Journal of Spices and Aromatic Crops
Vol. 34 (1) : 72-80 (2025)
10.25081/josac.2025.v34.i1.9777

Indian Society for Spices

Determinants of spice exports in India: A panel data regression analysis

M Vilasini[1*] & S Gopalsamy[2]
[1]*School of Arts and Science, VMRF, Chennai.*
[2]*Department of International Business, Alagappa University, Karaikudi - 630004, Tamil Nadu*
Email: vilasini9518@gmail.com

Received 11 January 2023; Revised 30 July 2025; Accepted 20 August 2025

Abstract

This study aims to investigate the determinants of spices namely pepper, cinnamon and clove exports in India using panel data regression analysis, with a focus on the impact of distance, population size, exchange rate of the importing country and import value and volume of the spice imported by India. The secondary data was collected for a period of ten years (2012–2021) and analyzed among the five major spice export markets of India. Our findings suggest that total export volume, exchange rate, and distance between exporting and importing countries have a positive and significant effect on spice exports, while an importing country's population size has a negative impact. Overall, the study provides insights into the factors that determine spice exports. Our finding may have implications for policymakers, setting export prices, and developing a refined strategy for spice exports from India.

Keywords: Spice export, panel regression, supply-side, demand-side

Introduction

Spices play a substantial role in the realm of international trade. India holds the distinction of being the world's largest spice producer. According to the ((FAO, 2020, as cited in Helgi Library, n.d.), n.d.) global spice consumption reached 12,269 kilograms in 2020, marking a 2.3 percent increase compared to the previous year. India's contribution to the world's spice consumption in 2020 was projected to be 39 per cent. The International Organization for Standardisation (ISO) states that out of the 109 spice varieties listed, India produces 75. Among these spices, three major ones export of pepper, cinnamon, and clove have been chosen for this study. This paper delves into the export dynamics of these spices from India. In the face of the Covid-19 pandemic, India's spice exports managed to maintain their upward trajectory, setting a new record high of 30,987 crore and 17.59 lakh MT (metric tons) in 2020–2021, according to the annual report of the Spices Board. Despite the challenges posed by the pandemic, the actual volume of spice exports for the year reached 15,31,154 MT, valued at 30,576.44 crore (US $4,102.29 million). Although slightly lower than the previous fiscal year's export volume of 17,58,985 MT, worth 30,973.32 crore (US $4,178.80 million),

these figures are a testament to the resilience of India's spice trade.

During this reporting period, India exported 225 different types of spices and spice products to over 180 countries. Notable among these trading partners are China, the US, Bangladesh, Thailand, the UAE, Sri Lanka, Malaysia, and the UK. The country is ranked as the largest producer and exporter of spice globally. Pepper stands out as a major spice in India's export portfolio. Peppers play a pivotal role in the spice trade, being one of the most traded commodities on the global market. In recent times, the demand for pepper has witnessed a notable surge. Further cementing study findings show India's position as the world's second-largest producer of this spice (Yogesh & Mokshapathy, 2013).

