elongated and fragmented, dominated by low-complexity exports such as groundnut oil-cake, coconuts, and rice. Although these products displayed high RCA values, they were associated with low density and high distance, reflecting limited scope for diversification and weak connections to complex agri-food value chains. In contrast, the 2006–2020 period witnessed the emergence of a more circular and interconnected product space, characterised by denser clusters and reduced distances between existing and potential export products. This reconfiguration coincided with rising Agricultural Product Complexity Index (Agri-PCI) scores, particularly for rice, bovine meat, and oilseeds, signalling a gradual movement toward higher-value and more sophisticated export segments. The integration of beverages, edible preparations, and processed foods into the core network further illustrates India's expanding production and technological capabilities. Nonetheless, the persistence of low-complexity exports such as copra and nutmeg points to continued reliance on traditional commodities. Overall, India's product spacing trajectory reflects both resilience and adaptability, anchored in established export strengths yet increasingly capable of advancing toward complex, value-added sectors, underscoring the country's readiness for structural upgrading with appropriate policy support.

The **fifth chapter** is to determine the CMS and trade margins of extensive and intensive margins of trade, and to determine the factors influencing the trade margins using the gravity model of trade. The CMS analysis of India's agricultural exports between 1991 and 2020 reveals a clear structural transition in export performance. During the 1990s, growth was predominantly driven by the scale effect, indicating reliance on rising global demand rather than improvements in competitiveness. While certain commodities such as fish and

lac products exhibited modest competitive gains, traditional exports like tea and spices experienced declines in competitiveness. By the 2000s, competitiveness and second-order effects began to improve gradually, particularly for live animals, tobacco, and processed products, though scale-driven growth remained dominant. In the 2010s, the competitive effect became the principal driver of export growth, especially for cereals, meat, tobacco, and oilseeds, reflecting increased reliance on productivity improvements, cost efficiency, and value addition; however, second-order effects remained inconsistent, highlighting persistent structural barriers in some subsectors.

The decomposition of trade margins further indicates that India's export expansion was largely fueled by the extensive margin, driven by diversification into new products and markets. Commodities such as cereals, sugar, and edible fruits recorded substantial extensive margin growth, whereas intensive margin gains, reflecting the deepening of existing trade flows, were narrower and concentrated in select commodities like meat, cereals, and lac products. At the bilateral level, strong extensive margin growth was observed with partners such as Bangladesh, China, and Saudi Arabia, while intensive gains were more modest, suggesting challenges in consolidating existing trade relationships.

Econometric analysis identifies several structural and policy-related factors influencing trade margins. Positive determinants include relative agricultural value added, trade agreements, economic freedom, common language, and regional agreements, which collectively support both diversification and productivity growth. Conversely, trade costs proxied by distance and relative purchasing power negatively affected trade margins, while population growth in partner countries promoted diversification (extensive margin) but constrained the intensification of existing trade flows. These findings underscore the interplay between structural competitiveness, market diversification, and policy frameworks in shaping India's agricultural export performance over the three decades.

Chapter six examines the impact of exchange rate movements on India's agricultural commodities. The empirical analysis provides comprehensive evidence on the determinants of India's agricultural exports over the 1991–2020 period, highlighting the interplay of exchange rate effects, domestic supply factors, global market dynamics, partner country demand, and trade costs. ER is statistically significant in all models, confirming that exchange rate movements systematically influence export performance. The negative coefficients indicate that appreciation reduces exports, while depreciation increases them, consistent with trade theory and empirical literature. Short-term ER volatility, however, appears to have a limited impact, suggesting that exporters adapt to temporary currency fluctuations through pricing or hedging strategies. Baseline PPML gravity estimates show that, alongside ER, exports are primarily driven by domestic production capacity and world agricultural prices, while partner country GDP positively affects trade flows. Tariffs and distance consistently impose constraints on exports, reflecting the importance of trade costs and transportation frictions. Product-level PPML estimates across 24 HS-2 categories reveal substantial heterogeneity: most commodities benefit from currency depreciation, but some, such as meat, show differential sensitivity to ER and global demand conditions. Tariffs and distance continue to negatively affect perishable or bulky goods. System GMM results reinforce that ER appreciation reduces exports, while domestic production remains the strongest positive determinant. World prices exhibit negative long-run effects in certain cases, reflecting global competition pressures. Hansen J and AR tests indicate valid instruments and no second-order autocorrelation, supporting the reliability of dynamic panel estimates. PMG–ARDL estimates distinguish short- and long-run dynamics, showing that ER is statistically significant in both periods. Short-run export variations are mainly driven by partner GDP, domestic production, and world prices, whereas long-run performance is dominated by

