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Export Performance and Trade Competitiveness of India's Frozen Shrimps: A Temporal Analysis

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Authors' contributions

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

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ABSTRACT

Shrimps are crucial aquaculture species that contribute significantly to the economy, including farm income, employment, and export earnings. India, the world's second-largest producer of aquaculture products, has yet to exploit its potential in aquaculture exports fully. The export of frozen shrimp has been increasing due to large consumption by importing countries and sufficient exportable surplus. This study analysed the export competitiveness and direction of exports to

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various markets using the Nominal Protection Coefficient (NPC) and Markov Chain Analysis. The analysis revealed that all countries were competitive in exporting frozen shrimp from India, with the United States, Southeast Asia, and China being the most loyal importers. The study projected shrimp export for the next five years, with the USA being the major destination in the future. However, Japan's share in the future will decrease due to importing frozen shrimp from Indonesia and Vietnam. Policymakers are now attempting to regain trade by adopting suitable policy measures. The study highlights the importance of evaluating export competitiveness and market direction in the era of globalisation and the need for effective trade promotion and price competitiveness.

Keywords: Shrimps; export; NPC; markovchain etc.

1. INTRODUCTION

“India, the second-most populous country in the world, is a major player in the aquaculture industry, contributing to nearly 1% of the Gross Domestic Product (GDP) and 5% of the Agricultural GDP. The aquaculture sector has experienced a double-digit average annual growth of 10.87% since 2014-15, with a record total production of 145 lakh tonnes from 2020-21”[1]. “Shrimp farming, particularly brackishwater aquaculture, has emerged as an alternative source of fish production in India. India is the second largest aquaculture products-producing country globally, accounting for 7.56% of global production. It contributes about 1.24 per cent to the country's Gross Value Added (GVA) and over 7.28 per cent to the agricultural GVA”[1]. “The aquaculture sector has demonstrated an outstanding double-digit average annual growth of 10.87 per cent since 2014-15, with a record total production of 145 lakh tonnes from 2020-21”[2].

Shrimps, known as the "Pinkish Gold" of the sea, are the mainstay of Indian seafood export earnings, with a share of 70% in the seafood export basket in 2020-21. The leading importers of Indian frozen shrimp are the United States of America (USA), China, the European Union (E.U.), Japan, South East Asia (SEA), and the Middle East (M.E). (Anno, 2021b). Shrimp exports from Karnataka are mainly routed through the new Mangaluru and Goa ports. Many state export agencies dealing with frozen shrimp exports are registered with the Seafood Exporters Association of India (SEAI) and the Marine Products Export Development Agency (MPEDA). MPEDA estimates that 10,000 to 15,000 tonnes of shrimp production, worth about Rs. 300-350 crore, are lost annually due to disease problems[3].

The seafood sector is growing into a multimillion-dollar industry with immense potential for the future, as it is one of the fast-moving commodities with persistent demand and high unit value[4-6]. Shrimps have opened a new frontier to tap high-income markets in many importing nations [7-9]. The quality standards of aquaculture products should be high to fetch a better market price in world trade. MPEDA is interested in popularizing shrimp farming in India to earn a better income and improve their standard of living, in addition to contributing to the national income.

2. METHODOLOGY

Perfect knowledge of the design of the study is essential for any scientific enquiry. Hence, a brief discussion of the methodology, nature of data collection and analytical tools employed in achieving the objectives of the study are presented as follows.

2.1 Nature and Sources of Data

For achieving the objectives of the study, secondary data was collected. The secondary data was collected to know the export competitiveness and direction of trade of shrimps and their products from India to other countries, the data were collected from the MPEDA website and other published sources which were used to analyse, direction of trade and competitiveness of India with respect to frozen shrimp and their products from India which throw sufficient light on the international trade performance of shrimps and their products.

2.2 Analytical Tools

2.2.1 Export competitiveness

Trade competitiveness depends upon the level of domestic prices relative to international prices. Comparative advantage in shrimp farming encompasses the entire economic process of

shrimp production to its export. The degree of comparative advantage in shrimp productionand export influences a country's international competitiveness. To reveal the trade competitiveness of Indian frozen shrimp in the world market, the Nominal Protection co-efficient (NPC) was used. The Markov chain technique was employed to direct the trade of frozen shrimp from India.