Cinnamon has experienced a substantial increase in global demand due to shifts in food preferences worldwide. Despite this growth, Indian cinnamon maintains its esteemed reputation, due to its widespread usage in sweet and savory dishes, beverages, confectionery items, and its traditional medicinal properties. Clove, another highly prized spice, finds its roots in India. Beyond its significance in the culinary realm, the cosmetic and pharmaceutical sectors also rely heavily on cloves, bolstering the export sector. Export prices play a pivotal role in assessing a country's international competitiveness. Extensive research in the field of international trade has explored various dimensions of export prices. Studies have adopted diverse methods to gauge export competitiveness and dissect the factors influencing export prices. One such study (Daulika *et al*., 2020)while to analyze the position competitiveness of Indonesian natural rubber that is by using a revealed comparative advantage (RCA delves into Indonesian rubber exports, analysing export competitiveness and the driving factors behind rubber prices. Similarly, Bui & Chen (2017) conducted an in-depth analysis of factors impacting rice exports in Vietnam. This study identifies key determinants, including total rice production, distance, exchange rates, population, GDP, and income per capita in exporting and importing countries. Wardani *et al*. (2018) examine Indonesia's food exports, pinpointing factors like population size, real exchange rates, export prices, trade openness, and tariffs that shape export competitiveness. Darshani *et al*. (2020) the Sri Lankan spices sector is still left behind its exact potential as spices account only for 1 percent of total exports of Sri Lanka. Therefore, this study examines the main determinants of the export flow of spices in Sri Lanka. Secondary data from the first quarter of 2010 to the fourth quarter of 2018 were used. The single equation error correction technique, which is mostly used to analyse nonstationary data, was employed for the analysis. Results revealed that the export volume of spices mainly depends on world GDP (44.9849 explored Sri Lankan spice exports, unveiling the influence of variables like Sri Lankan GDP, world GDP, real wage rate index, and productivity on export volumes and values. Other researchers (Sachitra & Chong, 2015; Abdullahi *et al*., 2021); Kiani *et al*., 2018; Gunduz *et al*., 2020; Supriana & Yanti, 2013; Bekele & Mersha, 2019) have undertaken similar investigations into factors driving export performance in various industries and countries. Furthermore, Bekele & Mersha (2019) establish that Ethiopia's coffee exports correlate significantly with the country's GDP, population, distance, institutional quality, and trade openness in the importing nation.

Population and distance variables derive from the foundational concepts of the gravity model and market size theory. Salette & Tinbergen (1965) and Pöyhönen (1963) were the first to apply the gravity model to studies of international trade (measured by distance). Ball & Linnemann (1967) conducted the initial research, which showcased a model that focused on the overall balance of imports and values within the economy (Tesfaye, 2014). The gravity model's basic formulation explains bilateral trade flows through the attraction of two countries, which is used as a stand-in for the cost of transportation and other considerations.

Market size theory suggests that the size of a market in terms of the population of potential consumers can have a significant impact on the demand for goods and services produced within that market. This theory is proposed

by Krugman (1980) larger markets offer greater opportunities for sales and profitability due to the potential size of the customer base. The present study aims to investigate the determinants of spices namely pepper, cinnamon and clove exports in India using panel data regression analysis, with a focus on the impact of distance, population size, exchange rate of the importing country and import value and volume of the spice imported by India.

Methodology

This study focuses on India's spice exports, analyzing data from its five major trading partners: the USA, UAE, China, Bangladesh, and Thailand. These countries were the top importers of Indian spices between 2012 and 2022. The analysis covers three key commodities and builds upon insights from previous research. The study adopts the gravity model, utilizing panel data sourced from international organizations such as the FAO, the World Bank, and the WTO.

Panel data regression was employed to examine the factors influencing India's spice exports. The methodology involves three main tests: Pooled Ordinary Least Squares (POLS), Random Effects Model (REM), and Fixed Effects Model (FEM). Additionally, the Hausman test was used to determine whether REM or FEM is more appropriate, while the Breusch-Pagan Lagrangian Multiplier (BPLM) test was applied to choose between POLS and REM. The Breusch-Pagan test was also conducted to assess heteroskedasticity in the data.

By identifying key determinants, the research aims to provide valuable insights into the dynamics of India's spice trade. The analysis focuses on stable trade relationships with key partners, making them ideal subjects for this study. With data spanning a decade, the research ensures a comprehensive understanding of export trends and their underlying factors. The findings highlight the role of economic and trade policies in shaping export performance. Additionally, the research sheds light on external market conditions that impact India's spice trade.

The estimation of spice exports for three commodities, namely pepper, cinnamon, and clove, is presented in equations 1, 2, and 3, elucidated below.

