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Direction Analysis of Coconut Exports From India: Markov Chain Approach

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ABSTRACT

India is one of the largest producers of coconut contributing 18% of world production. The paper tries to analyze the structure and direction of Indian coconut exports for the period 2000-01 to 2014-15. Compound growth rate is used to analyze the growth in area, production, yield and export (quantity and value) of coconut during the period. The Markov chain analysis is used to assess the transition probabilities for the major export destinations for fresh coconut and coconut oil. U A E, Nepal, Oman are the most stable importers for the fresh coconut while Bangladesh is the only stable importer for coconut oil. The paper suggests to focus on exports to these countries. It is also needed to encourage research on health effects of coconut oil to remove the myths around it and ensure its acceptability.

KEYWORDS : Direction of trade, Markov chain, Coconut export, Compound growth rate

Introduction

Coconut (Cocos nucifera L) is a major horticultural crop grown in India. It has been the livelihood for crores of peoples in the country. It is a commodity of immense use as a staple food, good source of edible oil, inseparable component of Indian socio-religious life. It is a palm tree grown all over the world in tropics. However, its major share of production comes from three major producers. Together these countries account for three fourth of the world production. In India, coconut is grown in 1.97 million hectares with an annual production of about 11.8 million tonnes. India is the third largest producer of coconut in the world contributing 18% of the world production. India's export has grown from Rs. 63.3 lakhs in 2000-01 to Rs. 8928 lakhs in 2013-14. UAE has the lion's share in India's export of fresh coconuts (64.1%). Other major importers are Bahrain, Iran, Oman and UK. Though it is a major producer of coconut, its size of export is very thin. Only 0.31% of total production in the country is exported in the form of fresh coconut. So, India has a large export potential in coconut which is still untapped.

In this backdrop, the present paper tries to analyse the structure, trends and direction of Indian coconut exports.

Source of data

Annual data on area cultivated, production and productivity per hectare are obtained from various publications of Coconut Development Board, Kochi; mainly from their statistical abstract "Coconut Statistics". Data on country wise exports of coconut are obtained from Directorate General of Commercial Intelligence and Statistics (DGCI&S), Kolkata. The data for this study belong to the 15 years period from 2000-01 to 2014-15.

Methodology

The compound growth rate is calculated by using the semi log regression model to estimate the growth in production and export. The model is given by

$$\ln Yt = \beta_1 + \beta_2 + u_t$$

Where

Y_t is the dependent variable i.e. area, production, productivity or export in present study,
t is the trend variable,
u_t is the stochastic error term,
β_1 and β_2 are the parameters. β_2 indicates the proportional change of Yt for a unit change in time t at a point of time and called the instantaneous rate of growth. The compound rate of growth r is calculated from this instantaneous growth rate by using the formula

$$r = [\text{antilog}(\beta_2) - 1] \times 100$$

The pattern of direction of trade is analyzed using the Markov chain analysis by using the annual export data on fresh coconuts for the period 2000-01 to 2014-15. 10 major importers of Indian coconut are considered for the analysis. They are Bahrain, Iran, Kuwait, Mauritius, Nepal, Oman, Qatar, Saudi Arabia, U A E and U K.

Application of Markov chain models to international trade was popularized by Dent (1967). Markov switching models with a finite set of states assume that a system moves from one state to another with a given probability which remains constant over time. The next state the system moves to is determined by, in which state the system is at present, and not by the states in which the system was in previous periods. In the present case, Indian exports to a country in the year 2015 is determined by its export pattern in the year 2014 and not by the same in 2013 or 2012. These models analyse the dynamics of the pattern of international trade by using the market share of each importing country in the total export of the exporting country. Thus, an importer is assumed to loose its market share to another importer or gain its share from another importer with a given probability from one period to the next period.

The main task of these Markov chain methods is to estimate transition probability matrix P whose elements indicate the probabilities of changes in the direction of exports. Each element p_{ij} in the matrix P denotes the probability that the ith country looses its market share to jth country in one period. P is a square matrix of order r where r is the number of importing countries, each of whose rows sum to unity. The elements in the principal diagonal of matrix P (p_{ii}) determine the probability that the corresponding importing country retains its share in the exports of India in the next period. This shows the loyalty of that country to Indian exports. The off diagonal elements in a row corresponding to a country denote the loss of market share by that country to other importers. The off diagonal elements in a column corresponding to a country denote the gain to that country of other country's share.