2.2.2 Nominal protection co-efficient (NPC)

The NPC is a direct measure of the competitiveness of a country towards a commodity in the context of free trade. The nominal protection coefficient (NPC) is the domestic price ratio to the world reference price of the commodity under consideration.
Symbolically,

$$NPC = \frac{Pd}{Pr}$$

Where,

NPC = Nominal Protection Coefficient
P_d = Domestic price of the commodity
P_r = World reference market price of the commodity

In order to make a decision, NPC must be less than one. The commodity is competitive (it is deemed a good import alternative under the importable hypothesis and worth exporting under the exportable hypothesis). The commodity is not competitive (not a good import substitution or not worth exporting) if NPC is bigger than one. The wholesale price of the good in the chosen market is typically the domestic price. The international price that has been modified for marketing, trading margins, transfer costs, and other expenses to make the commodity equal to the internationally traded commodity is known as the reference market price (Table 1).

2.2.3 Markov chain model

The Major frozen shrimp product importing countries from India are the United States of America (USA), Japan, the European Union (E.U.), China, South East Asia (SEA), the Middle East (M.E.) and others.

The major marine products exported from India are frozen shrimp, dried items, living items, and chilled items. Annual export data of shrimp products were used to analyse the direction of trade and the changing patterns of frozen shrimp exports.

“The trade directions of Indian shrimp exports were analysed using the first-order Markov chain approach. The LINGO software was used to analyse the transition probability matrix. Central to Markov chain analysis estimates the transitional probability matrix ‘P’ whose elements, Pij, indicate the probability of exports switching from country ‘i’ to country ’j’ over time. The diagonal element Pij, where i=j, measures the probability of a country retaining its market share or, in other words, the loyalty of an importing country to a particular country’s exports”[2].

Table 1. Tabular representation of nominal protection coefficient (NPC)

Sl. No.	Particulars	Unit	Major Importing Countries			
			1	2	3	4
1.	Wholesale price	Rs./Kg				
2.	Marketing margin (5%)	Rs./Kg				
3.	Port clearing & handling charges	Rs./Kg				
4.	Freight on Board Price (1+2+3)	Rs./Kg				
5.	Freight charge	Rs./Kg				
6	Insurance at 2 % of price	Rs./Kg				
7.	Landed cost (4+5+6)	Rs./Kg				
8.	Exchange rate	1$ = ₹				
9.	Domestic price (Cost, Insurance and Freight) (row 7 / row 8)	US $/Kg				
10.	Reference market price	US $/Kg				
11.	NPC (row 9/row 10)					

Annual export data for 2011-12 to 2020-21 was used to analyse the direction of trade and changing patterns of Indian shrimp exports. In this context, major shrimps importing countries and others were considered. The average exports to a particular country were considered to be a random variable which depends only on the past exports to that country, which can be denoted algebraically as:

$$E_{jt} = \sum_{i=1}^{n} [E_{it-1}P\text{ij} + e\ \text{jt}]$$

Where

E_{jt}= Exports from India to the j^{th} country in the year "t"
$E_{i\ t-1}$ = Exports of i^{th} country during the year t-1
P_{ij} = The probability that exports will shift from i^{th} country to j^{th} country
e_{jt}= The error term which is statistically independent of E_{it-1}
n = the number of importing countries

The transitional probabilities P_{ij}, arranged in a (c x n) matrix, have the following properties.

$$\sum_{i=1}^{n} P_{Ij} = 1 \text{ And } 0 \leq P_{Ij} \leq 1$$

Thus, the expected export share of each country during the period 't' is obtained by multiplying the exports to these countries in the previous period (t-1) with the transitional probability matrix. The probability matrix was estimated from 2011-12 to 2020-21.

Thus, the transitional probability matrix (T) is estimated using a linear programming (L.P.) framework by a method called minimisation of Mean Absolute Deviation (MAD).

$$\text{Min, } OP^* + I\ e$$

Subject to

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

$$GP^* = 1$$

$$P^* \geq 0$$

Where,

P* is a vector of the probabilities P_{Ij}
O is the vector of zeros
I am an appropriately dimensioned vector of area.
e is the vector of absolute errors
Y is the proportion of exports to each country.
X is a block diagonal matrix of lagged values of Y
V is the vector of errors
G is a grouping matrix to add the row elements of P arranged in P* to unity.