Equation 1

$$PEP\_EV_{it} = \alpha it + \beta 1TEQ_{it} + \beta 2POP_{it} + \beta 3ER_{it} + \beta 4\ DIS_{it} + \beta 5TIQ_{it} + \beta 6TIV_{it} + u_{it}$$

Equation 2

$$CIN\_EVit = \alpha_{it} + \beta 1TEQ_{it} + \beta 2POP_{it} + \beta 3ER_{it} + \beta 4\ DIS_{ij} + \beta 5TIQ_{it} + \beta 6TIV_{it} + u_{it}$$

Equation 3

$$CLO\_EVit = \alpha_{it} + \beta 1TEQ_{it} + \beta 2POP_{it} + \beta 3ER_{it} + \beta 4\ DIS_{ij} + \beta 5TIQ_{it} + \beta 6TIV_{it} + u_{it}$$

Where, PEP refers to pepper, CIN refers to cinnamon, CLO refers to clove

EV is the total value of India's whole spices exported, TEQ is the total quantity of India's whole spice exported, POP is the total population of the importing country, ER is the exchange rate of the importing country, DIS is the distance from the importing country, TIQ is the total import quantity of Indian spices, TIV is the total import value of Indian spices, α, $\beta 1$, $\beta 2$ are the coefficients and u is the error term.

Results and discussion

The study conducted spice export estimations using descriptive statistics, along with panel data regression analysis for each respective commodity. The descriptive statistics for all dependent and independent variables related to pepper exports are summarized in the Table 1. The columns provide detailed information on each variable, while the mean values indicate a consistent upward trend over the period from 2012 to 2021.

The determinants of India's pepper export value in the international market were analyzed using Pooled OLS, FEM, and REM. As shown in Table 2, all exogenous variables, except TIQ, are statistically significant. The analysis further reveals that population has a negatively significant effect on pepper exports under Pooled OLS and REM. However, the FEM results indicate that all exogenous

Table 1. Descriptive statistics test for pepper

Variable	Obs	Mean	Std. Dev.	Min	Max
Country	0				
Year	50	2016.5	2.901442	2012	2021
Pepper USD Mn	50	69.15804	58.15255	4.706168	214.0484
PEPPER Qty	50	3.75e+07	4.11e+07	1652957	2.14e+08
Population	50	3.91e+08	5.15e+08	8664969	1.41e+09
Exchange rate	50	25.07295	30.57763	1.381663	85.08
Distance	50	3116.008	2741.462	1173.875	8388.406
Import qty	50	1.31e+08	3.10e+07	6.49e+07	1.68e+08
Total USD Mn	50	509.5239	129.3199	256.1786	696.5798

Table 2. Result of panel data regression analysis for pepper

	Pooled OLS		REM		FEM	
Variable	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
TEQ	.8569402	0.000	.8569402	0.000	.8520361	0.000
POP	-.1930628	0.000	-.1930628	0.000	2.169681	0.306
ER	.1434043	0.000	.1434043	0.000	.14641	0.857
Dis	.8606033	0.000	.8606033	0.000	0	
TIQ	-.2451426	0.188	-.2451426	0.181	-.2878716	0.141
TIV	.3679162	0.031	.3679162	0.026	.2682462	0.166
Cons	-11.869	0.000	-11.869	0.000	-47.95881	0.213
N		50		50		50
R-sq		0.9753		0.9753		0.0970
Significance	F(6,43)= 283.46		Waldchi2(6)=1700.78		F(5,40)= 159.91	
Hausman test					chi2(5)=1.28 Prob>chi2 =0.9366	
BPLM test	Prob>chibar2 =1.0000					
BreuschGod freyLM test	Prob>chi2=0.0827					
BP/C-W test		0.0827				

variables are statistically insignificant, except for TEQ and DIS, which exhibit a positive effect on spice exports. Based on the Breusch-Pagan Lagrangian Multiplier (BPLM) test, Pooled OLS is identified as the best-fit model for this study.

The descriptive statistics for all dependent and independent variables related to pepper exports are summarized in the Table 3. The dataset includes observations from 2012 to 2021, covering a 10-year period. With the exception of total quantity and total trade value, all variables exhibit a positive upward trend over this period. The minimum value of 0 indicates that there were instances of no cinnamon exports during certain periods.