We assume the model

$$m_{jt} = \sum_{i=1}^{r} p_j m_{i-1} + u_j$$

where

m_{jt} is the market share of country j at time t in India's export,
r is the number of importing countries,
p_{ij} is the probability of country i loosing its share to country j,
t is the time ranging from 1 to T,
T is the total number of observations (number of years),
u_{jt} is a random error component.

The probabilities p_{ij} of the matrix P must satisfy the following two properties to adhere to the definitions of the probability theory.

$0 \leq p_{ij} \leq 1$

$p_{i1} + p_{i2} + \ldots\ldots + p_{ir} = 1$

The set of probabilities satisfying these conditions are called the admissible estimates. Thus, negative values, values greater than 1 and rows summing to more than 1 are inadmissible estimates. There are different methods to estimate transition probability matrix P. Some of them are briefly discussed below.

Unrestricted Least Squares
This is the earliest method adopted to estimate transition probabilities of a Markov chain. This method was first introduced by Miller (1952) and further improvements were made by Goodman (1953). This method estimates the probabilities by minimizing the sum of the squared deviations between the actual and expected outcomes by incorporating the principle of ordinary least squares. But, this method can lead to inadmissible estimates. Also it faces the problem of heteroscedasticity.

Weighted least squares
This method is a modification of the Miller's unrestricted least squares method proposed by Madansky (1959) to overcome the problem of heteroscedasticity. Madansky suggested modifying Miller's estimates by forcing the variances of the correction terms to be unity through the use of a weighting technique in the objective function. While this was effective in solving heteroscedasticity problem, it was unable to properly rectify the inadmissible estimates.

Restricted Least Squares
As the unrestricted least squares procedure, both unweighted and weighted, had many problems, many statisticians thought of explicitly including all the restrictions in the model and it resulted in restricted least squares procedure. This method has two versions one by Lee, Judge and Takayama (1969) and another by Theil and Rey (1966). Lee, Judge, and Takayama used standard quadratic programming procedure. Theil and Rey's used the stepwise imposition of admissibility conditions to unrestricted model.

Weighted restricted least squares
Though the restricted least square method overcame the problem of admissibility, the results were not efficient. So, different weighting procedures were proposed by different statisticians.

Maximum likelihood method
Lee, Judge and Zellner (1968) developed a different class of estimators based on the maximization of the likelihood function of transition probabilities. Dent (1972) also developed a different version of maximum likelihood estimators on the basis of the assumption of normality of disturbance term.

Minimum absolute deviation (MAD) method
Ashar and Wallace (1963) developed a procedure which minimizes the sum of absolute deviation between observed and predicted values subject to constraints of admissibility. Since it is computationally easy to estimate the probabilities using the MAD procedure, this method is widely used in applied research. It gives efficient estimates with large samples.

In the present study, we use the minimization of Mean Absolute Deviation (MAD) methodology proposed by Ashar and Wallace (1963). We use the linear programming procedure, as it satisfies the two properties of admissibility stated above.

The linear programming problem is formulated as

Minimize	$OP^* + Ie$
Subject to	$XP^* + V = Y$
	$GP^* = I$
	$P^* \geq O$

Where,

O is the vector of zeroes,
P* is the vector of probabilities Pij,
I is an appropriately dimensioned vector of area,
e is a vector of absolute errors |u|,
Y is the vector of proportion of export to each country,
X is the block diagonal matrix of lagged values of Y,
V is the vector of errors,
G is the grouping matrix to add the row elements of P arranged in P* to unity.

Results and discussion
Compound growth rates were computed for the period 2000-01 to 2014-15 for production of coconut and export quantity and value for the fresh coconut and coconut oil. The results are shown in table 1.

The results showed that all the variables exhibited positive growth in the study period. While the growth in area was very meager (0.7%), the growth of output was substantial (4.8%). Much of this can be attributed to growth in productivity which grew at a compounding rate of 4.1%. This clearly indicates that the coconut growers in the country are adopting improved technologies and becoming competitive to face the global challenge.

One important result we can observe is that the export of both coconut and coconut oil registered a substantially high growth rate much more than the growth of production. This shows that Indian coconut industry is undergoing a transition from domestic market driven to export oriented one. Among exports, fresh coconuts in terms of volume has shown a very high growth of about 50%. Coconut oil, which is a traditional export item, has grown at a rate of 5.6% in terms of quantity. Exports of both coconut and coconut oil have shown higher growth in terms of value than in terms of quantity. While export quantity of fresh coconut grew at 49.8%, its value grew at 55.2%. Similarly, the quantity of export of coconut oil grew at 5.6%, whereas its value grew at 16.2%. Both these reveal that the export prices of these commodities are increasing considerably. These results are in line with the results of Kusuma and Basavaraja (2014) in the case of Mango exports from India. All these indicate a bright future for coconut growers of the country.

