

Stability Analysis of Indian Spices Export – A Markov Chain Approach

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ABSTRACT

Spices are an important horticultural crop of India as it adds substantially to the agriculture GDP. It has been seen that there is high fluctuations in the export of spices to other countries. To, this end, we employ the concept of Markov chain (MC) to analyze the dynamics of spices export to different countries of the world. It was observed that the countries which were stable destination for Indian spices export were Canada for black pepper, UK for chilli, Bangladesh for turmeric, UAE for cumin and Malaysia for coriander. The transitional probability matrix obtained using MC indicated that most of the traditional importers have shown low retention probability which may be due to tough competition arising in spices trade and trade related barriers in the developed nations. So, policies may be framed by planners for export towards these countries. Though in most of the spices, India has managed to retain one of its original markets, but it should not have high dependency on one market alone to avoid trade risk in the long-run. New markets also need to be explored and more stress has to be given to the traditional buyers for maintaining present status of export and market share in future.

Keywords: Spices, Export, Transitional probability matrix, retention probability, markov chain

India has been traditionally recognized as a 'land of spices', as a wide variety of spices is grown in the country since ancient times. Spices have been playing an important role in the Indian agrarian economy as it accounts for 5 percent of the agriculture GDP of the country. Indian spices exports have been able to record strident gains in both volume and value. Spices exports have registered substantial growth during the last five years, registering a compound annual average growth rate of 21% in value and 12% in volume (Spices board, 2013). About 75 different spices are grown in India and it exports around 54 varieties of spices. Indian spices flavor foods in over 130 countries and their intrinsic value make them distinctly superior in terms of taste, colour and fragrance. USA, Canada, Germany, Japan, Saudi Arabia, Kuwait, Bahrain and Israel are some of the main markets for Indian spices, having import demand for many of the spices. But gradually there

is now stiff international competition from other spices producing nations such as Vietnam (for black pepper), Guatemala (for cardamom) and China (for ginger) etc. that have emerged as strong contenders in spices production and export. Under such a scenario, it is appropriate to examine the direction and stability of exports of major spices grown in the country to various markets with a suitable econometric model, which may help us to quantify the shifts in the shares to different markets as well as between the markets over a period of time. So, accordingly probability model based on Markov chain approach is considered for the present study. There is a growing awareness of the usefulness of this technique for analysis in many areas including exports, particularly when the process is constant but has a gradual change (Eswarprasad *et al.*, 1997). Hugar (2002) used the Markov chain approach to analyze onion export markets and it's stability

for increasing India's exports. Sananse *et al.* (2004) studied basmati rice export from export potential point of view and found that rice has greater competitiveness. Mahadevaiah *et al.* (2005) analyzed the dynamics of changes in the export of cotton from India by estimating the probability of retention and switching pattern by employing a first order Markov chain model. Purohit *et al.* (2008) used two state Markov chain model to find the probabilities of occurrence of dry and wet weeks and also carried out weekly analysis of rainfall at Bangalore.

In the present study, five major spices, viz. black pepper, chilli, turmeric, cumin and coriander are considered as they have the foremost position in value terms in the world spice trade. These five spice crops together accounts for over 75 per cent of total spices exported from the country. So in lieu of the above scenario it becomes imperative to trace the export potential and stability of these major spices.

Data base and Methodology

In this paper, the structural change in spices exports from India in terms of market retention and market switching was examined by using the Markov chain approach. Country wise export data (in quantity terms) for the period 2002-03 to 2012-13 was collected from Spices Board.

The estimation of the transitional probability matrix (P) was central to this analysis. The element P_{ij} of the matrix indicated the probability that the exports would switch from the i^{th} country to j^{th} country over a period of time. The diagonal elements P_{ij} indicated the probability that the export share of a country would be retained in the successive time periods, which in other words, measured the loyalty of an importing country to a particular exporting country. The off-diagonal or transfer probabilities indicate the probability that the export share of a particular country will shift to another country over time. Thus, the export share of a country during period 't' was obtained by multiplying the actual exports in the previous period (t-1) with transition probability matrix.

In the context of the current application, there were six major importing countries considered for each five spices. The average export to a particular country was considered to be a random variable

which depends only on its past export to that country which was denoted algebraically by Eq. (1)

$$E_{it} = \sum_{i=1}^r E_{it-1} P_{ij} + e_{it} \quad \dots 1$$

Where,

E_{jt} = Exports from India to the j^{th} country during the year t

E_{it-1} = Exports to the i^{th} country during the year t – 1

P_{ij} = Probability that exports will shift from the i^{th} country to j^{th} country

e_{jt} = Error-term which is statistically independent of e_{jt-1} , and

r = Number of importing countries.

