Stability Analysis of Australia's Wool Exports- A Markov Chain Model

P. Soumya[1*] and R. A. Yeledhalli[1]

[1]*Department of Agribusiness Management, College of Agriculture, UAS Dharwad, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Author PS designed conducted the study, involved in data collection, analysis, tabulation and writing the research paper. Author RAY involved in planning, constant monitoring throughout the study, analyzing and interpreting the results. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The present study is an attempt to analyse growth, instability and direction of trade of wool exports from Australia. Compound Annual Growth Rate, Cuddy-Della Valle Index and Markov chain analysis are the tools used for analysing data from 2008 to 2017. The growth rate of export in terms of quantity is negative and very low (-0.59% per annum) and the growth rate of exports in terms of value is positive (3.99% per annum). The instability index is low (2.78%) for exports in quantity terms and is medium (18.10%) for exports in value terms. China is the most stable market for export of wool from Australia with retention probability of 80.08%. The other reliable importers are Republic of Korea and Czech Republic. The study suggested the need to diversify Australian wool market.

*Corresponding author: E-mail: soumyapasupuleti@gmail.com;

1. INTRODUCTION

Australia is one of the largest wool producer and exporter in the world. Australia produces Australian merino wool - the world's best quality woolen fiber. This is due to many factors such as selection of superior animals for breeding purposes and favourable climate of Australia. The Australian farmers are experienced in selecting suitable breeds and Australian climate is suitable for production of clean and fine wool which is of high strength. When compared to Europe or the USA, the wool in Australia is grown in vastly different conditions. Australian sheep graze free-range in wide range of climatic conditions.

Since 1936, Australian woolgrowers have been investing in Research and Development and promotion in case of wool. The share of wool in global apparel market is 1.2% in terms of quantity and 8% in terms of value. Australia produces approximately 23.4% of clean wool in the world. In Australia there are 60000 woolgrowers and 68 million sheep. 81% of world's superfine wool is produced in Australia. 98% of wool produced is exported from this country.

During the year 2017, 3.48 lakh tonnes of wool is exported from Australia. The wool exports from Australia to China has increased substantially. Now China has become single largest wool market for Australia. In the year 2017, China imported 77% of total quantity of wool exported from Australia.

2. LITERATURE REVIEW

Some of the reviews are discussed below for better understanding of concepts and tools.

Kusuma and Basavaraja [1] conducted a study on stability analysis of mango export markets of India using Markov chain analysis. Based on the magnitude of transition probabilities, Indian mango export markets were categorized into stable markets (Bangladesh, U.K, U.A.E) and unstable markets (Nepal, Saudi Arabia). The study suggested that efforts should be initiated to promote mango exports from India to explore and exploit market potential of other countries.

Jacob and Job [2] analysed growth rates and instability index of area, production and productivity of pepper in Kerala and export of pepper from India. There is decrease in growth rate of area, production and productivity and negative growth rate in export quantity and positive growth rate in export value from 2005-06 to 2013-14.

Joshi et al. [3] studied probability of retention and changing direction of export of spices from India. The countries which were stable importers for Indian spices were Canada for black pepper, UK for chilli, Bangladesh for turmeric, UAE for cumin and Malaysia for coriander. The study suggested the need for policies to promote export to traditional importers of Indian spices and also there is a need to explore new markets to avoid over dependency on single market.

Samsai et al. [4] assessed changing structure of coir exports from India. Markov chain analysis was attempted to assess the transition probabilities for major markets for Indian coir during the period 2006-07 to 2011-12. China was the most favourable destination among the major importers of Indian coir as reflected by the probability of retention of 94.10 per cent followed by USA (35.00%) and The Netherlands (4.3%). The study suggested the need for strategies to promote export of Indian coir to all the countries instead of dependence on very few countries.

Devi et al. [5] conducted a study to find out the direction of trade of chillies from India using Markov chain analysis. Data were analyzed for a period of seven years i.e., from 2004-05 to 2010-11. The results showed that stable markets for export of chilli from India were USA, UAE and Sri Lanka whereas Malaysia, Bangladesh and Pakistan were unstable markets.