Using the estimated transitional probabilities, shrimp exports to various destinations were predicted by multiplying them with the respective shares of the base year. Indian frozen shrimp exports to different countries were predicted for 2021-22 to 2025-26 using 2-step, 3-step, 4-step, and 5-step transitional probabilities.

3. RESULTS AND DISCUSSION

The findings of the study are discussed in depth here. The main goal here was to focus on the causes of the major trends and results obtained. This type of analysis is intended to identify policy measures and implement corrections that can be implemented to overcome the problems.

3.1 Export Competitiveness

Export competitiveness indicates a firm's ability to produce commodities with a certain level of efficiency to compete in the international market. Competitiveness is a dynamic process that needs to be created and sustained. The Nominal Protection Coefficient (NPC) has been used to determine shrimp export competitiveness in the global market. Frozen shrimp is a major marine item exported to other countries. Hence, the study mainly concentrates on the export competitiveness of frozen shrimp.

3.2 Export Competitiveness of Frozen Shrimp

The competitiveness of frozen shrimp exports, the Nominal Protection Coefficient (NPC) was estimated under the exportable hypothesis for the year 2021. The analysis of export competitiveness indicated that all the countries were competitive in exporting frozen shrimp from India, which is evident from NPCs of less than unity.

The nominal protection coefficients of frozen shrimp to different destinations under the exportable hypothesis for 2021 were computed, and the results are presented in Table 2. The estimated NPCs for the European Union and South East Asia suggested they were less

competitive markets with an NPC value of 0.84. Japan followed this with an NPC value of 0.82, and the Middle East, with an NPC value of 0.79, was found to be a moderately competitive market. China and the USA were found to be highly competitive markets with NPC values of 0.70 and 0.76, respectively. Hence, China is the most lucrative market among the studied ones to which frozen shrimp was exported during the study period and also shown in Fig. 1.

The Nominal Protection Coefficient (NPC) technique explains the comparative advantage enjoyed by the commodity in the context of free trade. The analysis of export competitiveness of shrimps, in general, indicated that all countries considered for the study were found to be competitive for shrimps export from India, as it is evident from NPC values less than unity. The NPCs for frozen shrimp exports were estimated under the exportable hypothesis. Similar results were found in the study by Geethalakshmi [10], who reported that the competitiveness of frozen shrimps to the major destinations was competitive and exportable. (Fig. 1) The outcomes of this study revealed that the hypothesis, which states that there is a significant competitiveness in shrimp export, has been proven and, hence, accepted.

Table 2. Export competitiveness of Indian frozen shrimp to major destinations during 2021-22

Sl. No.	Particulars	Unit	Japan	United States of America	European Union	China	South East Asia	Middle East
1.	Wholesale price (All Major Port)	Rs./Kg	450.00	450.00	450.00	450.00	450.00	450.00
2.	Marketing margin (5%)	Rs./Kg	22.50	22.50	22.50	22.50	22.50	22.50
3.	Port clearing & handling charges	Rs./Kg	24.00	34.00	32.00	22.00	26.00	28.00
4.	FOB Price (1+2+3)	Rs./Kg	496.50	506.50	504.50	494.50	498.50	500.50
5.	Freight charge	Rs./Kg	0.65	0.80	0.70	0.60	0.62	0.68
6.	Insurance at 2 % of price	Rs./Kg	9.00	9.00	9.00	9.00	9.00	9.00
7	Landed cost (4+5+6)	Rs./Kg	506.15	516.30	514.20	504.10	508.12	510.18
8.	Exchange rate	$ = Rs.	81.38	81.38	81.38	81.38	81.38	81.38
9.	Domestic price (row 7 / row 8)	US $ / Kg	6.21	6.34	6.31	6.19	6.24	6.26
10.	Reference price	US $ / Kg	7.5	8.3	7.45	8.78	7.36	7.83
11.	NPC (row 9/row 10)		0.82	0.76	0.84	**0.70**	0.84	0.79