The transitional probabilities P_{ij} , which can be arranged in a (c × r) matrix, having following properties: $0 \leq P_{ij} \leq 1$ and

$$\sum_{i=1}^n P_{ij} = 1 \text{ for all } i$$

The transition probability matrix was estimated in the linear programming (LP) framework by a method referred to as minimization of mean absolute deviation (MAD); the LP formulation on analysis was stated as per expression (2)

$$\text{Min } O P^* + I_e \quad (2)$$

Subject to,

$$X P^* + V = Y$$

$$G P^* = 1$$

$$P^* \geq \varphi$$

where, P^* is a vector of the probabilities P_{ij} ; O is a null vector; I is an appropriately dimensional vector of areas; e is the vector of absolute errors (| U |); Y is the vector of exports to each country; X is a block diagonal matrix of lagged values of Y; V is the vector of errors; and G is a grouping matrix to add the row elements of P arranged in P^* to unity. P^* vectors were arranged to obtain the transitional probability matrix which indicated the overall structure of the transitions that had taken place in the system. Essentially, the transitional probability matrix captures the dynamics of the changes in major spices exports from India.

Table 1. Transitional probability matrix of Indian black pepper export (2002-03 to 2012-13)

Country	USA	UK	Canada	Italy	Germany	Russia	Other countries
USA	0.0006	0.4520	0.0729	0.0945	0.2505	0.1274	0.0020
UK	0.0091	0.0029	0.0013	0.2247	0.4024	0.3592	0.0005
Canada	0.0159	0.0000	0.1944	0.2621	0.3052	0.2223	0.0000
Italy	0.0009	0.0373	0.0990	0.1400	0.1706	0.5522	0.0000
Germany	0.1838	0.5069	0.0000	0.0000	0.0000	0.1419	0.1673
Russia	0.9324	0.0000	0.0125	0.0177	0.0279	0.0089	0.0007
Others	0.0911	0.4830	0.0004	0.0016	0.1827	0.2411	0.0000

Results and Discussion

The changing pattern of spices exports were estimated by obtaining the transitional probability matrices for the annual export data of five major spices, black pepper, chilli, turmeric, cumin and coriander (in terms of quantity) for the period 2002-03 to 2012-13. Six major importers of each spice were considered for analysis. The spice trade with the remaining countries was pooled under 'other countries'. The results of transitional probability matrix for different spices are presented below.

Black pepper

The major black pepper importers from India, i.e. USA, UK, Canada, Italy, Germany and Russia were considered for analysis. It is evident from Table 1 that Canada was the most stable importer of Indian pepper, as reflected by the retention of 19.44 per cent share in the study period. USA has shown low probability retention of 0.06 per cent. The main problem faced by Indian pepper is the high cost of production and low yield compared to other countries. Periodic surges or sharp declines in the Indian spice export were normally associated with fluctuations in the world pepper prices. Unlike India, other producing countries do not have much domestic consumption and with a higher productivity and less production cost, they have become more competitive. This has resulted in decreased volume of exports from India which has taken up by Vietnam in recent past becoming largest producer and exporter of black pepper in the world. (Yogesh and Mokshapathy, 2013) Besides Canada, Italy comes out to be the second most stable importer of black pepper retaining 14 per cent share. Germany

and countries pooled as 'other countries' reported zero transition probability, indicating instability in India's exports to these countries. It is interesting to note that USA having low retention probability of 0.0006 is likely to gain from Russia (93%), Germany (18%) and other countries (9%). Likewise, UK having low retention probability of 0.0029 is likely to gain from Germany (51%), others (48%) and USA (45%). Germany having zero probability of retention of its own share is likely to gain 40 per cent from UK, 30 per cent from Canada, 25 per cent from USA and 17 per cent from Italy.

Chilli

Transitional probability matrix of chili export (Table 2) indicated that UK, with the highest retention probability of 98 per cent emerged out to be the most stable and loyal market for Indian chilli. Malaysia, Sri Lanka, and UAE were other important importers of chilli from India who have maintained their loyalty with the country, retaining a share of 70 per cent, 38 per cent and 38 per cent respectively. Interestingly, the 'other countries' category which is the minor importers of chili shows a retention probability of unity. This suggests beneficial trade with these nations. UK, in addition to its high retention ability is likely to gain from the switch over from USA and UAE with a high probability of 0.4465 and 0.3621 respectively. Bangladesh was found to be the most unstable importer showing zero retention probability, losing about 43 per cent of its share to Sri Lanka, 20 per cent to USA, about 13 per cent to UK and UAE and 9.23 per cent to Malaysia. While USA retained about 27 per cent of its previous share of chilli exports from India but lost 44.65 per cent