Mohit et al. [6] conducted a study on stability analysis of mango exports from India. The data from 2000 to 2015 was analysed using Markov chain model. The results showed that Bangladesh, UAE and Nepal were the stable markets whereas USA, UK and Saudi Arabia were unstable markets for mango exports from India.

Umesha and Tulasimala [7] analysed direction of coconut exports from India. The study revealed positive annual growth in area, production, yield and export (quantity and value) of both fresh coconut and coconut oil for the period from 2000-01 to 2014-15. The Markov chain analysis proposed that UAE, Nepal, Oman are the loyal markets for the fresh coconut while Bangladesh is the only loyal market for coconut oil. The paper suggests the need to focus on exports to these countries.

Shree et al. [8] made an attempt to study direction of trade of dairy products employing Markov Chain Analysis. The period considered for analysis was from 2007-08 to 2012-13. Results revealed that during the study period for dairy products, India was not able to retain its share to Bangladesh, Egypt Arab Republic, Saudi Arabia and also other countries except United Arab Emirates in case of exports and to United States, France, Netherlands and Italy in case of imports. In India, imports of dairy were more than exports because the quality of milk produced in India at present is below the internationally accepted standards. For improving dairy business, the study proposed need for development of awareness, mindset and commitment on improving the quality of milk.

Anjum and Madhulika [9] conducted a study to analyse growth and instability of major crops in India. The Cuddy Della Valle Index and Coppock's instability index are used for analysis. The entire period of study divided into 3 sub periods i.e., 1990-91 to 1999-2000, 2000-01 to 2009-10 and 2009-10 to 2016-17. The growth rate of area, production and productivity of the crops showed several fluctuations during the study period and also different patterns were observed in case of instability.

Bagal et al. [10] studied instability analysis of spices exported from India for a period of 17 years i.e., from 2000-01 to 2016-17. The compound annual growth rate calculated is 23.84 per cent and is significant at 5 per cent. The instability index calculated is 51.82 per cent for spices exports from India to all the continents. There is presence of Instability in India's spices exports from India both in quantity and value (current and constant prices).

Gogoi et al. [11] analysed export performance of bamboo products. CAGR, Instability index and Markov chain approach were used to analyse data from 2009 to 2018. The study showed positive significant annual growth rate of 31.73% in export of bamboo-based products. The Markov chain analysis revealed that stable importers for bamboo poles were Bhutan and Bangladesh, for bamboo charcoal was Bhutan, for bamboo plywood was Nepal, for Bamboo basketwork was category "others" and for bamboo paper-based products was UAE. The study suggested need to improve trade standards and remove trade related barriers.

The present study is an attempt to examine trends, instability and direction of trade of wool exports from Australia.

3. METHODOLOGY

3.1 Nature and Sources of Data

Time series data for a period of 10 years i.e., from 2008 to 2017 is collected from UNCOMTRADE (United Nations Commodity Trade statistics). The commodity considered for the study is Wool, not carded or combed (HS 5101) under Harmonised System coding, HS 1992 and it is referred generally as wool in the present study.

3.2 Compound Annual Growth Rate

The compound annual growth rate was estimated using the exponential function of the following form

$$Y = ab_t \text{---(1)}$$

Take the logarithm, it becomes

$$log\ Y = log\ a + t\log b \text{-------------------------(2)}$$

and it can be written as

$$lnY = lnb_0 + b_1\ lnt \text{----------------------------(3)}$$

Where,

t = time variable,
Y= variable for which growth rate is calculated and
b_1=regression coefficient of t on Y.

The Compound Annual Growth Rate (CAGR) is obtained as

$$CAGR(\%) = (Antilog\ b_1 - 1) \times 100 \text{----------(4)}$$

3.3 Instability Index

The extent of variability in the quantity and value of exports examined by using Cuddy-Della Valle Index [12]. The simple coefficient of variation overestimates the level of instability in time-series data characterized by long term trends whereas the Cuddy-Della Valle index corrects the coefficient of variation. The formula for Cuddy-Della Valle Index is

$$CDV(\%) = C.V \times \sqrt{1 - \bar{R}^2} \text{------------------------(5)}$$

Where,

CVD = Cuddy-Della Valle Index
C.V = Coefficient of variation (in percent)
$\bar{R}^2$ = Adjusted Coefficient of determination

3.4 Markov chain analysis

In the Markov chain analysis, a transitional probability matrix 'P' is developed, whose elements, P_{ij} indicate the probability of exports switching from country 'i' to country 'j' over time. The diagonal element P_{ij} where i=j, measure 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.