Note: FOB: Freight on Board: CIF: Cost, Insurance and Freight

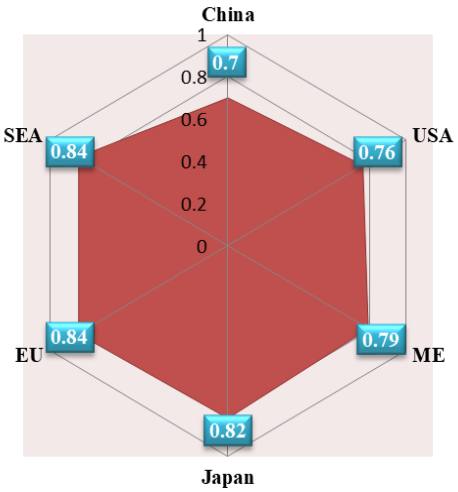

Fig.1. Nominal Protection Coefficient (NPC) for frozen shrimp during 2021

3.3 Direction of Trade

The dynamics of export trends are an important aspect of evolving export-oriented programmes to enhance or sustain current export trends. Hence, knowledge of the changing export trade across the destinations is important. The structural changes in export proportions of frozen shrimp to major destinations such as Japan, the United States of America, the European Union, China, South East Asia, the Middle East and other countries were analysed employing a first-order Markov chain model. The transitional probability matrix was computed for the export of frozen shrimp. The actual quantity of exports to importing countries in different years of the series was used in computing the transitional probabilities. The directions of trade and projections of future exports were analysed using the transitional probabilities. The probability of retaining the previous period's market share was interpreted by studying the diagonal elements of the transitional probability matrix. The row elements in a matrix indicate the probability of a loss in trade on account of competing countries. The column elements indicate the probability of gain in trade from other competing countries. These transitional probability values were then used to forecast the future trade direction for each country by estimating exports to destination countries up to 2024-25.

3.4 Transitional Probability Matrix of Frozen Shrimps from India to Different Destinations

Table 3 and Fig. 2 display the transitional probability matrix for frozen shrimp exports, which provides a broad indication of the change in direction of the frozen shrimp trade during the study period. The major frozen shrimp importing countries considered for the study were Japan, the United States of America, the European Southeast, East Asia and the Middle East. Other countries' exports were grouped under the broad heading "Others."

Transitional probabilities of frozen shrimp exports to different destinations from India are presented in Table 3, displaying a rough idea of the change in trade direction over the study period: Japan, the United States of America, the European Union, China, South East Asia and the Middle East were the top six importers of shrimp. The exports to the remaining countries were taken together under the 'other' countries. The diagonal elements in a transitional probability matrix indicate the probability of trade retention, while the row elements indicate the probability of trade loss due to competing countries. The elements in the column indicate the probability of gain in trade from other competing countries.The USA has been India's most stable and loyal market, as reflected by the higher probability of retention at 1.0, i.e., the retention of export share was around 100 per cent. SEA has 79 per cent export retention and lost remaining shares to Japan, USA, E.U., China, ME and other countries. China has 72 per cent export retention and lost 19 per cent shares to others. It gained from the share of Japan to an extent of 3 per cent and 4 per cent from the USA. Japan has 46 per cent export retention and lost the remaining to the other countries. The Other Pooled Countries have higher retention of exports with a 19 per cent share and lost remaining shares to Japan, the USA, and the Middle East.

It is evident from Table 3 that concerning the reliability of export, the United States of America, South East Asia, and China are the more loyal importers of frozen shrimp as reflected by a higher probability of 1.00, 0.79, and 0.72, respectively, which means that probability that the USA retained its export share of 100 per cent. Likewise, South East Asia retained its share by 79 per cent and China by 72 per cent. Higher probabilities indicate that these countries are more reliable and loyal in importing frozen shrimp. Destinations like the European Union, Japan, the Middle East and Others are relatively unstable, with a lower probability of 48 per cent, 46 per cent, 20 per cent and 19 per cent, respectively.

