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Direction and Destination Pattern of Fresh Oranges Export from Pakistan: A Markov Chain Approach

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ABSTRACT

Current study is an endeavor to examine the behavior of the big five Pakistani oranges importers i.e., Afghanistan, Kazakhstan, Russia, the UAE, and Ukraine. 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. Based on the TPM, the study concludes that, in terms of quantity, Afghanistan and the UAE showed the highest retention levels and remained consistent. However, the CDVI of all the importing nations for the exports of fresh oranges from Pakistan displayed inconsistent export growth. This study demonstrated the significance of Markov chain theory and its application in the Pakistani context for behavioral prediction of importing countries. This study measures the retention behavior of importing countries, and the results showed that Kazakhstan, Russia, and Ukraine are not willing to import fresh oranges from Pakistan in the future. Regulations and directions that can increase fresh oranges production and exports, as well as alternative management strategies and policies to improve fresh oranges exports in Pakistan, are required.



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Introduction

Fruit, vegetable, ornamentals (flowers, trees, and shrubs), 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 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 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 endeavor 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 variable 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 source.

Literature Review

The study, "Forecasting the Production of Groundnut in Turkey Using an ARIMA Model," conducted by Celik, Karadas, and Eyduran (2017), used data from 1950 to 2015 to anticipate groundnut production volumes in Turkey for the years 2016 to 2030 using autoregressive integrated moving average (ARIMA) models. The ARIMA (0, 1, and 1) model, one of the six ARIMA models examined, was shown to be the most effective at forecasting the output of groundnuts over the next 15 years. In 2016, 138,980 tones of groundnuts were produced annually, with that figure expected to more than double to 167,281 tons by 2030. The groundnut production trend was on the rise, according to the ARIMA (0, 1, 1).

The theory of Markov chains, which is also a successful union of linear algebra and probability theory, is a fundamental concept in computational processes. The use of a Markov chain for long-term or short-term predictions can always ensure an accurate probability. Also, because of the nature of Markov chains, this decreases the demand for vast amounts of data. The probability for the future depends only on the current situation and not on the history described in the study by Yutong (2021).

Bhagat and Jadhav (2021), conducted a study on the growth, instability, and forecasting of grape exports from India that attempted time series modelling for grape exports in quantity and value 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 (a span of 29 years) were used in the analysis. 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 a solid market. Bangladesh, the United Kingdom, and the UAE appear to be moderately stable.

Research on the impact of globalization on the production and export of turmeric in India An economic analysis by Angles, Sundar, and Chinnadurai (2011), examined the direction of the turmeric export business from India. Based on a TPM, they discovered that the US was not a consistent importer of Indian turmeric, even though the amount imported by the US was higher. The US would lose its share of 42.28 percent to the UAE, 25.88 percent to Japan, and 24.87 percent to the rest of the world, respectively. The United Kingdom was found to have retained and maintained its loyalty to its initial proportion of approximately 35.20 percent during the time. In both pre- and post-war periods Koujalagi and Mundinamani (2012) checked the direction of business in Indian pomegranates and discovered Bangladesh, Saudi Arabia, and the UAE as having a stable retention probability for pomegranates, which reflects the high likelihood of 0.80, 0.76, and 0.65, respectively.

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 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 taxonomy of research gaps: identifying and defining the seven research gaps by Miles (2017) in the cited research. To fill this gap, the researcher used Markov chain theory in study.

Methodology

The secondary data is used in this study. The product for this study is the export of fresh oranges from Pakistan to the world. 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 and the growth and consistency of fresh oranges exported from Pakistan. Pakistan exported fresh oranges (HS Code 08051000) with a value of Rs. 815.903 million and in quantity terms, 17,651.245 tones during FY 2019–20. Excel and LPS software combination is used for analysis of the collected data.