The determinants of India's cinnamon export value in the international market were analyzed using Pooled OLS, FEM, and REM. The results indicate that TEQ has a significant

Table 3. Descriptive test for cinnamon

Variable	Obs	Mean	Std. Dev.	Min	Max
Country	0				
Year	50	2016.5	2.901442	2012	2021
Cinnamon trade US	50	.3851283	.9203359	0	4.229784
Cinnamon qty	50	68700.56	140159.7	0	560121
Population	50	3.91e+08	5.15e+08	8664969	1.41e+09
Exchange rate	50	25.07295	30.57763	1.381663	85.08
Distance	50	3116.008	2741.462	1173.875	8388.406
Import Qty	50	1.31e+08	3.10e+07	6.49e+07	1.68e+08
Total Import US	50	509.5239	129.3199	256.1786	696.5798

positive effect on cinnamon exports across all models, while POP exhibits a significant negative effect in three models. DIS shows a significant positive effect in two models, whereas ER, TIQ, and TIV are found to have no significant impact on cinnamon exports. The Breusch-Pagan Lagrangian Multiplier (BPLM) test identifies the Pooled OLS model as the best fit, while the Hausman test suggests the Random Effects Model (REM) is appropriate. Furthermore, the Breusch-Godfrey LM test confirms the absence of serial correlation, but the BP/C-W test indicates the presence of heteroskedasticity in the data.

Table 5 presents descriptive statistics for clove for the data spanning the 10-year period from 2012 to 2021. Most variables exhibit a positive growth trend, with the exception of quantity and total trade value, which show varying patterns. The minimum value of 0 indicates periods with no recorded clove exports, reflecting instances of inactivity in clove trade during certain timeframes.

Table 6 shows that TEQ has a significant positive effect on clove exports across all models, while POP, ER, TIQ, and TIV do not exhibit significant effects. Distance to market (DIS) demonstrates a positive impact on clove exports in specific contexts, though this effect may vary across regions. The R-squared values indicate that the independent variables explain a substantial proportion of the variation in clove exports in both the Pooled OLS and REM models. However, the Hausman test suggests that the Pooled OLS model is preferred over the REM model.

As per the results of the pooled OLS model, the robust OLS model for pepper, cinnamon, and clove given in Table 2, Table 4, and Table 6 shows that total export quantity, exchange rate, and distance show positive significance with export value, and population shows negative significance with export value. Larger populations may also include a significant segment that is price-sensitive. If Indian pepper is priced higher compared to competitors. Table 6 shows that only one independent variable, total export quantity, has positive significance. The following discusses the explanation for the relationships between independent and dependent variables: Total export quantity (TEQ), which is determined by demand for the product in the market, has a positive relationship with export value. The reason for this could be that when the demand for a product increases, the suppliers are willing to sell more of the product; hence, it shows an increase in export value, which explains the positive relationship.

One of the most important macroeconomic factors, the exchange rate, is typically determined by the supply and demand for each currency in the foreign exchange market. The exchange rate (ER) is positively related to the export value of spices. When the exporting country is a developing country and the importing country is a developed nation, an

Table 4. Results of panel regression analysis for cinnamon

Variable	Pooled OLS		REM		FEM		Pooled OLS(robust)	
	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
TEQ	.8015768	0.000	.8015768	0.000	.8022715	0.000	.8015768	0.000
POP	-.3799467	0.000	.3799467	0.000	4.254728	0.583	-.3799467	0.000
ER	.0348484	0.822	.0348484	0.821	-1.442071	0.571	.0348484	0.863
Dis	1.323013	0.000	1.323013	0.000	0		1.323013	0.000
TIQ	.2044025	0.744	.2044025	0.742	-.1726933	0.778	.2044025	0.742
TIV	.1873853	0.754	.1873853	0.752	-.0481536	0.943	-.1873853	0.729
Cons	-16.68536	0.062	-16.68536	0.054	-82.79165	0.548	-16.68536	0.074
N		50		50		50		50
R-square		0.9622		0.9622		0.2837		0.9622
Significance	F(6,43)=144.06		Waldchi2(6)=864.8		F(5,31)= 24.56		F(6,34)= 150.17	
Hausman test	chi2(5)= 5.26Prob>chi2 =0.3845							
BPLM test	Prob>chibar2=1.0000							
Breus-chGd frey-LM test	Prob>chi2=0.0074							
BP/C-W test	Prob>chi2=0.0003							