International markets for marine commodities are changing fast because of globalisation and liberalisation. Hence, documentation of these changes would aid policymakers in framing appropriate export promotional policies to attain terms of trade in favour of the exporting country. Though it would be difficult to detect the exact nature of the changes in the direction of exports, Markov chain analysis provides a probable approach to broadly unveiling these changes. The Markov chain model analysed the changes in the export of Indian frozen shrimp to different destinations. The changing pattern of frozen shrimp exports was estimated by obtaining the transitional probability matrices for the annual export data of frozen shrimp (in quantity) for 2011-12 to 2020-21. The major shrimp importers from India, i.e. Japan, the United States of America, the European Union, China, South East Asia and the Middle East were considered for

analysis. The frozen shrimp trade with the remaining countries was pooled under 'other countries. It is evident from Table 4 that the USA has been the stable importer of Indian frozen shrimp, as reflected by the high probability of retention of 100 per cent during the study period. This implied the share of imports by the USA, and it was also interesting to find that even though the USA is one of the producers of frozen shrimp in the world, it imports high-quality frozen shrimp from India and exports its low-quality shrimps to neighbouring countries. Japan, the European Union, and the Middle East have depicted low probability retention of less than 50 per cent (Fig. 2).

The transition probabilities for the other countries were approximately equal to zero in the study period, indicating instability in India's frozen shrimp to these countries. The sharp decline in frozen shrimp export from India during the disease outbreak and COVID-19 reflects our inability to retain the market share. These call for appropriate policy measures and marketing efforts to sustain in these growing markets. We must improve our export competitiveness by decreasing costs and improving yield and quality. Also, we must move away from the present policy regime of controlled exports through export quotas to enable our exporters to enter into long-term contracts with the buyers in the international markets and achieve growth. These results are well supported by the NPC analysis (Table 4.), wherein China and the USA are highly protected destinations for frozen shrimp export from India.

Table 3. Transitional probability matrix of frozen shrimp from India to different destinations (2011-12 to 2020-21)

	Losses							
	Destinations	**Japan**	**United States of America**	**European Union**	**China**	**South East Asia**	**Middle East**	**Others**
Gains	**Japan**	**0.4663**	0	0	0	0	0	0.5337
	United States of America	0	**1.0000**	0	0	0	0	0
	European Union	0.0623	0	**0.4818**	0	0.4558	0	0
	China	0.0385	0.0403	0	**0.7224**	0	0	0.1988
	South East Asia	0.0041	0.0410	0.0316	0.0308	**0.7998**	0.0164	0.0763
	Middle East	0.3535	0	0.4406	0	0	**0.2059**	0
	Others	0.0394	0	0.4558	0	0	0.3112	**0.1936**

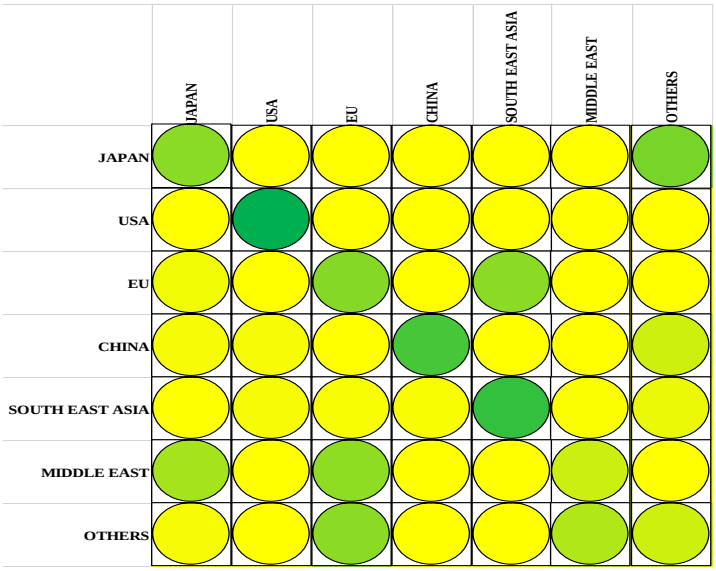

Fig. 2. Correlation matrix of Table 3

Table 4. Projections for export of frozen shrimp to major importing countries from India (Tonnes)