In the context of current application, structural change was treated as a random process with five importing countries for wool. The assumption was that the average export of wool exports from a country amongst importing countries in any period depends only on the export in the previous period and this dependence is same for all the periods. This was algebraically expressed as

$$E_{jt} = \sum_{i=1}^{r} E_{it-1} \, P_{ij} + e_{jt} \text{-----------------------(7)}$$

Where,

E_{jt} = Exports of wool from Australia to the jth country in the year t
E_{it-1} = Exports of ith country during the year t-1
P_{ij} = 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}, which can be arranged in a (c × r) matrix, have the following properties.

$$O < P_{ij} < 1$$

$$\sum_{i=1}^{r} P_{ij} = 1 \text{ for all i----------------------------(8)}$$

Thus, the expected share of each importing country during period 't' is obtained by multiplying the exports of wool to these countries in the previous period (t-1) with the transitional probability matrix. The probability matrix is estimated for wool exports from Australia and also exports are predicted for the period from 2009 to 2018. Projections are made from 2018 to 2022.

Thus, transitional probability matrix (T) was estimated using linear programming (LP) frame work by a method referred to as minimizing of Mean Absolute Deviation (MAD).

Min, O P* + I$_e$
Subject to X P* + V = Y
GP* = 1
P* >0

Where,

P* is a vector of the probabilities Pij
O is the vector of zeros
i is an appropriately dimensional vectors of areas
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.

Prediction of quantity of wool exports were made by using the Transitional Probability Matrix.

$$B_t = B_0 \times T \text{ --------------------------------------(9)}$$

$$B_{t+i} = B_{t+i-1} \times T \text{------------------------------(10)}$$

Where,

B_0 = Quantity exported in Base year
B_t = Quantity exported in next year (prediction)
T = Transitional probability matrix

Different values have different interpretations in transition probability matrix. The value of diagonal elements indicates the probability of retention of the previous year's share, while values in the columns reveal probability of gain by a particular country from other countries, values in rows reveal probability that a country might lose to other countries in respect of a wool exports.

4. RESULTS AND DISCUSSION

4.1 Growth and Instability Analysis of Wool Exports

Table 1 presents the growth rates and instability index of wool exports from Australia both in terms of quantity and value. The growth rate of

export in terms of quantity is negative and very low (-0.59% per annum) and the growth rate of exports in terms of value is positive (3.99% per annum). Both the growth rates are significant at 10% probability level. The instability index is low (2.78%) for exports in quantity terms and is medium (18.10%) for exports in value terms.

4.2 Direction of Trade of Wool Exports

The transitional probability matrix in Table 2 depicted changes in trade directions of wool from Australia for the period from 2008 to 2017. The major importing countries considered under the study are China, India, Italy, Czech Republic, Republic of Korea and the remaining importing countries are grouped under the category "Others".

China retained 80.08 per cent of its original share followed by Republic of Korea (37.53%), Czech Republic (30.66%) and India (19.01%). Italy lost all of its share to China. China gained 94.17% from the category "Others", 43.42% from India, 34.57% from Republic of Korea and 31.56% from Czech Republic. India lost 20.55% of its share to others and 16.55% to Italy. Czech Republic lost 24.20% and 13.59% of its share to Republic of

Korea and Italy, respectively. Republic of Korea lost 23.77% of its share to Czech Republic. China is the most stable market for export of wool from Australia. Republic of Korea and Czech Republic are also reliable importers whereas India, Italy and Others are unreliable importers.

