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Growth Instability and Forecasting of Non-Frozen Citrus Juice Export from Pakistan: A Markov Chain Approach

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ABSTRACT

Current study endeavors to examine the behavior of the big five importers (i.e., Afghanistan, the United States of America (USA), the United Kingdom (UK), the United Arab Emirate (UAE), and Germany), where Pakistani exports constitute above 50 percent of its non-frozen citrus juice. For measuring the occurrence probability of a random variable, the Markov chain analysis is applied to the time series data from FY 2013–14 to FY 2019–20 collected from secondary sources. The Markov chain process with the transition probability matrix (TPM), the compound annual growth rate (CAGR), the coefficient of variation, and the Cuddy Della Valle instability index (CDVI) have displayed interesting results. The TPM results for non-frozen citrus juice exports in terms of quantity revealed that the United States, other countries, Afghanistan, the United Arab Emirates, and the United Kingdom demonstrated the highest retention level and are consistent with Pakistan's non-frozen citrus juice exports. In terms of quantity, according to the results of the CAGR, except for Afghanistan and other countries, the remaining importing countries showed growth. The results of CDVI in terms of quantity showed inconsistent growth for all the importing nations for the exports of non-frozen citrus juice from Pakistan.

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Introduction

Fruit, vegetable, ornamentals (flowers, trees, and shrubs), and herbal, and medicinal plants are all part of horticulture (Mohamed & Worku, 2020; Iqbal et al., 2021). A large portion of the world's food supply chain is devoted to horticulture. In terms of sustainability and environmental friendliness, horticulture has a bright future, according to a study conducted by Jaskani and Khan (2021). According to Jambor and Babu (2016), foreign trade is critical for a country's economic development as well as food needs. Trade plays a very important role in the provision of food items and is one of the ways to make food available in a country. The other way is to produce it herself, which depends upon the climate of the countries, which is not similar in every country.

The Pakistani citrus sector is currently in an evolution phase. Evolution from magnitude to superiority, low production to high production, fresh fruit to packaged drinks, and so on. Instead of exporting fresh citrus fruit, Pakistan can earn more foreign cash from juice exports, as concluded in a study on the growth of citrus fruits in Pakistan conducted by Cheema and Jamali (2020). The worldwide production of frozen fruits and vegetables is huge. These products are being expanded internationally. According to the report (Sector Profile, 2019), the overall export market for frozen vegetables and fruits in 2015 was US$ 6.07 billion. Frozen peas, potatoes, beans, spinach, strawberries, grass, candied maize, juices, and a variety of other fruits and vegetables are common products in this category. This provides a window for Pakistani growers of vegetables and fruits to sell extra produce, which is widely available during high seasons of production. The freezing procedure for adding extra value to fresh produce is an important process (Hajihashemi & Samani, 2022).

The study on the export competitiveness of Pakistani horticultural products, conducted by Akhtar, Akmal, Shah, Niazi, and Tahir (2013), examined export quantity and export value trend analysis for citrus in Pakistan. The study's findings were based on the quantity and value of exports of citrus from 1990 to 2011. The quadratic trend model was used for that study's trend analysis. The study on value chain assessment and measuring export determinants of citrus fruits in Pakistan by Ahmad, Mehdi, Ghafoor, and Anwar (2018), relied on historical data. These studies focused only on the fresh parts of the citrus fruit. These studies ignore the measurement of retention and switching behavior of the importing nations towards Pakistan's citrus products. These studies also missed the important aspects of export in value terms to the importing countries as well as growth and stability for both fresh and value-added citrus products. The theory of the Markov chain was not used in any of the export studies conducted for Pakistan’s exports. This situation provides a methodological, knowledge-based, and theoretical research gap. Therefore, this study endeavors to examine the behavior of the big five importers (i.e., Afghanistan, Kazakhstan, Russia, the UAE, and Ukraine), where Pakistani exports constitute 60% of its fresh oranges. For measuring the occurrence probability of random variables i.e., exports of fresh oranges in this study, the Markov chain analysis is applied to the time series data from FY 2013-14 to FY 2019-20 collected from secondary sources.