Market / Years	Japan		United States of America		European Union	China		South East Asia		Middle East		Others	
	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
2011-12	85799.7	71208.1	68354.2	85855.3	154221.3	141660.7	84515.3	71649.3	343961.5	345382.9	38155.1	40583.8	87014.1
2012-13	76648.3	70184.9	92447.2	109956.2	158356.5	164872.4	87776.5	73912.1	340943.9	344854.6	41418.8	54776.3	130623.3
2013-14	71483.8	73665.3	110880.4	129508.4	174685.6	173187.5	75782.6	66453.6	380060.7	383581.6	58040.0	53302.5	112822.3
2014-15	78772.2	80024.5	129666.8	148862.8	188031.3	187054.5	59518.7	55625.5	409930.6	413553.5	64607.9	57602.0	120715.9
2015-16	75393.3	72951.8	153694.7	169188.5	186349.0	168433.3	50041.5	46282.8	328899.9	347982.2	53904.5	46876.5	97608.81
2016-17	69038.8	70599.7	188617.1	210313.8	189833.4	177647.9	45443.1	47765.5	484818.6	474266.9	52973.1	51304.2	104223.8
2017-18	85651.1	83164.2	247780.0	275052.1	190314.3	195535.6	49700.5	54904.9	616706.6	579963.8	62219.9	61799.7	124871.1
2018-19	84080.1	86400.2	281912.8	309320.6	165570.9	178921.9	225519.3	176679.0	446965.7	432934.3	60232.1	59662.3	128277.8
2019-20	78507.0	85962.3	305177.7	327617.8	165773.4	171447.9	329479.4	244886.6	223397.8	254227.7	57386.9	55917.9	129929.0
2020-21	86814.0	81749.9	291948.0	309673.2	152770.0	162678.6	218343.0	164430.8	217710.0	243751.4	48606.0	55071.0	133319.0
2021-22*		80274.4		326291.3		170594.6		126289.2		269094.8		56467.9	
2022-23*		78747.9		342409.6		170512.6		199518.2		292971.6		57544.4	
2023-24*		75721.1		358426.6		170678.4		280915.6		312029.7		58629.8	
2024-25*		72121.6		374474.3		170878.8		298065.1		325204.7		59476.6	

Note: Forecasted export of frozen shrimps*

3.5 Projections of Frozen Shrimp Exports to Major Importing Countries

Using the transitional probability matrix, absolute quantities and market shares of frozen shrimp exports to major importing countries were projected up to 2025 A.D. Table 4 furnishes the actual and estimated quantities and projected frozen shrimp exports. The forecasts are only indicative and estimate the market shares rather than the actual quantity.

From Table 4, it can be seen that the United States of America was the major importer of frozen shrimp. Its total exports varied between 68,354 tonnes in 2011 and 2,91,948 in 2021. The reason attributed to this wide fluctuation is purely based on the importers' demand. The estimated market share varied between 85,855 tonnes in 2011 and about 3,09,673 in 2021. However, the predicted share in 2025 indicated a 3,74,474-tonne increase from 31,09,673-tonne (Table 4). Except for Japan, all country's Indian frozen shrimp exports to all destinations are expected to increase.

The market share projections of shrimps in quantity to the major importing countries were computed up to 2024-25 using the transitional probability matrix (Table 4). The actual and projected values are also presented in Table 4 for easy understanding. The projections are based on actual and estimated values from 2011-12 to 2020-21. It is evident from Table 4. that the actual quantity of shrimp exported to Japan decreased during this period. Similarly, in countries like the USA, the E.U., China, the Middle East and other countries, the actual quantity of shrimp exported also increased during the study period. The forecasted quantity of shrimps exported to Japan was showing a decreasing trend, which is mainly due to the importing shrimps from other Asian countries like Taiwan, Vietnam, and Japan also started adopting the bio-floc method of shrimps farming, which is the new scientific method of shrimps farming which requires a less cost of production.

4. CONCLUSION

Exports of frozen shrimps have significantly increased over the years. There is a need to encourage exports of frozen shrimp and reduce the government regulations on export quota allocations as well as improve upon the productivity in order to maintain India’s position in the world aquaculture exports. The results of Markov chain analysis have indicated that the exports of frozen shrimps are likely to be concentrated in USA and China. A high dependence on one or two export markets would increase the trade risk in the long run. There is need to diversify the geographical concentration.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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