Growth rate analysis

The compound annual growth rate (CAGR) is used to assess the fresh oranges export performance. The exponential growth function is used to analyze the growth in quantity exported and in value terms for fresh oranges exports from Pakistan.

$$Y = a \cdot b^t$$

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,

$$\text{Log } y = \text{log } a + t \text{ Log } b$$

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

$$\text{CGR} = [\text{Antilog}(\text{log } b) - 1] \times 100$$

3.2 Instability analysis

The coefficient of variation and the Cuddy Della Valle instability index are used to investigate the instability of fresh oranges exports.

3.3 Coefficient of variation (CV)

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

Where,

σ = Standard deviation

\bar{x} = Arithmetic Mean

Cuddy Della Valle instability index (CDVI)

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

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 degrees of freedom.

Markov chain analysis

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 over 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 fresh oranges, using the Markov model. The chain analysis by Markov entails the development of a "TPM," 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 countries. The assumption was that in any given time period between the importing countries, average fresh oranges export from Pakistan were dependent on previous period exports, and that this dependence was equal across all periods. A Markov chain algebraic expression is

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

Where;

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

E_{it-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 E_{it-1}

N = the number of importing countries

The transitional probabilities P_{ij} , which can be arranged in a (column \times row) matrix, have the following properties.

$$\sum_{j=1}^n (P_{ij}) = 1 \text{ and } 0 \leq P_{ij} \leq 1$$

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 TPM. The linear programming (LP) framework was used for estimation of the TPM through a method called the minimization of mean absolute deviation (MAD).

$$\text{Min, } OP^* + Ie$$

Subject to,

$$\begin{aligned} XP^* + V &= Y \\ GP^* &= 1 \text{ and } P^* \geq 0 \end{aligned}$$

Analysis and Results

Transition probability matrix (TPM)

As the primary countries importing fresh oranges from Pakistan, Afghanistan, Kazakhstan, Russia, the United Arab Emirate (UAE), Ukraine, and the rest of the world were classified as "other countries." The TPM 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 column element indicates the possibility of gains in trade volume from other competing countries.

Countries	Afghanistan	Kazakhstan	Russia	U.A.E.	Ukraine	Others
Afghanistan	0.4636	0.0000	0.1127	0.1475	0.0649	0.2113
Kazakhstan	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Russia	0.0000	0.1054	0.000	0.0000	0.0000	0.8946
U.A.E.	0.0000	0.0000	0.0000	0.4442	0.0000	0.5558
Ukraine	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Others	0.7011	0.0000	0.0000	0.0000	0.0169	0.2820

Table 1. Transition probability matrix in terms of quantity of fresh oranges export

The likelihood of retention at 0.4636, i.e., the probability that Afghanistan preserves its export share over the study period, demonstrates that Afghanistan was one of the most stable markets among the top buyers of Pakistan's fresh oranges. Pakistan's fresh oranges exports to Afghanistan currently account for 46.36 percent of the total; of the remaining 53.64 percent of the Afghan market, 11.27 percent was directed to Russia, 14.75 percent to the UAE, 6.49 percent to Ukraine, and 21.13 percent to others. Afghanistan was the most reliable and loyal market for Pakistan's fresh oranges exports. Afghanistan keeps its 46.36 percent share while gaining 100 percent from Kazakhstan, 100 percent from Ukraine, and 70.11 percent from others. Pakistan can rely on Afghanistan for fresh oranges exports (Table 1).

The likelihood of retention at 0.4442, i.e., the probability that UAE preserves its export share over the study period, demonstrates that UAE was one of the most stable markets among the top buyers of Pakistan's fresh oranges (Table fresh oranges). Now, Pakistan's fresh oranges exports to UAE have retained 44.42 percent of their previous year's share; others received them from the remaining 55.58 percent of the UAE market. The UAE was Pakistan's most dependable and loyal market for fresh oranges exports. UAE keeps its 44.42 percent share while gaining 14.75 percent from others (Table 1).

Other categories of countries have a moderate probability retention rate of 0.2820, which suggests that they keep their 28.20 percent export share. It means that it had lost most of its market share to remaining importing countries: out of the remaining 71.80 percent, 70.11 percent went to Afghanistan, and the remaining 1.69 percent went to Ukraine. Other categories of countries keep their 28.20 percent share while gaining 21.13 percent from Afghanistan, 89.46 percent from Russia, and 55.58 percent from the UAE. Kazakhstan has a zero-probability retention rate, which suggests 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 of it went to Afghanistan. Kazakhstan keeps its zero percent retention rate of probability while gaining 10.54 percent from Russia (Table 1). Pakistan cannot rely on Kazakhstan for fresh oranges exports.