Literature Review

A study forecasting apple production in Turkey conducted by Eyduran et al. (2022) examined annual apple output in Turkey for the years 2020-2025 using annual FAOSTAT data from 1961-

2019, to provide farmers, consumers, and investors with important apple production suggestions. The ARIMA (1, 1, 0) time series analysis approach was shown to be more suitable for analyzing the research's first-degree difference time series data than other Autoregressive Integrated Moving Average (ARIMA) models. The output will rise from 3,706,954 to 3,987,050 tons between 2020 and 2025, according to ARIMA (1, 1, 0) forecasting projections. The findings of the study provide policymakers with a starting point for sustainable apple production, making it easier for them to develop new agricultural plans for the future.

Bhagat and Jadhav (2021), conducted a study on the growth, instability, and forecasting of grape export from India attempts time series modeling for grape exports, in quantity and values from India, as well as grape exports in quantity and value estimates for the next five years. Various exponential smoothing models, the Mann-Kendall test, compound growth rate, coefficient of variation, Cuddy Della Valle index, Markov Chain analysis, and secondary data on grape export volume and value in India from FY 1990-1991 to FY 2018-2019 were used in the analysis (a span of 29 years). The results show that India exported more grapes during the time of the study. Indian grapes experienced a positive annual growth rate of 12.81 percent. In terms of quantity and value, the grape export indexes were 29.47 percent and 23.37 percent, respectively. The volume of Indian grapes shipped from the country has climbed by 30.77 percent over the last 10 years, while the significance of grape exports has climbed by 22.91 percent. Among the major importers of Indian grapes, the Netherlands was found to be the solid market. Bangladesh, the United Kingdom, and the UAE appear to be moderately stable.

Rejikumar et al. (2021), conducted a study on structural analysis of Indian gold exports: perspectives for trade policy development. The Markov Chain Analysis also forecasts that the UAE will dominate Indian exports of jewels in the future. Gold jeweler's world market is US $300 billion, with China, India, the USA, Germany, and Switzerland being significant users. 17.3 percent of global jewelry products were imported into Switzerland in 2017, while its share in India is limited. Similarly, Hong Kong is the second largest importer, accounting for 15 percent of all jewelers in production, but India's supply is quite limited. A study direction of trade and changing pattern of Indian coffee exports-An application of Markov chain analysis, conducted by Tejaswi, Naik, Kunnal, and Basavaraj (2010) to measure a random variable that is Indian coffee exports by using Markov Chain Analysis for the nine years from FY1994-1995 to FY2002-2003, studied the direction of trade in Indian coffee exports and shifting patterns. In the case of the US, loyalty was high by 80 percent, followed by other nations (51 percent), the Russian Federation (36 percent), Italy (34 percent), Germany (20 percent), and Spain 4 percent, according to the Markov chain statistics results.

The above-mentioned review of the literature of the previous research conducted to examine the retention and switching behavior of horticulture production and exports in different contexts indicated the use of the Markov chain theory, but this theory was not used in any of the export studies conducted for Pakistan's exports. It provides a methodological, knowledge-based, and theoretical research gap as evidenced by developing a research problem and purpose statement by Jacobs (2011), a framework for rigorously identifying research gaps in qualitative literature reviews by Müller-Bloch and Kranz (2015), and a taxonomy of research gaps: identifying and defining the seven research gaps by Miles (2017) in the cited researches. To fill this gap, the researcher used the Markov chain theory in the study.

Methods

The exports of non-frozen citrus juice (HS Code 20091900) were valued at Rs. 57.618 million and in quantity terms were 5,177,236 liters during FY 2019- 20. The secondary data is used in this study. The product for this study is the export of citrus non-frozen juice both in quantity and value terms from Pakistan to the world. The data sources are Government websites like the Pakistan board of investment, Pakistan horticulture development and Export Company (PHDEC), statistics bureau of Pakistan, ministry of finance, ministry of agriculture and food security, ministry of economic affairs, and agriculture marketing and information services in Punjab. Time series data is collected from FY 2013-14 to FY 2019-20 in order to best understand the retention and switching behavior of importing nations, growth, and consistency in non-frozen citrus juice export.

Analytical tools and techniques

Excel and LPS software combination was used for the analysis of the collected data.