In absolute terms, the area under coconut cultivation increased from 1.82 million hectares in 2000-01 to 1.97 million hectares in 2014-15. The production increased from 12.67 billion nuts in 2000-01 to 20.43 billion nuts in 2014-15. The export value of fresh coconut increased from just 63.3 lakh rupees in 2000-01 to 89.28 crores in 2014-15. The export value of coconut oil rose from 15.28 crores in 2000-01 to 147.08 crores in 2014-15. But exports of both these products is very small compared to the total production. Fresh coconut and coconut oil export accounted for 0.31% and 0.37% of total production respectively in 2014-15.

Table 2 shows the estimated transition probability matrix for the export of fresh coconut from India for the period 2000-01 to 2014-15. It indicates the changes in the direction of exports from India. The row elements for a particular country indicate the probability of loosing the market share by that country to competitive importers. The column elements for a country indicate the probability of gains to that country from other importers in terms of market shares. The main diagonal elements show the retention of market share by the corresponding country and an indicator of loyalty of that country to Indian exports. India exports fresh coconuts to about 50 countries. The major importers among them are Bahrain, Iran, Kuwait, Mauritius, Nepal, Oman, Qatar, Saudi Arab, U A E, and U K. Since the share of all others are small in size, all of them were clubbed into 'others' category.

The results in table 2 indicate that U A E is the most reliable importer of fresh coconuts from India indicated by retention probability of 89% of its market share from one period to the next period. This is followed by Nepal with a retention probability of 83%, Oman with 66% and other countries group with retention of 73%. The most unstable importers are Bahrain, Mauritius, and Saudi Arabia which tend to loose their entire share to other countries in the subsequent period. The medium stable importers are Iran with a retention of 37%, Kuwait with 19%, Qatar with 16% and U K with 12%. Therefore, India

can improve its exports of fresh coconuts by strategically improving the trade with U A E and Nepal. It is also suggested to explore trade opportunities in non-traditional markets by aggressive campaigning as there are good potentialities for enhancing the coconut export.

Table 1 compound growth rates of area, production, productivity and exports of coconut in India

Variable	CGR	instantaneous growth	Std. Error	t-Statistic	Prob.
Area	0.7	0.006574	0.002137	3.076323	0.0088
production	4.8	0.046736	0.005383	8.681397	0
productivity	4.1	0.040162	0.004481	8.961787	0
export quantity (coconut)	49.8	0.404372	0.023422	17.26496	0
export value (coconut)	55.2	0.439843	0.028776	15.28479	0
export quantity (coconut oil)	5.6	0.054079	0.01702	3.177413	0.0073
export value (coconut oil)	16.2	0.149878	0.012056	12.43191	0

CGR = Compound Growth Rate

Table 2 Transition probability matrix for export of fresh coconuts from India

	Bahrain	Iran	Kuwait	Mauritius	Nepal	Oman	Qatar	Saudi Arabia	U A E	U k	Others
Bahrain	0.00	0.00	0.00	0.00	0.00	0.08	0.32	0.55	0.00	0.00	0.05
Iran	0.15	0.37	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.32	0.05
Kuwait	0.24	0.00	0.19	0.00	0.45	0.01	0.03	0.00	0.00	0.00	0.09
Mauritius	0.23	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.29	0.34	0.00
Nepal	0.00	0.00	0.00	0.02	0.83	0.00	0.00	0.01	0.03	0.04	0.07
Oman	0.00	0.29	0.00	0.00	0.00	0.66	0.00	0.00	0.05	0.00	0.00
Qatar	0.02	0.00	0.31	0.10	0.00	0.00	0.16	0.00	0.00	0.00	0.41
Saudi Arabia	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.67	0.00	0.00
U A E	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.89	0.05	0.00
U k	0.00	0.00	0.00	0.16	0.00	0.10	0.00	0.12	0.51	0.12	0.00
Others	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.73