4.3 Projections of Wool Exports from Australia

The actual and predicted values of wool exports from 2008 to 2017 along with projections of wool exports from 2018 to 2022 are presented in Table 3. The quantities of exports predicted are based on the transition probability matrix. China is major importer of wool from Australia. For the period from 2008 to 2017, the share of predicted exports has decreased but the share of actual exports has increased for China whereas for India and Italy, the share of predicted exports has increased but the share of actual exports has decreased. The share of actual quantity of exports is in consistent with the share of predicted quantity of exports in case of Republic of Korea and Czech Republic. There is presence of slight difference between actual and predicted quantity of exports. This is due to changes in policy.

Table 1. Growth rate and instability index of wool exports

Particulars	Exports (quantity)	Exports (value)
CAGR(%)	-0.59*	3.99*
C.V(%)	3.19	19.99
CDV(%)	2.78	18.10

*Note : * significant at 10% probability level*

Table 2. Transition probability matrix for export of Wool from Australia for the period from 2008 to 2017

	Country	China	India	Italy	Czech Republic	Republic of Korea	Others
GAIN	China	**0.8008**	0.0743	0.0296	0.0361	0.0000	0.0592
	India	0.4342	**0.1901**	0.1655	0.0000	0.0046	0.2055
	Italy	1.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000
	Czech Republic	0.3156	0.0000	0.1359	**0.3066**	0.2420	0.0000
	Republic of Korea	0.3457	0.0000	0.0413	0.2377	**0.3753**	0.0000
	Others	0.9417	0.0000	0.0000	0.0000	0.0198	**0.0386**

LOSS

Table 3. Predicted and Actual values of exports of wool to major importing countries from Australia (Quantity in lakh tonnes)

Year/ Country	China		India		Italy		Czech Republic		Republic of Korea		Others	
	P	A	P	A	P	A	P	A	P	A	P	A
2008	331.97	246.47	25.79	24.10	14.67	26.50	15.81	13.63	6.28	3.63	24.14	49.00
	(79.29)	(67.83)	(6.16)	(6.63)	(3.50)	(7.29)	(3.78)	(3.75)	(1.50)	(1.00)	(5.77)	(13.49)
2009	286.04	271.48	22.89	27.44	13.28	9.84	13.95	8.45	5.74	5.46	21.45	22.21
	(78.73)	(78.72)	(6.30)	(7.96)	(3.65)	(2.85)	(3.84)	(2.45)	(1.58)	(1.58)	(5.90)	(6.44)
2010	264.63	272.62	25.38	26.16	13.94	14.28	13.69	14.12	4.66	4.80	22.58	23.31
	(76.73)	(76.73)	(7.36)	(7.36)	(4.04)	(4.02)	(3.97)	(3.97)	(1.35)	(1.35)	(6.55)	(6.56)
2011	272.02	259.40	25.22	26.20	14.50	18.15	15.32	13.88	5.80	4.58	22.43	25.67
	(76.56)	(74.57)	(7.10)	(7.53)	(4.08)	(5.22)	(4.31)	(3.99)	(1.63)	(1.32)	(6.31)	(7.38)
2012	267.40	261.30	24.25	21.84	14.08	14.66	14.71	14.77	5.71	4.22	21.74	21.12
	(76.86)	(77.33)	(6.97)	(6.46)	(4.05)	(4.34)	(4.23)	(4.37)	(1.64)	(1.25)	(6.25)	(6.25)
2013	259.40	267.45	23.56	21.89	13.52	13.82	14.97	15.30	5.68	5.81	20.78	21.26
	(76.77)	(77.40)	(6.97)	(6.33)	(4.00)	(4.00)	(4.43)	(4.43)	(1.68)	(1.68)	(6.15)	(6.15)
2014	264.37	240.45	24.03	25.60	13.85	14.31	15.73	14.95	6.41	6.49	21.16	22.93
	(76.51)	(74.04)	(6.95)	(7.88)	(4.01)	(4.41)	(4.55)	(4.60)	(1.85)	(2.00)	(6.12)	(7.06)
2015	246.54	259.22	22.73	23.89	13.64	14.44	14.81	15.65	6.62	8.82	20.39	21.36
	(75.92)	(75.49)	(7.00)	(6.96)	(4.20)	(4.20)	(4.56)	(4.56)	(2.04)	(2.57)	(6.28)	(6.22)
2016	260.50	252.04	23.79	23.02	14.10	13.53	16.26	15.27	7.63	9.34	21.09	19.08
	(75.86)	(75.86)	(6.93)	(6.93)	(4.11)	(4.07)	(4.73)	(4.60)	(2.22)	(2.81)	(6.14)	(5.74)
2017	251.37	271.12	23.10	20.32	13.72	14.41	16.01	17.25	7.68	7.93	20.40	17.71
	(75.65)	(77.74)	(6.95)	(5.83)	(4.13)	(4.13)	(4.82)	(4.95)	(2.31)	(2.27)	(6.14)	(5.08)
2018	265.22		24.00		14.05		16.97		7.60		20.92	
	(76.05)		(6.88)		(4.03)		(4.87)		(2.18)		(6.00)	
2019	264.54		24.26		14.43		16.59		7.48		21.45	
	(75.85)		(6.96)		(4.14)		(4.76)		(2.15)		(6.15)	
2020	264.83		24.26		14.40		16.42		7.36		21.49	
	(75.94)		(6.96)		(4.13)		(4.71)		(2.11)		(6.16)	