Table 2. Transitional probability matrix of Indian chilli export (2002-03 to 2012-13)

Country	Malaysia	Bangladesh	Sri Lanka	USA	UAE	UK	Others countries
Malaysia	0.6992	0.0000	0.1339	0.0619	0.0537	0.0000	0.0514
Bangladesh	0.0923	0.0000	0.4249	0.2006	0.1376	0.1446	0.0000
Sri Lanka	0.0961	0.2400	0.3786	0.1337	0.0061	0.0000	0.1455
USA	0.0000	0.0473	0.1396	0.2701	0.0000	0.4465	0.0964
UAE	0.1744	0.0000	0.0000	0.0426	0.3841	0.3621	0.0368
UK	0.0000	0.0024	0.0000	0.0000	0.0170	0.9805	0.0000
Others	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000

of its previous share to UK. UAE also lost about 36 per cent of its previous share to UK. This shows that export of Indian chilli have strong preference for UK in the export market. Even though Indian dry their export in the international market. Therefore, in order to overcome this bottle neck and to capture higher share in the world trade, much emphasis needs to be laid on quality improvement of dry chillies, apart from cost efficiency in their production, use of standard packing and simplification in export procedure in order to maintain India's dominance in world market. (Mamatha, 1996).

Turmeric

The transitional probability matrix witnessed that the countries pooled under the category of 'other countries' was found to be stable importer of Indian turmeric retaining the highest share with a retention probability of 0.9933. Rest almost all countries failed to retain a high share of import over the years. Bangladesh though managed to retain 4.52 per cent of its original share which is still higher than any other individual countries share in turmeric export. It is noteworthy to see that UAE which was a loyal importer of Indian turmeric in the past would lost its share of about 60 per cent to Bangladesh and 26 per cent to UK, but gained a share of 59.85 per cent from Japan. In future its share may be reduced from total turmeric traded from India. The country like China gives stiff competition to India in turmeric trade. USA would lose its maximum share (90.27%) to Japan. UK would lose its maximum share to USA (70.64) and Bangladesh to UK (86.66%). One of the reasons for low retention probabilities of traditional importer of turmeric is that Indian turmeric is high priced, so the importing countries import from other

countries like Burma and Thailand where the price is comparatively low. Secondly, in many areas such as, food, textiles and cosmetics, turmeric is being replaced by synthetic chemicals, as a coloring agent, Angles *et al.* (2011).

Table 3. Transitional probability matrix of Indian Turmeric export (2002-03 to 2012-13)

	UAE	Japan	USA	Iran	UK	Bangladesh	Other countries
UAE	0.0015	0.0032	0.0104	0.0001	0.2610	0.6024	0.1214
Japan	0.5985	0.0347	0.3083	0.0367	0.0156	0.0061	0.0000
USA	0.0058	0.9027	0.0313	0.0007	0.0595	0.0000	0.0000
Iran	0.2642	0.0158	0.3875	0.0223	0.2055	0.0956	0.0092
UK	0.0001	0.0006	0.7064	0.2828	0.0018	0.0005	0.0079
Bangladesh	0.0093	0.0165	0.0197	0.0002	0.8666	0.0452	0.0425
Others	0.0025	0.0000	0.0000	0.0006	0.0006	0.0030	0.9933

Cumin

As observed from the Table 4, UAE was found to be the stable market among major importers of cumin from India as reflected by the retention of 32.42 per cent share over the study period. Thus UAE is the most reliable and loyal market for Indian cumin as evident by the transitional probability matrix. USA with 0.2292 probability of retention is the second stable importer of Indian cumin. UK retained about 5 per cent share. Nepal, Japan and Malaysia were the most unstable markets for cumin. USA lost 25.27 per cent of its share to UK and about 25.71 per cent of its share to Japan. Nepal lost almost its entire share (99%) to USA, which mean in future USA can gain its share from Nepal, but Nepal is likely to gain 22

Table 4. Transitional probability matrix of Indian cumin export (2002-03 to 2012-13)