Table 5. Descriptive test for clove

Variable	Obs	Mean	Std. Dev.	Min	Max
Country	0				
Year	50	2016.5	2.901442	2012	2021
Cloves trade US	50	0.39307	0.660456	0	2.487503
Cloves qty	50	47896.74	66913.54	0	281744
Population	50	3.91E+08	5.15E+08	8664969	1.41E+09
Exchange rate	50	25.07295	30.57763	1.381663	85.08
Distance	50	3116.008	2741.462	1173.875	8388.406
Import Qty	50	1.31E+08	3.10E+07	6.49E+07	1.68E+08
Total Import US	50	509.5239	129.3199	256.1786	696.5798

Table 6. Results of panel regression analysis for clove

Variable	Pooled OLS		REM		FEM	
	Coef.	P>|t|	Coef.	Coef.	P>|t|	Coef.
TEQ	7713388	0.000	.7713388	0.000	.8022715	0.000
POP	-.1963949	0.180	-.1963949	0.171	4.254728	0.583
ER	.0018306	0.991	.0018306	0.991	-1.442071	0.571
Dis	1.199516	0.005	1.199516	0.003	0	
TIQ	1.516289	0.094	1.516289	0.085	-.1726933	0.778
TIV	-.2379307	0.782	-.2379307	0.780	-.0481536	0.943
Cons	-42.43091	0.002	-42.43091	0.001	-82.79165	0.548
N		50		50		50
R-sq		0.9201		0.9201		0.0003
Significance		F(6,36)=69.14	Waldchi2(6)= 414.84			F(5,33)= 33.91
Hausman test	chi2(5) = 17.52 Prob>chi2 =0.0036					
BPLM test	Prob>chibar2=1.0000					
Breusch God-freyLM test	Prob>chi2=0.0619					
BP/C-W test	0.0619					

increase in the exchange rate of the importing country do not have a negative influence on the value of goods imported. However, these findings are inconsistent and show a negatively significant relationship between the exchange rate and spice export value which contrasts with the studies of Gachena *et al.*, (2020); Supriana & Yanti, 2013; Sharma, 2020; Abolagba *et al.*, 2010) but is consistent with the findings of Eshetu & Mehare, (2020). Some previous studies found a positive and significant relationship between the exchange rate and agricultural export volume.

The result obtained indicate that distance has a positive and significant impact on export value. Distant countries often have limited access to high-quality spices due to geographical constraints. Indian spices, known for their superior quality and unique flavors, are sought after in these markets despite the higher transportation costs. The findings of the study differ from those of certain previous studies. Vijith Krishnan, (2016) established negative effects on the Ethiopian spice export value. Kiani et al. (2018) reported negative relationship on the agriculture exports of Pakistan.

The results of the current study show that population has a significant negative impact when importing countries' populations increase. As a result, the findings show a negative relationship between the export value and the population, and the study's findings contradict the findings of Supriana & Yanti, (2013) who found that the population positively influences the export value. and the study findings concur with our findings that population negative significant in the Turkey cotton export report by (Gündüz et al., 2020). The studies also found a negative impact on basmati rice exports in Pakistan (Hayat & Khatoon, 2021).

Conclusion

This study employed panel regression to examine the factors that influence the export of selected spices, such as pepper, cinnamon, and clove, to India. The pooled ordinary least squares (OLS) and pooled OLS (robust) models yielded positive significant relationships

between total export quantity (TEQ) and spice exports for all three commodities. Additionally, for pepper and cinnamon, exchange rate (ER) and distance (DIS) were found to have significant positive relationships with spice export, while population (POP) had a significant negative relationship with spice export. In summary, the study analyzed the impact of different variables on the export value of spices. Positive relationships were found between TEQ and EV for pepper and cinnamon, as well as clove. However, a negative relationship was found between ER and EV, and POP showed a negative relationship with EV. Other variables had an insignificant relationship.

