An Analysis of Indian Sugar Exports: Markov Chain Approach

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Short Research Article

ABSTRACT

India, the world's leading producer and exporter of sugar, plays a crucial role in the food industry due to sugar's sweet flavour and its multifaceted applications as a sweetener, preservative, texture enhancer, colouring agent, flavouring agent, and bulking agent. In the year 2020- 21 India exported an impressive 70 lakh tonnes of sugar, following 59 lakh tonnes in 2019- 20. India's sugar exports reach as many as 121 countries, with Sudan, Myanmar, Sri Lanka, Somalia, the United Arab Emirates, Pakistan, and Iran being some of the most consistent importers. The present study discusses the above approach envisaging the above analysis of Indian sugar exports to different countries from 2001-02 to 2020-21 employed Markov chain analysis, the results unveiled that Sudan retained the lion's share at 89.4% of India's sugar exports, followed by Myanmar at 57.3%, Somalia at 55.8%, Iran at 48%, the United Arab Emirates at 36.6%, Sri Lanka at 28.2%, Bangladesh at 10.7%, Pakistan at 5.4%, with the remaining 56.2% distributed among various other nations. Notably, India maintained loyal sugar exporters in Sudan, Myanmar, Somalia, Iran, the UAE, and Sri Lanka.

Keywords: Export; India; markov chain analysis; sugar; transition probability matrix.

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1. INTRODUCTION

Sugar exports have been a significant part of India's agricultural and economic activities. India is one of the world's top producers and exporters of sugar. The country typically exports sugar to various international markets. The volume of sugar exports from India varied from year to year based on factors like domestic sugar production, international demand, and government policies. India has consistently been one of the world's leading sugar exporters [1-5]. It competes with countries like Brazil and Thailand in the global sugar market. India exports sugar to a wide range of countries across the globe. Some of the major importers of Indian sugar include Sudan, Somalia, Myanmar, Sri Lanka, Iran, the United Arab Emirates (UAE), Pakistan, Bangladesh, and various other nations [6-8]. The volume of sugar exports from India to various countries changes every year as it was influenced by factors such as domestic sugar production, sugar prices, and global demand etc. Indian government need to implement policies related to sugar exports to regulate domestic sugar prices and ensure an adequate supply in the domestic market [9,10]. These policies also change over time based on market conditions [4,5]. While certain countries like Sudan and Myanmar have been consistent importers of Indian sugar, often required a push diversified export markets to reduce dependence on a few nations and to mitigate risks. Indian sugar exporters typically adhere to international quality standards to meet the requirements of importing countries. Market trends and conditions, including international sugar prices and competition from other sugar-producing nations, can significantly impact India's sugar export prospects [11-14]. It's important to understand the export dynamics of Indian sugar, hence, the present study was under taken the analysis of export dynamics of Indian sugar by markov chain approach.

2. MATERIALS AND METHODS

An analysis of structural changes in sugar exports originating from India, specifically focusing on the dynamics of market retention and market switching. To gather the necessary data, it was collected country-wise export data in terms of quantity for the time span ranging from 2001-02 to 2020-21 from the official website of the Food and Agriculture Organization (FAO) at https://www.fao.org.

A critical component of the analysis revolved around the estimation of the transitional probability matrix, denoted as 'P'. Each element within this matrix, denoted as 'Pij,' represented the likelihood that exports would transition from the exporting country 'i' to the importing country 'j' over a defined time period. The diagonal elements of this matrix, 'Pii,' carried the significance of gauging the probability that a specific importing country would maintain its share of imports from the same exporting country in successive time periods. In simpler terms, these diagonal elements served as a measure of the degree of loyalty exhibited by an importing country towards a particular exporting country. In contrast, the off-diagonal or transfer probabilities encapsulated the likelihood that the export share of a given exporting country would shift to another destination country as time progressed.

Consequently, the determination of a country's export share during a specific period 't' was achieved through the multiplication of the actual export quantities in the preceding period (t-1) by the transition probability matrix. This approach allowed to gain valuable insights into the intricate patterns and shifts in sugar exports from India across various destination countries over the examined time frame. 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)

$$E_{jt} = \sum_{i=1}^{r} E_{it-1} P_{ij} \, e_{jt} \tag{1}$$

Where,

E_{jt} = Exports from India to the jth country during the year t.

E_{it-1} = Exports to the ith country during the year t − 1

P = Probability that exports will shift from the ith 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 Pij, which can be arranged in a (c × r) matrix, having following properties: 0 ≤Pij ≤ 1 and

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

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)

Min O P* + Ie   (2)

Subject to, XP* + V = Y GP* = 1

P*≥ϕ

Where,

P* is a vector of the probabilities Pij; 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 sugar exports from India.