Russia has a zero-probability retention rate, which suggests 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, 10.54 percent went to Kazakhstan and 89.46 percent to others. Russia keeps its zero percent retention rate of probability while gaining 11.27 percent from Afghanistan. Pakistan cannot rely on Russia for fresh oranges exports. Ukraine has a zero-probability retention rate, which suggests 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 of it went to Afghanistan. Ukraine keeps its zero percent retention rate of probability while gaining 6.49 percent from Afghanistan and 1.69 percent from others. Pakistan cannot rely on Ukraine for fresh oranges exports. In terms of value for fresh oranges exported during the study period, Kazakhstan was shown to be the most stable

market. Afghanistan was determined to be moderately stable markets, while Russia, the UAE, Ukraine, and other categories of importing countries showed no stability.

Countries	Afghanistan	Kazakhstan	Russia	U.A.E	Ukraine	Others
Afghanistan	0.2967	0.0000	0.1246	0.2082	0.0748	0.2956
Kazakhstan	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
Russia	0.0000	0.0986	0.0000	0.7198	0.0233	0.1583
U.A.E	0.5620	0.0000	0.0000	0.0000	0.0432	0.3949
Ukraine	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Others	1.0000	0.0000	0.000	0.0000	0.0000	0.0000

Table 2. The TPM in terms of value of fresh oranges export

Kazakhstan maintained its market share of 100 percent. Kazakhstan increased its market share relative to Russia by 9.86%. Afghanistan maintained its previous year's market share of 29.67 percent. With 12.46 percent, 20.82 percent, 7.48 percent, and 29.56 percent, Afghanistan lost its market share to Russia, the UAE, Ukraine, and other categories of importing countries, respectively. On the other hand, market share was gained by Afghanistan from the UAE, Ukraine, and other categories of importing countries, with an observed value of 56.20 percent, 100 percent, and 100 percent, respectively. Russia shows no stability, and it lost its share to Kazakhstan, the UAE, Ukraine, and other categories of importing countries with 9.86 percent, 71.98 percent, 2.33 percent, and 15.83 percent, respectively (Table 2).

UAE shows no stability, and it lost its share to Afghanistan, Ukraine, and other categories of importing countries with 56.20 percent, 4.32 percent, and 39.49 percent, respectively. On the other hand, market share was gained by the UAE from Afghanistan and Russia, with an observed value of 20.82 percent and 71.98 percent, respectively. Ukraine shows no stability, and it lost all of its 100 percent to Afghanistan. While Ukraine increased its share by 7.48 percent, 2.33 percent and 4.32 percent of the market share came from Afghanistan, Russia, and the UAE, respectively. Other categories of importing countries show no stability, and they lost all of their exports to Afghanistan. While other categories of importing countries increased their shares by 29.56 percent, 15.83 percent, and 39.49 percent of the market share from Afghanistan, Russia, and the UAE, respectively, Kazakhstan was found to be the most stable market, followed by Afghanistan (Table 2).

Country	Afghanistan		Kazakhstan		Russia		U.A.E		Ukraine		Others	
	Obs.	Est.	Obs.	Est.	Obs.	Est.	Obs.	Est.	Obs.	Est.	Obs.	Est.
Years	68	-	0.1	-	02	-	17	-	05	-	82	-
2013-14	07	06	00	0.1	0.1	08	33	24	0.1	04	60	58
2014-15	34	44	0.1	0.8	08	05	16	14	06	04	37	33
2015-16	83	78	00	0.5	0.8	0.9	05	05	0.7	03	11	13
2016-17	47	48	0.1	0.5	09	05	14	13	06	04	24	30
2017-18	41	40	0.9	0.5	02	02	20	19	03	04	36	32
2018-19	69	67	16	15	0.6	0.3	02	03	03	04	09	11
2019-20												

Table 3. Goodness of fit test

Goodness of fit $\chi^2_{cal} = 33.80$ χ^2_{tab} at 25 degrees of freedom = 37.65 *Obs. – Observed and Est. – Estimated.*

While examining the observed and estimated shares in percent in every country, the variances were largely negligible. The estimated chi square (33.80) was below the 25 degree of freedom table value (37.65), at a 5 percent significance level, showing the equal distribution of observed and expected exports of fresh oranges.