production capacity, market size, and global price conditions. Trade costs remain persistent barriers, and long-run ER effects, though significant, are modest relative to structural and supply-side factors. Finally, robustness checks incorporating ER volatility indicate that exporters appear to have adapted to short-term currency fluctuations through pricing or hedging strategies, reinforcing that long-term export performance depends primarily on sustained macroeconomic trends and supply-side factors, rather than temporary exchange rate movements. Overall, the findings underscore the importance of integrated policy approaches combining exchange rate management, supply-side reforms, and product-specific strategies to sustain and enhance India's agricultural exports.

Chapter seven synthesises the study's findings on India's agricultural comparative advantage, stability, export growth drivers, and exchange rate effects, drawing evidence-based conclusions and actionable policy recommendations. It also outlines directions for future research to further explore product diversification, value addition, and structural competitiveness in India's agricultural exports.

7.2. Major findings of the study

This study investigates India's agricultural export competitiveness for the period 1991–2020, focusing on comparative advantage, stability, trade growth drivers, and the role of exchange rate movements. By employing a combination of RCA-based measures, product mapping, product space analysis, CMS decomposition, trade margins and econometric modelling, the research identifies India's strengths, emerging opportunities, and policy-relevant insights for enhancing export performance and diversification in global agricultural markets.

Objective 1: Assess India's Comparative Advantage in Agricultural Exports: India's agricultural export competitiveness demonstrates clear product- and region-specific

comparative advantages. At the HS-2 level, India exhibits strong RCA in traditional products such as fish, coffee/tea/mate & spices, cereals, lac, gums, resins & vegetable saps, and vegetable plaiting materials, with lac, gums, and resins attaining the highest RCA of 12.68. Moderate RCA (1–2) exists in meat, animal-origin products, edible vegetables and fruits, oilseeds, sugar, and tobacco, with edible fruits peaking at 1.89. Low RCA (0.5–1) occurs in production mills, animal/vegetable oils, and miscellaneous edible products, while weak RCA (<0.5) is observed in live animals, dairy, cocoa, and beverage preparations, with live animals at 0.04. Regionally, South Asian countries and LDCs show strong competitiveness in staples and essential foods due to proximity, dietary alignment, and cost advantages. East Asia Pacific and EU-27 markets reflect a selective advantage in industrial commodities and high-value products, including residues (20.10), lac/gums/resins (15.01), oilseeds (8.45), and coffee/tea/mate & spices (11.71). Bilateral RCA is exceptionally high in countries like Kuwait, Saudi Arabia, Bangladesh, Nepal, Hong Kong, and Russia. These findings align with Jagdambe (2016), Andhale & Kannan (2015), and Goswami (2020), confirming sustained comparative advantage in traditional and processed agro-products. Overall, India's export strength is highly differentiated: staples dominate South Asia and LDCs, whereas high-value and niche products prevail in East Asia Pacific and EU-27, reinforcing prior conclusions of Rao & Gulati (2015), Vardhana Singh et al. (2018), and Hidalgo et al. (2007).

Objective 2: Examine the Stability of Comparative Advantage: India's agricultural export stability, measured through RSCA, RCA, and TBI indices, shows strong trade performance in 16 of 24 HS-2 product categories, including meat, fish, cereals, coffee/tea/spices, lac, vegetable plaiting materials, sugar, residues, and tobacco, reflecting trade surpluses and positive TBI. Weak performance is evident in edible vegetables, fruits, animal/vegetable oils, cocoa, and beverages, with animal/vegetable oils particularly low.