Country	USA	Nepal	UAE	UK	Japan	Malaysia	other countries
USA	0.2292	0.0005	0.0934	0.2527	0.2571	0.0449	0.1223
Nepal	0.9902	0.0004	0.0002	0.0002	0.0002	0.0087	0.0000
UAE	0.1246	0.0101	0.3242	0.0416	0.2448	0.1572	0.0975
UK	0.2503	0.2196	0.4644	0.0491	0.0001	0.0166	0.0000
Japan	0.0001	0.0047	0.0001	0.9862	0.0002	0.0087	0.0000
Malaysia	0.0005	0.0092	0.0092	0.0138	0.8949	0.0008	0.0716
others	0.0044	0.0024	0.0128	0.0078	0.0033	0.0169	0.9522

per cent share from UK. UAE, in addition to its high probability of retention is likely to gain from the switch over from UK with high probability of 0.4644. Similarly UK having its low probability of retention (4.91%) is likely to gain from switch over from Japan and USA with a high probability of 0.8949 and 0.2571. Japan like Nepal has almost zero retention probability of its own share of imports of India cumin but is likely to gain about 89 per cent from Malaysia, 26 per cent from USA and 24 per cent from UAE. Similarly, Malaysia, which also has a very low probability of retention of its own share of import, is likely to gain from UAE (16%) and USA (4.49%). The countries pooled under the 'other countries' category retained 95 per cent of its original share, which implied that even though they import in lower quantities, there is high stability, they have retained most of its original share. Hence, compared to major importing countries at present, the countries pooled under 'others category' would import more cumin from India in near future. In addition to having a reasonably high retention probability (95%) they

are likely to gain from USA (12.23%), UAE (9.75%) and Malaysia (7.16%). The fluctuations in the market shares are due to exports from Syria, Turkey and Iran which have significant influence in the determination of world cumin prices.

Coriander

The Table 5 presents the transitional probability matrices for the annual export data of Coriander. The perusal of the table reveals that Malaysia has been the only stable importer of Indian cumin, as reflected by the high probability of retention, retaining about 23 per cent of share. Thus, Malaysia is most reliable and stable market for Indian coriander. Rest all the countries were found to be unstable markets for India coriander showing very low probability of retention. This is attributed to the stiff competition offered and higher market penetration efforts made by the major coriander exporting countries like Turkey, Egypt Romania Morocco and China. UK and Singapore have reported very low probability retention of 0.0006 and 0.0001 respectively, indicating that they were the unstable importer of Indian coriander. The transition probabilities of remaining countries were also low. UAE depicts 1.4 per cent retention probability of its own share, S. Arabia 0.35 per cent and S. Africa 1.1 per cent, indicating instability in India's export to these countries. The sharp decline in the export of coriander from India reflects our inability to retain our share in the traditional markets and explore new markets. Being a major importer of Indian coriander, if countries lose their share, it will create a high instability in the export of coriander from India in future. The 'other countries' category has remain a stable and loyal market for Indian coriander reporting 32.44 per cent probability of

Table 5: Transitional probability matrix of Indian coriander export (2002-03 to 2012-13)

Country	Malaysia	UAE	UK	S. Arabia	S. Africa	Singapore	Other countries
Malaysia	0.2293	0.0002	0.0002	0.0002	0.0959	0.1760	0.5063
UAE	0.4398	0.0140	0.0867	0.1400	0.1230	0.1921	0.0000
UK	0.0000	0.9882	0.0006	0.0016	0.0012	0.0003	0.0000
S. Arabia	0.0419	0.0079	0.9421	0.0035	0.0020	0.0093	0.0008
S. Africa	0.0001	0.0167	0.0066	0.9045	0.0108	0.0532	0.0001
Singapore	0.0000	0.0001	0.0002	0.0000	0.9916	0.0001	0.0001
Others	0.6753	0.0073	0.0002	0.0002	0.0002	0.0004	0.3244

retention. Malaysia in addition to its high probability of retention is likely to gain from the switch over from 'other countries' (67.53%) and UAE (44%). UAE is likely to gain from UK (99%). UK having very low probability of retention of its own share of import but is likely to gain 94 per cent from S. Arabia and 9 per cent from UAE.

Conclusion

The Markov chain approach to examine the change in direction of export of major Indian spices revealed that the markets which gained its share in export of major spices and shown loyalty are Canada for black pepper, UK for chilli, Bangladesh for turmeric, UAE for cumin and Malaysia for coriander. The transitional probability matrix has indicated that India is likely to lose most of its export share in its traditional markets which have come out to be the most unstable importers such as Germany and USA for black pepper, Bangladesh for chili, UAE and UK for turmeric, Japan, Nepal and Malaysia for cumin and Singapore and UK for coriander. Though in most of the spices India has managed to retain one of its original markets, but India cannot depend excessively on one market alone to avoid trade risk in the long-run. New markets also needs to be explored and more stress has to be given to the countries like USA, UK, UAE, Malaysia and other countries category for maintaining present status of export and market share in future. In the changing economic scenario, where more competitors are lining up in the spices trade, government policy should aim at increasing productivity, reducing cost per unit of production, improving trade standards

and meeting all the trade related barriers which are of greater concerns for the importing nations. This can enhance India's competitiveness in the world market and regain its repute in the spice trade.

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