This means that the observed proportions of the export shares are consistent with the estimated export shares calculated from the Markov process, which confirms the goodness of fit and the usage of the Markov chain model for calculating export shares in different countries (Table 3).

Years	Countries					
	Afghanistan	Kazakhstan	Russia	U.A.E.	Ukraine	Others
2020-21	10119226	11392	1372248	1978568	817461	3552350
2021-22	7870458	144635	1140437	2371466	713393	5410857
2022-23	8300323	120202	887001	2214298	602236	5527185
2023-24	8445578	93490	935446	2207889	632100	5336742
2024-25	8382550	98596	951817	2226467	638309	5353507

Table 4. Prediction of fresh oranges export

The market share of Pakistani fresh oranges among major importers has been calculated from FY 2020–21 to FY 2024–25 for a period of five years with the use of the TPM. Table 4 shows estimated shares of fresh oranges in certain chosen nations. Afghanistan is the principal country in the next five years to import fresh oranges. It has a significant value in terms of quantity and proportion of exports of fresh oranges from Pakistan to Afghanistan.

The predicted results show that the market share of Afghanistan is going to decrease in the future, from 10119226 in FY 2020–21 to 8382550 in FY 2024–25. The predicted results show that the market share of Kazakhstan is going to increase in the future, from 11392 in FY 2020–21 to 98596 in FY 2024–25.

The predicted results show that the market share of Russia is going to decrease in the future, from 137, 2240 in FY 2020–21 to 95,817 in FY 2024–25. The predicted results show that the market share of the U.A.E. is going to increase in the future, from 1978568 in FY 2020–21 to 2226467 in FY 2024–25. The predicted results show that the market share of Ukraine is going to decrease in the future, from 817461 in FY 2020–21 to 638309 in FY 2024–25. The other category of countries is the second major fresh oranges export destination for Pakistan. The predicted results show that the market share of the other category of importing countries is going to increase in the future, from 3552350 in FY 2020–21 to 5353507 in FY 2024–25 (Table 4).

Rates of growth in fresh oranges exports

The following table shows the findings obtained by applying the exponential growth function to the estimation of fresh orange exports. 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.

Compound growth rates of export in terms of quantity of fresh oranges

Sr. No	Country name	CAGR (Quantity)	T Value	R2
1	Afghanistan	88.36	2.3977	0.5348
2	Kazakhstan	969.98	1.7785	0.3874
3	Russia	166.83	0.6722	0.0828
4	U.A.E	26.87	1.2956	0.2513
5	Ukraine	202.00	2.3011	0.5143
6	Others	55.99	3.6056	0.7222

Table 5.

Table 5 shows that the Kazakhstan growth rate of exports in quantity terms was found to be 969.98 percent per annum. While Ukraine, Russia, and Afghanistan experienced annual growth rates of 202 percent, 166.83 percent, and 88.36 percent, respectively. Other categories of importing countries and the U.A.E. show positive annual growth rates of 55.99 percent and 26.87 percent, respectively. All the importing countries Kazakhstan, Afghanistan, Russia, the U.A.E., Ukraine, and others have shown an increase in fresh oranges exports.

Compound growth rates of export in terms of value of fresh oranges

Sr. No	Country name	CAGR	T Value	R2
1	Afghanistan	56.12	2.1353	0.4769
2	Kazakhstan	540.39	1.8147	0.3971
3	Russia	122.31	0.6076	0.0687
4	U.A.E	39.03	2.2501	0.5031
5	Ukraine	150.00	2.7898	0.6088
6	Others	200.25	5.5588	0.8607

Table 6.