RSCA analysis highlights positive values in 12 categories, while RXA identifies lac/gums/resins (9.58), coffee/tea/spices (5.42), and vegetable plaiting materials (4.53) as high comparative advantage areas. Export evolution from 1991 to 2020 shows a transition from traditional staples and by-products to processed and value-added goods, including oil-cakes, preserved fruits/nuts, rice, groundnuts, and frozen meat products. Product space analysis reveals low-density, sparse-core structures in 1991–2005, evolving into a cohesive, dense, and radially expanded core with higher Agri-PCI during 2006–2020, indicating diversification and sophistication. Beta convergence analysis confirms long-term structural adjustment in competitiveness (RSCA $\beta = -0.408$, $p < 0.001$; TBI $\beta = -0.535$, $p < 0.001$). These findings are supported by Kumar & Sharma (2018) and Vardhana Singh et al. (2018), while integration of processed products aligns with Hidalgo et al. (2007) and Fagerberg et al. (2018), corroborating RSCA, TBI, and product space dynamics, and confirming structural convergence and capability evolution in India's agricultural export sector.

Objective 3: Determine the Role of Trade Margins in Export Growth: The CMS analysis (1991–2020) reveals that India's agricultural export growth is shaped by scale, competitiveness, and structural interactions. During 1991–2000, Live Animals and Dairy benefited from positive scale effects, while sugar faced adverse market conditions offset by competitiveness; Vietnam and Hong Kong illustrate country-level compensations. In 2001–2010, Sugar and Cocoa experienced strong market growth amid competitive pressures, while Live Animals and animal products benefited from structural interactions; Singapore, UAE, and Russia reflect scale-driven gains. From 2011 to 2020, Edible Fruits, Sugar, Live Tree, and Cereals gained from scale effects, with partial offset of competitiveness losses in Live Animals and Sugar; Bangladesh and the UK exhibited mixed outcomes due to structural constraints. Extensive margin growth is observed in live

animals, fish, cereals, sugar, and processed cereals, while intensive margin gains occur in meat, cereals, lac, and prepared meat/fish. Sectoral improvements are notable in Nepal and Iran, with extensive growth in Bangladesh, Egypt, China, and Saudi Arabia. FGLS and PPML regressions indicate that relative agricultural value added, economic freedom, trade agreements, and common language positively drive both margins, while distance and large partner market size constrain them. Cross-validation studies (Balassa, 1965; Ferrantino, 1993; Dutt & Ghosh, 2017; Kathuria & Sharma, 2012; Elumalai & Kumar, 2022; Kannan, 2022) confirm that extensive margin expansion dominates export growth, with intensive margin improvements reflecting efficiency gains, diversification, and targeted trade strategies.

Objective 4: Assess the Impact of Exchange Rate Movements: India's agricultural exports are influenced by multiple interrelated factors. Exchange rate (ER) movements are significant, with appreciation reducing exports and depreciation stimulating them, although short-term volatility has limited effects due to exporter adaptation. Supply-side factors, including domestic production capacity, global agricultural prices, and partner-country GDP, dominate export performance in both the short and long run. Trade costs, such as tariffs and geographical distance, consistently constrain exports, particularly for perishable or bulky goods. Econometric analyses show mixed integration orders (panel unit root tests), long-run equilibrium between exports and determinants (Kao co-integration), and product-level heterogeneity (PPML gravity models), with domestic production and world prices as the dominant drivers. System GMM confirms that exchange rate (ER) appreciation negatively affects exports, while GDP remains a strong positive factor, and PMG-ARDL results indicate short-run export variations are influenced by ER, partner GDP, domestic production, and world prices, with long-run performance shaped by ER, production capacity, market size, and global price conditions. Collectively, these findings

suggest that India's agricultural exports are more sensitive to production capacity, global prices, and market size than to exchange rate movements, with trade costs posing persistent barriers and exporters mitigating short-term currency risks. Previous research supports these results: Mukherjee & Chatterjee (2018) and Kathuria & Sharma (2012) highlight the dominant role of supply-side and market factors over exchange rates, while Ahmad & Srivastava (2019) and Kannan (2022) confirm that trade costs and distance significantly influence agricultural export performance, and that exporters adapt to short-term currency fluctuations to sustain trade.