3. RESULTS AND DISCUSSION

The dynamics in the direction of sugar export from India were computed using transitional probability matrix and presented in Table 1. The major importing countries are Sudan, Myanmar, Somalia, Iran, UAE, Sri Lanka, Bangladesh, Pakistan, Dijbouti and the remaining importing countries are categorised under others.

Table 1 indicates that the Sudan retained its share (89.4%) remaining (10.6 %) loss distributed among Myanmar and Djibouti with (6.5 %), (4.1 %) and (10.28 %). It gained (15.5 %) share from Myanmar. Myanmar retains its original share of (57.3%) and lost at a share of (15.5%) to Sudan, (15%) to Djibouti and (2.4 %) to UAE. Somalia retains original share of (55.8 %) and lost to Djibouti at a share of (26.2%) and (17.9 %) to other countries. it gained (9.9 %) from Myanmar, (2.6%) from Pakistan and (11.3 %) from other countries. Iran retains its original share up to 48.9%, loss to other countries extent of (51.1 %) and gained (5.6 %) and (3.2%) from Djibouti and Pakistan respectively. UAE retained extent of original share is (36.6%), losses (14 %) to Pakistan and (49.4%) share to other countries and gained from Myanmar (29.4%), Pakistan (8.4 %) and other countries (6.2 %) respectively. Sri Lanka retained its original share extent of (28.2%). Sri Lanka loss (30.1%) to Pakistan, (31.8%) to Bangladesh and (9.9%) share to other countries respectively and gained (14%) share from UAE, 9.5% from Pakistan and (25.3%) share to other countries. Bangladesh retains its original share of 10.7%, lost at an extent of share of (89.3%) to other countries it gains at a share of 31.8 % from Sri Lanka, (13.2%) from Pakistan and (1%) from other countries respectively. Djibouti does not retain any of its original shares but it lost at an extent of (5.6 %) to Iran and (94.4%) to other countries. It gains from (5.1%) from Sudan, (26.2%) Somalia, (15 %) Myanmar and (6.9%) Pakistan. Sugar exports to other countries retain its original share extent of (56.2%). Other countries lost at a share of (25.3%), (11.3%), (6.2%) and (1%) with Sri Lanka, Somalia, UAE and Bangladesh respectively. It gains major share from Djibouti with (94.4%), Bangladesh (89.3%) from Iran, (51.1%), Pakistan (49.8%), UAE (49.4%), Somalia (17.9%) and Sri Lanka (9.9%) respectively.

Table 1. Transitional probability matrix of Indian sugar exports 2001-02 to 2020-21

Countries	Sudan	Sri Lanka	Somalia	Myanmar	UAE	Pakistan	Bangladesh	Djibouti	Iran	others
Sudan	0.894	0	0	0.065	0	0	0	0.041	0	0
Sri Lanka	0	0.282	0	0	0	0.301	0.318	0	0	0.099
Somalia	0	0	0.558	0	0	0	0	0.262	0	0.179
Myanmar	0.155	0	0.099	0.573	0.024	0	0	0.15	0	0
UAE	0	0.14	0	0	0.366	0	0	0	0	0.494
Pakistan	0	0.095	0.026	0.01	0.084	0.054	0.132	0.069	0.032	0.498
Bangladesh	0	0	0	0	0	0	0.107	0	0	0.893
Djibouti	0	0	0	0	0	0	0	0	0.056	0.944
Iran	0	0	0	0	0	0	0	0	0.489	0.511
others	0	0.253	0.113	0	0.062	0	0.01	0	0	0.562

4. CONCLUSIONS

The findings from the Markov chain analysis have revealed a consistent pattern in the export of sugar from India over the past decade. This pattern highlights that the most reliable and steadfast Indian sugar exporters have been Myanmar, Sri Lanka, Somalia, the United Arab Emirates, Pakistan, and Iran. These countries have consistently maintained their positions as key destinations for Indian sugar exports. However, the implications of this study suggest a need for strategic diversification in India's sugar export markets. Relying solely on these limited countries for sugar exports may pose risks and limitations for India's sugar industry in the long term. In light of these findings, the current study's conclusion underscores the imperative to explore and cultivate new markets for sugar exports. By doing so, India can mitigate its over-reliance on the aforementioned nations and enhance the resilience and sustainability of its sugar export industry. Finally, the present study concluded that the Myanmar, Sri Lanka, Somalia, the United Arab Emirates, Pakistan, and Iran have been consistent loyal partners in sugar trade with India, it is crucial for India to proactively seek out new markets to ensure a more diversified and robust future for its sugar export industry.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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