Growth rate analysis

The CAGR is used to assess the nonfrozen citrus juice export performance. The exponential growth function is used to analyze the growth in quantity exported and in value terms.

$$Y = a.bt$$

Where,
Y = Depended variable for which growth rate is to be estimated (Quantity exported/export value/unit value).
a = intercept
b = Regression coefficient
t = Time value
This equation will be estimated after transforming (1) as follows,

$$Log\, y = log\, a + t\, Log\ b$$

Then the percent annual compound growth rate (g) will be computed by using the relationship.

$$CGR = [Antilog\ (log\, b) - 1] \times 100$$

Instability analysis

The coefficient of variation and the Cuddy Della Valle instability index are used to investigate the instability of non frozen citrus juice exports.

Coefficient of variation (CV)

$$\text{Coefficient of variation (CV)} = \frac{\sigma}{\bar{X}} \times 100.$$

Where,

σ = Standard deviation
$\bar{X}$ = Arithmetic Mean

Cuddy Della Valle instability index (CDVI)

$$\text{Instability index} = \text{CV}\sqrt{(1 - \text{R}^2)}.$$

Where,
CV = Simple Estimate of coefficient of variation in percent
And
R^2 = Coefficients of determinant from a time trend regression adjusted by the number of degree of freedom.

The analysis of the Markov chain was used to analyze the structural changes in any system that may be measured in terms of one result variable during time. The present study examines the dynamic nature of trade patterns in the key importing nations, which represent the export gains and losses of indigenous non frozen citrus juice, using the Markov model. The chain analysis by Markov entails the development of a "transitional probability matrix, which indicates that elements show the likelihood of exports changing through time from country to country." The diagonal item is where one evaluates the likelihood of keeping a country's market share, that is, an importing country's loyalty to the exports of a given country.

Structural change has been handled as a random process in the current application with five importing frozen juice countries. The assumption was that, in any given time period between the importing countries, average non frozen citrus juice exports from Pakistan were dependent on exports in the previous period, and this dependence on all periods was equal. A Markov chain algebraic expression is

$$E_{ji} = \sum_{i=1}^{n} \left(E_{(it-1)} * P_{ij} + e_{jt}\right)$$

Where

E_{jt} = Exports from Pakistan to the j^{th} country in the year t

Eit-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 this is statistically independent of Eit-1

N = the number of importing countries

The transitional probabilitiesP_{ij}, which can be arranged in a (column × row) matrix, have the following properties.

$$\sum_{n=1}^{n} \left(P_{ij}\right) = 1 \; and \; 0 \leq P_{ij} \leq 1$$

The transitional probabilities, which can be arranged in a (column row) matrix, have the following properties: Thus, the expected export share of each country during the period is obtained by multiplying the exports to these countries in the previous period with the transitional probability matrix. For the period from FY 2020-21 to FY 2024-25, the prediction is made. The linear

programming (LP) framework was used for estimation of the transitional probability matrix (T) through a method called the minimization of mean absolute deviation (MAD).

$$Min, OP^* + Ie \ldots$$

Subject to,

$$XP^* + V = Y$$
$$GP^* = 1 \; and \; P^* \geq 0$$

Where

P^* = A vector of the probabilities P_{ij}

O = the vector of zeros

I = an appropriately dimensional vectors of export quantity / export value;

e = the vector of absolute errors;

Y = the proportion of exports to each country;

X = block diagonal matrix of lagged value of Y;

V = the vector of errors

G = a grouping matrix to add the row elements of P arranged in P*to unity.

Prediction of exports

Predictions of the quantity of non frozen citrus juice export were made by using the TPM results.

$$B_t = B_0 * T$$
$$B_{t+i} = B_{t+i-1} * T$$

B_t = Quantity exported in current year,

B_0 = Quantity exported in base year,

B_{t+i} = Quantity exported in next year (prediction),

T = Transitional probability matrix.

Chi square for Goodness of fit test

The following chi-square statistics are used to determine whether the observed shares of exports to different countries and the predicted shares from the Markov chain model have similar distributions.

$$X^2_{(r-1)T} = \sum_t^T \sum_i^r N(t) \{Y_i(t) - y_i(t)\}^2 / y_i\,(t)$$

Where $Y_i(t)$ denotes the observed proportions of the ith country's share at time t; and $y_i\,(t)$ denotes the expected proportions of the i^{th} country's share at time t. $N(t)$ Represents the total number of countries at time t; R represents the countries and T represents year. The destination pattern of non frozen citrus juice exported from Pakistan to various countries around the world is studied using the percentage share of each country in terms of quantity exported.