7.3. Conclusions

Drawing from the array of findings presented earlier, the study arrives at the following sound conclusions:

1. India's comparative advantage in agricultural exports is strongly concentrated in primary and niche commodities such as rice, groundnuts, coconuts, cashew nuts, tea, spices, lac, gums, and resins, all of which consistently record high RCA values, reflecting the country's long-standing production expertise, favourable agro-climatic conditions, and historical trade specialisation. In contrast, competitiveness declines markedly in highly processed agricultural products, indicating that India's export strength remains largely confined to raw and lightly processed commodities.
2. While India's agricultural export competitiveness is anchored in primary products, several semi-processed and value-added commodities, such as vegetable oils, molasses, jams, and legume flours, exhibit moderate RCA values, suggesting untapped potential for export expansion. This indicates that targeted efforts toward value addition, quality improvement, branding, and product differentiation could

enable India to strengthen its position in higher-value segments of global agricultural trade.

3. The study reveals that India's comparative advantage is both sector- and region-specific, with strong export competitiveness in South Asia and Least Developed Countries for staples and agro-processed goods, driven by geographic proximity, shared consumption patterns, and cost advantages. At the same time, selective advantages in high-value and niche products are observed in developed regions such as the EU and East Asia, underscoring the importance of strategic market diversification, supply chain strengthening, and targeted export promotion.
4. India's agricultural exports demonstrate a high degree of stability in core subsectors such as rice, spices, oilseeds, and marine products, which continue to sustain the country's competitive position in global markets over time. This persistence indicates that comparative advantage in these traditional sectors is resilient and provides a stable foundation for India's agricultural export performance.
5. Evidence of convergence across subsectors suggests that weaker agricultural export categories are gradually improving and narrowing the gap with stronger ones, reflecting a long-term equalisation process within India's export structure. However, the strong persistence of already competitive products points to path dependence, highlighting the need for deliberate policy interventions to accelerate diversification and support lagging subsectors.
6. Although India's agricultural export basket is gradually evolving toward more complex and higher-value products, a significant number of weaker or underperforming sectors continue to exist, indicating substantial scope for diversification and structural upgrading. Targeted investments in infrastructure,

technology adoption, research and development, and value addition can help unlock these untapped opportunities and foster a more sophisticated export structure.

7. The findings indicate a structural shift in India's agricultural export growth from being largely scale-driven in the 1990s, when expansion was influenced mainly by global demand conditions, to increasingly competitiveness-driven growth in the 2010s. This transition reflects improvements in productivity, quality standards, and market penetration, although structural constraints persist in certain commodities and export destinations.
8. Despite improvements in competitiveness, the second-order effects from the CMS decomposition remain inconsistent across decades, pointing to persistent structural barriers such as inadequate infrastructure, limited product innovation, and incomplete adjustment to evolving global demand patterns. These bottlenecks continue to constrain India's ability to sustain export competitiveness over the long term.
9. Export growth during the study period has been driven predominantly by the extensive margin, with diversification into new products and markets playing a greater role than the intensification of existing trade relationships. While commodities such as cereals, sugar, and fruits exhibit strong extensive gains, intensive margin growth remains concentrated in a limited number of products such as meat, cereals, and lac-based products, indicating limited depth in existing export relationships.
10. Economic and institutional factors play a critical role in shaping both extensive and intensive trade margins, with relative agricultural value added, economic freedom, trade agreements, and common language significantly enhancing export diversification and intensification. In contrast, distance and high trade costs exert a

negative influence on trade margins, while relative purchasing power and population dynamics in partner countries produce mixed effects on export outcomes.

11. The analysis confirms that exchange rate movements are statistically significant across all estimation techniques, with appreciation reducing exports and depreciation enhancing competitiveness, consistent with theoretical expectations. However, the magnitude of the exchange rate effect is relatively small compared to domestic production capacity, global prices, and partner-country demand, indicating that structural competitiveness and supply-side factors are the dominant drivers of export performance.
12. The consistently negative and significant coefficients on tariffs and geographical distance reaffirm that trade costs and market access remain major constraints on India's agricultural exports, particularly for bulky and perishable products. Despite trade liberalisation and infrastructure improvements, logistical inefficiencies and trade frictions persist, highlighting the need for sustained investment in trade facilitation, infrastructure, and market access strategies.
13. Finally, the long-run results from PMG–ARDL and System GMM estimations demonstrate that sustainable agricultural export growth depends primarily on structural reforms, productivity enhancement, value addition, and institutional stability rather than short-term macroeconomic shocks. Robustness checks incorporating exchange rate volatility further show that exporters adapt to temporary currency fluctuations, reinforcing the conclusion that long-term competitiveness requires consistent and forward-looking policy support.