Year/ Country	China		India		Italy		Czech Republic		Republic of Korea		Others	
	P	A	P	A	P	A	P	A	P	A	P	A
2021	264.97		24.28		14.38		16.35		7.27		21.50	
	(75.98)		(6.96)		(4.12)		(4.69)		(2.08)		(6.17)	
2022	265.03		24.30		14.37		16.31		7.22		21.52	
	(75.99)		(6.97)		(4.12)		(4.68)		(2.07)		(6.17)	

Note: The figures within the parentheses indicate percentages to total exports; P: Predicted; A: Actual

5. CONCLUSION

Australia's wool exports showed negative growth rate in volume terms and positive growth rate in value terms. Australia exports major quantity of wool to China and it is most stable importer. The study suggests the need to diversify the Australian wool market. Steps should be taken by government exploit existing markets and explore new markets such as Indonesia.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kusuma DK, Basavaraja H. Stability analysis of mango export markets of India: Markov chain approach. Karnataka J Agric Sci. 2014;27(1):36-39.
2. Jacob A, Job E. Pepper production and export from India: Growth and instability analysis. Int J Curr Res. 2015;7(9):20388-20391.
3. Joshi D, Singh HP, Gurung B. Stability analysis of Indian spices export–a Markov chain approach. Econ Aff. 2015;60(2):257-262.
4. Samsai T, Mahendran K, Alagumani T, Praveena S. Changes in direction of trade and export performance of coir in India. Int J Agric Sci. 2015;7(8):643-646.
5. Devi IB, Srikala M, Ananda T, Subramanyam V. Direction of trade and export competitiveness of chillies in India. Agri Econ Res Rev. 2016;29(2):262-272.
6. Mohit S, Rajesh S, Aditi M. Quantification of changing structure of Indian mango exports using Markov chain analysis. Int J Agric Sci. 2016;8(60):3381-3384.
7. Umesha SE, Tulasimala BK. Direction analysis of coconut exports from India: Markov chain approach. Glob. J. Res. Anal. 2016;5(11):240-243.
8. Shree JS, Pandian ASS, Natarajan K. Changing direction of trade of dairy products in India - An application of Markov chain analysis. Int J Livest Res. 2017;7(3):57-62.
9. Anjum S, Madhulika. Growth and instability analysis in Indian agriculture. Int Multidiscip Res J. 2018;5(11):119-125.
10. Bagal NU, Kshirsagar PJ, Torane SR, Manerikar SS. Export of spices from India: An instability analysis. Internat Res J Agric Eco & Stat. 2020;11(1):55-63.
11. Gogoi J, Kumar N, Singh R, Tyngkan H Nongbri B. Export performance of bamboo products in India: a Markov chain analysis approach. 2020;08(02):107-116.
12. Cuddy JDA, Valle PAD. Measuring the instability of time series data. Oxford Bulletin of Econ Statist. 1978;40(1):53-78.