References

Abdullahi NM, Aluk & Huo X 2021 Determinants, efficiency and potential of agri-food exports from Nigeria to the EU: Evidence from the stochastic frontier gravity model. Agric. Econ. (Czech Republic) 67(8): 337–349. https://doi.org/10.17221/15/2021-AGRICECON

Abolagba EO, Onyekwere NC, Agbonkpolor BN & Umar HY 2010 Determinants of agricultural exports. J. Hum. Ecol. 29(3): 181–184. https://doi.org/10.1080/09709274.2010.11906261

Ball RJ & Linnemann H 1967 An econometric study of international trade flows. Econ. J. 77(306): 366. https://doi.org/10.2307/2229319

Bekele WT & Mersha FG 2019 A dynamic panel gravity model application on the determinant factors of Ethiopia's coffee export performance. Ann. Data Sci. 6(4): 787–806. https://doi.org/10.1007/s40745-019-00198-4

Bui THH & Chen Q 2017 An analysis of factors influencing rice export in Vietnam based on gravity model. J. Knowl. Econ. 8(3): 830–844. https://doi.org/10.1007/s13132-015-0279-y

Darshani MMG, De Silva N & Ekanayake HKJ 2020 Determinants of export performances of Sri Lankan spices. Uva Wellassa Univ. Sri Lanka.

Daulika P, Peng KC & Hanani N 2020 Analysis on export competitiveness and factors affecting natural rubber export price in Indonesia. Agric. Soc. Econ. J. 20(1): 39–44. https://doi.org/10.21776/ub.agrise.2020.020.1.6

Eshetu F & Mehare A 2020 Determinants of Ethiopian agricultural exports: A dynamic panel data analysis. Rev. Market Integr. 12(1–2): 70–94. https://doi.org/10.1177/0974929220969272

FAO 2020 Global spice consumption statistics (as cited in Helgi Library, n.d.). Retrieved March 3, 2023, from https://www.helgilibrary.com/charts/which-country-eats-the-most-spice

Gachena D, Haji J, Legesse B & Ketema M 2020 Determinants of export performances of major spices (turmeric and korarima) in Ethiopia. East Afr. J. Sci. 14(2).

Gunduz FF, Özlem A & Gündüz S 2020 Determination of the factors affecting cotton export of Turkey: A panel gravity model approach. The Academic Elegance 13: 547-564

Hayat MM & Khatoon R 2021 Determinants of Basmati exports from Pakistan: A panel data analysis. J. Econ. Impact 3(1): 12–18. https://doi.org/10.52223/JEI3012102

Kiani A, Muhammad H & Siddique A 2018 Determinants of agricultural exports of Pakistan: An application of gravity model. Dialogue 8(4): 467–478.

Krugman P 1980 Scale economies, product differentiation, and the pattern of trade. Am. Econ. Rev. 70(5): 950–959.

Pöyhönen P 1963 A tentative model for the volume of trade between countries. Weltwirtschaftliches Arch. 90: 93–100.

Sachitra V & Chong S 2015 Enhancing competitive advantage of Sri Lankan minor export crops. J. Glob. Econ. Manage. Bus. Res. 4(4): 185–194.

Salette G & Tinbergen J 1965 Shaping the world economy: Suggestions for an international economic policy. Rev. Écon. 16(5): 840. https://doi.org/10.2307/3498790

Sharma C 2020 Exchange rate volatility and exports from India: A commodity-level panel data analysis. J. Financ. Econ. Policy 12(1): 23–44. https://doi.org/10.1108/JFEP-11-2018-0157

Supriana T & Yanti CW 2013 Prospect of Indonesia black and white peppers export. Econ. J. Emerg. Mark. 5(1): 1–14. https://doi.org/10.20885/ejem.vol5.iss1.art1

Tesfaye E 2014 Determinants of agricultural export in Sub-Saharan Africa: Evidence from panel study. Am. J. Trade Policy 1(2): 62–70. https://doi.org/10.18034/ajtp.v1i2.364

Vijith Krishnan K 2016 Impact of non-tariff barriers on Indian exports: An econometric analysis. J. Trop. Agric. 54(2): 144–152.

Wardani MA, Mulatsih S & Rindayati W 2018 Competitiveness and factors affecting Indonesian food industry's export to Regional Comprehensive Economic Partnership. Etikonomi 17(2): 185–198. https://doi.org/10.15408/etk.v17i2.7239

Yogesh M & Mokshapathy S 2013 Production and export performance of black pepper. Int. J. Humanit. Soc. Sci. Invention 2(4): 36–44.