7.4. Policy Implications

This analysis assumes importance from a trade policy perspective. Policies should thus be

designed so as to promote exports of items, where the comparative advantage truly lies.

1. **Leverage Core Comparative Advantage:** The study shows that rice, spices, oilseeds, lac/gums/resins, and marine products exhibit high and persistent RCA (Objective 1) and strong RSCA/TBI values (Objective 2). Policies should therefore enhance value addition, processing, certification, and branding to strengthen India's global market presence and capture higher value from these core products.
2. **Promote diversification based on Extensive Margin Findings:** CMS and margin analyses (Objective 3) indicate that export growth is primarily driven by extensive margins, with emerging products like processed cereals, semi-processed oils, and fruits showing untapped potential. Targeted promotion of these products in new or growing markets can expand India's export portfolio and reduce reliance on traditional commodities.
3. **Strengthen Productivity in Weaker Subsectors:** Beta convergence results (Objective 2) highlight positive but gradual adjustment in weaker subsectors such as animal/vegetable oils, edible fruits, and dairy. Policies should focus on technology adoption, improved agronomic practices, and capacity building to accelerate structural catch-up and enhance competitiveness across all product categories.
4. **Address Structural and Trade Barriers:** CMS findings (Objective 3) show that trade margins are constrained by distance, tariffs, and infrastructural bottlenecks. Policies must prioritise logistics improvements, reduction of transaction costs, and targeted trade agreements to enhance access to high-growth partner markets.

5. **Enhance Competitiveness alongside Exchange Rate Stability:** While the study finds that bilateral exchange rate effects are limited (Objective 3), structural and supply-side factors significantly influence export performance. Policies should maintain exchange rate stability while emphasising productivity improvements, quality upgrades, and efficiency enhancements to sustain long-term competitiveness.
6. **Adopt Market-Specific Strategies:** Regional RCA analysis (Objective 1) reveals strong competitiveness in South Asia and LDCs for staples, and selective high-value advantages in the EU and East Asia. Policies should therefore combine supply-chain efficiency with region-specific marketing, trade promotion, and partnership strategies to exploit market-specific opportunities.

7.5. Direction for Future Research

Future research could substantially deepen the analysis of India's agricultural comparative advantage by moving to more disaggregated product classifications, such as the HS-8 level, thereby capturing micro-level competitiveness and niche products that may be concealed at higher levels of aggregation. Such granularity would allow researchers to identify emerging export strengths and product-specific constraints with greater precision. In addition, incorporating quality-adjusted revealed comparative advantage (RCA) measures that account for product grades, certifications, branding, and value addition would refine assessments of India's true global competitiveness. Comparative analyses with other emerging agricultural exporters could further situate India's performance within global value chains and shed light on relative upgrading and diversification trajectories. From a dynamic perspective, future studies may go beyond conventional convergence and stability testing by examining spatial dependence and non-linear adjustment processes

within India's agricultural export structure. Incorporating climatic shocks, technological diffusion, and targeted policy interventions would offer deeper insights into the persistence of comparative disadvantage in certain subsectors and the resilience of export performance over time. Moreover, sub-national analyses at the level of states or agro-climatic zones could uncover significant spatial heterogeneity in production capabilities and export potential that remains unexplored in national-level studies.

Building on the Constant Market Share (CMS) framework, further research could extend the temporal scope or explicitly assess the impact of external shocks, such as global financial crises, trade disruptions, or pandemics, on both the intensive and extensive margins of agricultural exports. The integration of firm-level export data would enable an examination of heterogeneity between large agribusiness firms and smallholder producers, thereby linking micro-level behaviour with aggregate export outcomes. Extending CMS analysis to service-linked agricultural exports, such as logistics, processing, and agri-services, could also capture emerging patterns in agricultural trade.

With respect to exchange rate dynamics, future studies could employ high-frequency data to analyse short-term pass-through effects and exchange rate volatility, while also examining the role of hedging instruments in mitigating currency risk. Bilateral exchange rate analyses with key trading partners may reveal asymmetric responses across developed and developing markets. Finally, cross-cutting methodological advances, such as integrating product space analysis, environmental sustainability indicators, and machine learning-based predictive models, could provide richer insights into the evolution of comparative advantage, export growth, and trade margins under diverse policy regimes and global demand conditions.

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