Citrus juice (non-frozen) exports

Afghanistan, USA, UK, UAE, Germany, and rest of the world were categorized under the category of "Other countries" as the primary Pakistan's orange juice (non frozen) importing countries. The transitional probability matrix's row elements provide information on the magnitude of trade losses due to competing countries. The diagonal element shows the likelihood of retaining the previous year's trade volume by the relevant country, whereas the columns element indicates the possibility of gains in trade volume from other competing countries.

Table 1: Transition probability matrix in terms of quantity of non frozen juice export

Countries	Afghanistan	U.S.A	U.K	U.A.E	Germany	Others
Afghanistan	**0.2622**	0.0100	0.1589	0.0000	0.1200	0.4489
U.S.A	0.0000	**0.8138**	0.1862	0.0000	0.0000	0.0000
U.K	0.0318	0.1077	**0.2013**	0.6591	0.0000	0.0000
U.A.E	0.0000	0.0000	0.0911	**0.2522**	0.2252	0.4315
Germany	1.0000	0.0000	0.0000	0.0000	**0.0000**	0.0000
Others	0.2663	0.1820	0.1504	0.0000	0.0709	**0.3304**

The likelihood of retention at 0.8138, i.e. the probability that USA preserves its export share over the study period, demonstrates that USA was one of the most stable markets among the top buyers of Pakistan's non frozen citrus juice. In the current time, Pakistan's non frozen citrus juice exports to the USA retained at 81.38 percent of their previous year's share; Out of the remaining 18.62 percent of USA market was directed to UK. USA was the most reliable and loyal market for Pakistan's non frozen citrus juice exports. USA keeps its 81.38 percent share while gaining 75.09 percent from UK, 25.14 percent from Afghanistan, 13.75 percent from others and 7.33 percent from UAE. Pakistan can rely on USA for non frozen citrus juice exports (Table 1).

Other category of countries has a moderate probability retention rate of 0.3304, which suggests that it keeps its 33.04 percent export share. It means that it had lost the majority of its market share to remaining importing countries; Out of the remaining 66.96 percent, 26.63 percent went to Afghanistan, 18.20 percent to USA, 15.04 percent to the UK and the remaining 7.09 percent went to Germany. Other category of countries keeps its 33.04 percent share while gaining 44.89 percent from Afghanistan and 43.15 percent from UAE. Afghanistan has a moderate probability retention rate of 0.2622, which suggests that it keeps its 26.22 percent export share. It means that it had lost the majority of its market share to remaining importing countries; Out of the remaining 73.78 percent, 1 percent went to USA, 15.89 percent to Germany and 44.89 percent to the other category of countries (Table 1).

Afghanistan keeps its 26.22 percent share while gaining 3.18 percent from UK, 100 percent from Germany and 26.63 percent from other category of countries. UAE has a moderate probability retention rate of 0.2522, which suggests that it keeps its 25.22 percent export share. It means that it had lost the majority of its market share to other importing countries; Out of the remaining 74.78 percent, 22.52 percent went to Germany, 9.11 percent to UK and the remaining 43.15 percent went to other category of countries. UAE keeps its 25.22 percent share while gaining 65.91 percent from UK (Table 1).

UK has a moderate probability retention rate of 0.2013, which suggests that that it keeps its 20.13 percent export share. It means that it had lost most of its market share to other importing countries; Out of the remaining 79.87 percent, 65.91 percent went to UAE, 3.18 percent to Afghanistan and

the remaining 10.77 percent went to UAE. UK keeps its 20.13 percent share while gaining 15.89 percent from Afghanistan, 18.62 percent to USA, 9.11 percent to UAE and 15.04 percent to the other category of countries. Germany has a zero-probability retention rate, which suggests that that it keeps its zero percent export share. It means that it had lost its entire market share to other importing countries; of that 100 percent, all that 100 percent went to Afghanistan. Germany keeps its zero percent retention rate of probability while gaining 22.52 percent from UAE, 6.64 from others and 12.00 percent from another Afghanistan (Table 1).