Table 3 Transition probability matrix for export of coconut oil from India

	Bangladesh	Bahrain	Kuwait	Malaysia	Nepal	Oman	Qatar	Saudi Arabia	U A E	U S A	Others
Bangladesh	0.69	0.07	0.05	0.02	0.02	0.02	0.00	0.11	0.03	0.00	0.00
Bahrain	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Kuwait	0.00	0.11	0.00	0.10	0.00	0.48	0.00	0.00	0.31	0.00	0.00
Malaysia	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.58
Nepal	0.53	0.00	0.00	0.00	0.24	0.00	0.03	0.00	0.20	0.00	0.00
Oman	0.00	0.03	0.07	0.00	0.46	0.02	0.00	0.10	0.32	0.00	0.00
Qatar	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.64
Saudi Arabia	0.00	0.00	0.00	0.00	0.07	0.00	0.03	0.00	0.90	0.00	0.00
U A E	0.00	0.02	0.07	0.04	0.00	0.01	0.09	0.31	0.26	0.00	0.20
U S A	0.00	0.01	0.00	0.04	0.00	0.00	0.20	0.08	0.00	0.43	0.23
Others	0.00	0.05	0.04	0.05	0.00	0.09	0.00	0.00	0.13	0.18	0.46

Table 3 shows the estimated transition probability matrix for the export of coconut oil from India for the period 2000-01 to 2014-15. It indicates the changes in the direction of coconut oil exports from India. The row and column elements for a country indicate respectively the probability of loss or gain to that country in terms of market share. Main diagonal elements show the reliability of that country to Indian coconut oil export. India exports coconut oil to more than 65 countries. The major importers among them are Bangladesh, Bahrain, Kuwait, Malaysia, Nepal, Oman, Qatar, Saudi Arabia, U A E and U S A. Since the share of all other countries are small in size, all of them were clubbed into 'others' category.

The results indicate that unlike fresh coconut, there are not many loyal importers for Indian coconut oil. Out of 10 countries and 'other' countries group, Bangladesh was the only loyal importer of coconut oil indicated by retention probability of 69% of its market share from one period to the next. Apart from this, there were moderately loyal importers like U S A with retention probability of 46%, U A E with retention probability of 26%, and Nepal with retention probability of 24%. Interestingly others group showed a good loyalty to Indian coconut oil with a probability of 48%. Bahrain, Kuwait, Malaysia, Qatar, and Saudi Arabia were completely unstable markets for Indian coconut oil tending to loose their entire share to other importers. Oman showed a very little retention probability of 2%.

Gain and loss analysis showed that U A E was the most significant gainer which gained 100% of Bahrain's share, 90% of Saudi Arabia's share, 32% of Oman's share, 31% of Kuwait's share, 20% of Nepal's share, 3% of Bangladesh's share and 13% of other countries' share. These results are in line with those of Mokashi and Hosamani (2014) with respect to Indian Grapes exports.

These results reveal that Indian coconut oil has a very volatile export market in terms of direction. India has export potential only in its neighborhood. This may be due to stiff competition to coconut oil by an array of substitutes like palm oil, soy oil and sunflower oil in the edible oil industry. This is also partly due to the belief that coconut oil which is a saturated fat, not good for health particularly cardiovascular risks. Many studies have shown that coconut oil is not harmful to cardiovascular health. But much more studies need to be conducted to establish the fact beyond debate. Also, there is an urgent need to propagate the results of such studies to common people. India has to explore new destinations for its potential export of coconut oil. It can improve the exports with its neighbor countries through strategic arrangements.

Conclusion

This paper has studied the changing structure and pattern of direction in Indian export of fresh coconut and coconut oil for the period 2000-01 to 2014-15. Though India is one of the large producers of coconut, its export is very much limited and a huge potential remains to be utilized. The compound growth rate estimation revealed that area, production, productivity and exports were growing at a significant positive level. The exports of fresh coconut and coconut oil in terms of both quantity and value showed a significantly high growth compared to production. The major importers of fresh coconut were U A E, Iran, Nepal, U K and others. Markov chain analysis for fresh coconut export revealed that U A E is the most stable importer while Bahrain, Mauritius and Saudi Arabia were the most unstable importers of fresh coconut. Markov chain analysis for coconut oil export revealed that Bangladesh was the only loyal importer. Apart from it, U S A, U A E and Nepal were moderately stable importers. Indian coconut oil was found to have a very volatile export market in terms of destination. The paper recommends to augment the exports of coconut and its products to U A E and neighboring countries like Nepal and Bangladesh through strategic agreements, aggressive campaigning and participating and organizing trade fairs and exhibitions. We also recommend to explore the trade opportunities in non-traditional importing countries as they have good signs of being loyal importers. We also recommend to induce the research on health impacts of coconut oil with larger samples and to propagate such results to larger group of potential importers to improve the market for coconut oil. It is also recommended to enhance and ensure the quality standards required by international markets. This will help in long way in improving the future of Indian coconut sector.

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