Pakistan can rely on USA for non-frozen citrus juice exports. Similar results were obtained by Jeemoni Gogoi (2020) for similar kind of studies. In terms of value citrus juice (non-frozen) exported during the study period, United Arab Emeritus (UAE) was shown to be the most stable market. Afghanistan, USA, and other categories of importing countries were determined to be moderately stable markets, while United Kingdom (UK) and Germany showed no stability. Similar results were obtained by Bhagat and Jadhav (2021) for similar kind of studies.

Table 2: Transitional probability matrix in terms of value of non frozen citrus juice export

Countries	Afghanistan	U.S.A	U.K	U.A.E	Germany	Others
Afghanistan	**0.2957**	0.2514	0.0485	0.0000	0.1211	0.2833
U.S.A	0.0000	**0.2153**	0.3983	0.0000	0.0000	0.3864
U.K	0.2491	0.7509	**0.000**	0.0000	0.0000	0.0000
U.A.E	0.0000	0.0733	0.0000	**0.5550**	0.2078	0.1639
Germany	0.0000	0.0000	0.0415	0.9585	**0.0000**	0.0000
Others	0.4037	0.1375	0.1265	0.0000	0.0664	**0.2657**

U.A.E maintained its previous year's market share of 55.50 percent. UAE lost market share to USA, Germany, and other importing countries, with 7.33 percent, 20.78percent, and 16.39 percent, respectively. In contrast, UAE increased its market share from the share of Germany by 95.85 percent. UK shows no stability, and it lost its share to Afghanistan and USA with 24.91 percent and 75.09 percent respectively. While UK increased its share by 4.85 percent, 39.83 percent, 4.15 percent, and 12.65 percent of the market share from Afghanistan, USA, Germany, and other category of importing countries. Afghanistan maintained its previous year's market share of 29.57 percent. With 25.14 percent, 4.85 percent, 12.11 percent and 28.33 Afghanistan lost its market share to USA, UK, Germany, and other category of importing countries respectively. On the other hand, market share was gained by Afghanistan from UK and other categories of importing countries, with an observed value of 24.91 percent and 40.37 percent respectively (Table 2).

USA maintained its previous year's market share of 21.53 percent. USA, with 39.83 percent and 38.64 percent, respectively, lost its market share to UK and other category of importing countries. On the other hand, market share was gained by USA from Afghanistan, UK, UAE, and other category of importing countries, observed at 25.14 percent, 75.09 percent, 7.33 percent and 13.75 percent respectively. Germany shows no stability, and it lost its share to UK and UAE with 4.15 percent and 95.85 percent respectively. While Germany increased its share by 12.11 percent, 20.78 percent and 6.64 percent of the market share from Afghanistan, UAE and other category of importing countries respectively. The other category of importing countries has moderate stability of 26.57 percent, but it has lost its market share 40.37 percent to Afghanistan, 13.75 percent to USA, 12.65 percent to UK and 6.64 percent to Germany. Other categories of importing countries

from Afghanistan, USA, and UAE gained 28.33 percent, 38.64 percent and 16.39 percent market share respectively. UAE was found to be the most stable market, followed by Afghanistan, USA, and other small importing countries (Table 2). Similar results were obtained by (N. Devi et al., 2019) for similar kind of studies.

Chi square test is used to see if the observed degree of serial correlation is significantly different from zero in a multiple-state situation. The summations will include s^2 terms and will cover all conceivable state.

$$X^2_{(r-1)T} = \sum_t^T \sum_i^r N(t)\{Y_i(t) - y_i(t)\}^2 / y_i(t)$$

Where $Y_i(t)$ denotes the observed proportions of the ith country's share at time t; and $y_i(t)$ denotes the expected proportions of the ith country's share at time t. $N(t)$ Represents the total number of countries at time t; R represents the countries and T represents year.

Table 3: Goodness of fit test

Country	Netherland		Thailand		India		Spain		SriLanka		Others	
Years	**Obs.**	**Est.**	**Obs.**	**Est.**	**Obs.**	**Est.**	**Obs.**	**Est.**	**Obs.**	**Est.**	**Obs.**	**Est.**
2013-14	1.4	-	6.3	-	5.8	-	1.3	-	4.2	-	81	-
2014-15	0.9	3.3	04	4.9	3.9	4.8	0.4	0.4	0.6	0.6	90	87
2015-16	25	21	20	20	15	15	00	11	07	06	33	26
2016-17	46	38	21	20	11	15	02	01	05	07	15	17
2017-18	22	28	21	20	16	15	23	13	07	07	32	27
2018-19	0.4	02	25	27	16	15	33	31	05	05	21	21
2019-20	11	17	26	25	14	15	19	13	09	09	22	21

Goodness of fit $\chi^2_{cal} = 34.35 \chi^2_{tab}$ at 25 degree of freedom $= 37.65$ Obs. – Observed and Est. – Estimated.

While examining at the observed and estimated shares in percent in every country, the variances were largely negligible. The estimated chi square (34.35) was below at the 25 degree of freedom table value (37.65), at 5 percent significance level, showing the equal distribution of observed and expected exports of non frozen citrus juice. This means that the observed proportions of the export shares are consistent with the estimated export shares calculated from the Markov process, which confirms Goodness of fit and the usage of the Markov chain model for calculating export shares in different countries (Table 3).

Table 4: Prediction of non frozen citrus juice export in terms of quantity

Years	Country					
	Afghanistan	**U.S.A**	**U.K**	**U.A.E**	**Germany**	**Others**
2020-21	961600	1417579	763234	744287	375676	1070177
2021-22	937066	1440215	799226	690757	358881	1106408
2022-23	924632	1468860	807364	700979	346451	1084268
2023-24	903304	1488895	809962	708920	345691	1075782
2024-25	894775	1503721	810274	712636	344318	1066830

Prediction of Non-Frozen Citrus Juice Export

The market share of Pakistan non frozen citrus juice among major importers has been calculated from 2020–21 to 2024–25 for a period of five years with the use of the transitional probability matrix. The U.S.A is the principal country in the next five years to import non frozen citrus juice. It has a significant value in quantity and proportion exports of non-frozen citrus juice from Pakistan to the U.S.A. The predicted results show that the market share of the Afghanistan is going to decrease in the future from 961600 in FY 2020-21 to 894775 in FY 2024-25. The predicted results show that the market share of U.S.A is going to increase in the future from 1417579 in FY 2020-21 to 1503721 in FY 2024-25. The predicted results show that the market share of U.K is going to increase in the future from 763234 in FY 2020-21 to 810274 in FY 2024-25 (Table 4).

The predicted results show that the market share of U.A.E is going to decrease in the future from 744287 in FY 2020-21 to 712636 in FY 2024-25. The predicted results show that the market share of Germany is going to decrease in the future from 375676 in FY 2020-21 to 344318 in FY 2024-25. The other category of countries export is the second major frozen juice export from Pakistan. The predicted results show that the market share of the other category of importing countries is going to decrease in the future from 1070177 in FY 2020-21 to 1066830 in FY 2024-25 (Table 4).

Rates of growth in orange non frozen citrus juice exports

The following table shows the findings obtained by applying the exponential growth function to the estimation of non frozen citrus juice export. The compound growth rates for export quantity and value were analyzed for a period of seven years, from 2013-14 to 2019-20, and the results are provided in tables 5 and 6, respectively.

Table 5: Compound growth rates of export in terms of quantity of non frozen citrus juice

Sr. No	Country name	CAGR (Quantity)	T Value	R2
1	**Afghanistan**	-12.71	-0.2931	0.0168
2	**U.S.A**	16.97	2.0051	0.4457
3	**U.K**	6.842	0.7668	0.1052
4	**U.A.E**	134.43	0.9136	0.1430
5	**Germany**	10.16	1.1771	0.2169
6	**Others**	-31.18	-1.7077	0.3684

Table 5 shows that the U.A.E growth rate of export quantity was found to be 134.43 percent per annum. While U.S.A, Germany and U.K growth rates were 16.97 percent, 10.16 and 6.842 percent per annum. Other category of importing countries and Afghanistan had negative annual growth rates of -31.18 percent, and -12.71 percent respectively. Four countries U.A.E, U.S.A, Germany and U.K have shown an increase in non frozen citrus juice export. While the Countries Afghanistan and other categories of importing countries have shown a decrease.

Table 6: Compound growth rates of export in terms of value of non frozen citrus juice

Sr. No	Country name	CAGR	T Value	R2
1	**Afghanistan**	-10.95	0.3472	0.0235

2	**U.S.A**	26.49	4.2943	0.7867
3	**U.K**	10.28	1.3317	0.2618
4	**U.A.E**	141.73	2.5416	0.5636
5	**Germany**	15.81	2.3920	0.5336
6	**Others**	-27.07	-1.5166	0.3150

Table 6 shows that among the six countries with the highest export value, only U.A.E were found a CAGR of 141.73 percent per annum, while the other three countries, U.S.A, Germany and U.K, were CAGR of 26.49 percent, 15.81 percent and 10.28 percent per annum respectively. Other category of importing countries and Afghanistan had negative annual growth rates of -27.07 percent and -10.95 percent respectively. U.A.E, U.S.A, Germany and U.K export in value of non frozen citrus juice exhibited a positive trend. Other category of importing countries and Afghanistan export in value of orange other juice exhibited a negative trend. Similar results were obtained by Devaraj (2021) for similar kind of studies.

Instability in non-frozen citrus juice exports

Because growth rates can only describe growth over time, instability can be used to assess the consistency of growth performance over time for the relevant variable. As a result, an instability analysis is carried out to better understand the magnitude and pattern of fluctuations in the quantity and value of non frozen citrus juice exported to different countries from Pakistan. The trend component is frequently included in the simple coefficient of variation (CV), which increases the level of instability in time series data with a long-term trend over time. Cuddy Della Valle's (1978) study of the instability index, which corrects the coefficient of variation, was used to solve this problem.

Table 7: Instability in export growth in terms of quantity of non frozen citrus juice

Sr. No	Country name	C.V	CDVI
1	**Afghanistan**	120.3	130.7
2	**U.S.A**	40.28	32.85
3	**U.K**	37.78	39.15
4	**U.A.E**	151.3	153.5
5	**Germany**	254.0	246.2
6	**Others**	167.87	146.34

Table 7 presents, Germany shows the most variability, with a coefficient of variance of 254 percent, followed by other category of importing countries with 167.87 percent, U.A.E with 151.3 percent and Afghanistan with 120.3 percent variability respectively. U.S.A and U.K had coefficients of variation of 40.28 percent and 37.78 percent respectively. Germany has the most variability in the Cuddy-Della instability index for quantity exported, with a CDVI of 246.2 percent. U.A.E, other category of importing countries and Afghanistan has variability with CDVIs of 153.5 percent, 146.34 percent and 130.7 percent respectively. U.K and U.S.A shows variability, with CDVIs of 39.15 percent and 32.85 percent.

Table 8: Instability in export in terms of value of non frozen citrus juice

Sr. No	Country name	C.V	CDVI

1	**Afghanistan**	95.01	102.8
2	**U.S.A**	47.61	24.09
3	**U.K**	37.6	35.78
4	**U.A.E**	154.7	111.9
5	**Germany**	47.78	35.74
6	**Others**	149.6	135.7

Table 8 shows that U.A.E in value terms the highest variability, with a coefficient of variation of 154.7 percent, followed by other category of importing countries and Afghanistan, with coefficients of variation of 149.6 percent and 95.01 percent respectively. Germany and U.S.A have variabilities, with nearly identical coefficients of variation of 47.78 percent and 47.61 percent. U.K has lowest variability of 37.6 percent per annum. In terms of the Cuddy-Della instability index, other category of importing countries shows the largest variability (CDVI 135.7 percent), while U.S.A shows the lowest variability (CDVI 24.09 percent). The variation in terms of CDVI of the countries U.A.E, Afghanistan, U.K and Germany shows 111.9 percent, 102.8 percent, 35.78 percent and 35.74 percent respectively.

During the study period, practically all nations' export quantities and values showed positive values, showing a large potential for non frozen citrus juice exports from Pakistan. As a result, regulations and directions can be increased orange production as well as alternative management strategies and policies to improve non frozen citrus juice exports in Pakistan are required. While the trend analysis using index numbers revealed changes in export quantity and value across the study period, which could be related to shift policies and their implementation at different times. Similar results were obtained by Bagal et al. (2020) for similar kind of studies.

Conclusion and Recommendations

Afghanistan, the United States of America (USA), the United Kingdom (UK), the United Arab Emirate (UAE), Germany, and the rest of the world were categorized under the category of "other countries" as the primary importers of Pakistan's non-frozen citrus juice. The likelihood of retention at 0.8138, i.e., the probability that the USA preserves its export share over the said study period, demonstrates that the USA was one of the most stable markets among the top buyers of Pakistan’s non-frozen citrus juice. The other group of importing countries has a moderate probability retention rate of 0.3304, implying that it will maintain its 33.04 percent export share. Afghanistan has a moderate probability retention rate of 0.2622, implying that it will maintain its 26.22 percent export share. UAE has a moderate probability retention rate of 0.2522 percent, which suggests that it keeps its 25.22 percent export share. The United Kingdom has a moderate probability retention rate of 0.2013, implying that it will maintain its 20.13 percent export share. Germany has a zero-probability retention rate, implying that it will maintain its zero percent export share.

The results of the transition probability matrix show that the U.S.A. exhibits excellent loyalty to the exports of non-frozen citrus juices from Pakistan. On the other hand, Afghanistan, the other category of importing countries, the U.A.E., and Spain show a moderate level of loyalty to Pakistan's citrus and non-frozen juice exports. While Germany demonstrates zero percent loyalty, policymakers should pay attention to Germany to make them loyal to Pakistan's citrus non-frozen

juice exports, as well as the need to work on moderate-level countries to get them to an excellent level of exports for Pakistan's non-frozen citrus juice exports. Keeping in view the results of the transition probability matrix, Pakistan can rely on the U.S.A. for non-frozen juice exports.

In terms of value for non-frozen citrus juices exported during the said study period, the U.A.E. was shown to be the most stable market. The UAE was found to have the most stable market, followed by Afghanistan, the USA, and other small importing countries. While the U.K. and Germany showed no stability, In terms of export value, keeping in view the results of the transition probability matrix, Pakistan can rely on the U.A.E. for non-frozen citrus juice exports. In terms of export value, the United Kingdom and Germany exhibit zero percent loyalty. The market share of Pakistani non-frozen citrus juice among major importers has been calculated for 2020–21 to 2024–25 for a period of five years with the use of the transitional probability matrix. Results show estimated shares of non-frozen citrus juices in certain chosen nations. The U.S.A. is the principal country in the next five years to import non-frozen citrus juices in quantity. It has a significant value in terms of the quantity and proportion of non-frozen citrus juice exports from Pakistan to the United States.

The compound annual growth rates (CAGR) for export quantity and value were analyzed for a period of seven years, from 2013–14 to 2019–20. The U.A.E. growth rate of export quantity was found to be 134.43 percent per annum. Citrus non-frozen juice exports have increased in four countries: the UAE, the United States, Germany, and the United Kingdom. Afghanistan and other importing countries experienced negative growth. The CAGR for citrus non-frozen juice exports in value from the UAE, US, Germany, and the UK exhibited a positive growth trend. Other categories of importing countries and Afghanistan's export value of citrus non-frozen juices exhibited a negative growth trend. Policymakers should pay attention to the countries showing a negative growth trend for Pakistan's non-frozen citrus juice exports to get them to a positive level of exports for Pakistan's non-frozen citrus juice exports.

With a CDVI of 246.2 percent, Germany has the highest variability in the Cuddy-Della instability index (CDVI) for quantity exported. The United Arab Emirates, the other importing country, and Afghanistan have the highest variability, with CDVIs of 153.5 percent, 146.34 percent, and 130.7 percent, respectively. The CDVI for the United Kingdom and the United States of America varied, with 39.15 percent and 32.85 percent, respectively. The Cuddy-Della Valle Index (CDVI) of Instability results show that all the importing countries are showing very high levels of instability for the exports of non-frozen citrus juice from Pakistan. In terms of the Cuddy-Della Valle instability index for exports of citrus non-frozen juice in value, other categories of importing countries had the largest instability (CDVI 135.7 percent), followed by the UAE at 111.9 percent, Afghanistan at 102.8 percent, the UK at 35.78 percent, and Germany at 35.74 percent, showing a high level of inconsistency in citrus non-frozen juice exports. While the USA showed a moderate level of consistency in the growth of citrus non-frozen juice exports (CDVI: 24.09 percent). Regulations and directions can increase citrus production, as can alternative management strategies and policies to improve citrus non-frozen juice exports from Pakistan.

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