Table 6 shows that among the six countries with the highest export value, only Kazakhstan found a CAGR of 540.39 percent per annum, while the remaining five countries in the other category of importing countries Ukraine, Russia, Afghanistan, and the U.A.E. showed CAGRs of 200.25 percent, 150 percent, 122.31 percent, 56.12 percent, and 39.03 percent per annum, respectively. Kazakhstan, Afghanistan, Russia, the United Arab Emirates, Ukraine, and other importing countries exported more fresh oranges than they imported.

Instability in fresh oranges 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 performed to better understand the magnitude and pattern of fluctuations in the quantity and value of fresh oranges exported from Pakistan to various countries. 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.

Instability in export growth in terms quantity of fresh oranges

Sr. No	Country name	C.V	CDVI
1	Afghanistan	112.1	83.73
2	Kazakhstan	258.6	221.7
3	Russia	171.5	179.9
4	U.A.E	86.34	81.83
5	Ukraine	107.6	82.17
6	Others	83.51	48.21

Table 7.

Table 7 presents Kazakhstan shows the highest variability, with a coefficient of variance of 258.6 percent, followed by Russia with 171.5 percent, Afghanistan with 112.1 percent, and Ukraine with 107.6 percent variability, respectively. U.A.E. and other categories of importing countries show coefficients of variation of 86.34 percent and 83.51 percent, respectively. Kazakhstan has the most variability in the Cuddy-Della instability index, with a CDVI of 221.7 percent. Russia, Afghanistan, Ukraine, and the U.A.E. have variability with CDVIs of 179.9 percent, 83.73 percent, 82.17 percent, and 81.83 percent, respectively. Other categories of importing countries show variability, with CDVIs of 48.21 percent.

Instability in export growth in terms of value of fresh oranges

Sr. No	Country name	C.V	CDVI
1	Afghanistan	116	91.94
2	Kazakhstan	254.2	217.9
3	Russia	191.7	202.7
4	U.A.E	79.72	61.56
5	Ukraine	114.6	78.54
6	Others	84.78	34.66

Table 8.

Table 8 shows that Kazakhstan, in value terms, shows the highest variability, with a coefficient of variation of 254.2 percent, followed by Russia, Afghanistan, and Ukraine, with coefficients of variation of 191.7 percent, 116 percent, and 114.6 percent, respectively. Other categories of importing countries and the U.A.E. have variations, with coefficients of variation of 84.78 percent and 79.72 percent, respectively. In terms of the Cuddy-Della instability index, Kazakhstan shows the largest variability (CDVI 217.9 percent), indicating a very high level of inconsistency in export growth, while other categories of importing countries show the lowest variability (CDVI 34.66 percent), showing a very high level of inconsistency in export growth. The inconsistency in terms of CDVI for the countries of Russia, Afghanistan, Ukraine, and the U.A.E. shows 202.7 percent, 91.94 percent, 78.54 percent, and 61.56 percent, respectively.

During the study period, practically all nations' exports in terms of quantities and values showed positive values, showing a large potential for fresh orange exports from Pakistan. Regulations and directions that can increase citrus production as well as alternative management strategies and policies to improve fresh oranges exports in Pakistan are required. While the trend analysis using

index numbers revealed changes in export quantity and value over the study period, this could be attributed to policy shifts and their implementation at various times.

Conclusion and Recommendations

Afghanistan, Kazakhstan, Russia, the United Arab Emirate (UAE), Ukraine, and the rest of the world were categorized under the category of "Other Countries" as the primary countries importing Pakistan's fresh oranges. The likelihood of retention at 0.4636, i.e., the probability that Afghanistan preserves its export share over the study period, demonstrates that Afghanistan was one of the most stable markets among the top importers of Pakistan's fresh oranges. The likelihood of retention at 0.4442, i.e., the probability that the UAE preserves its export share over the study period, demonstrates that the UAE was one of the most stable markets among the top buyers of Pakistan's fresh oranges. The other group of countries has a moderate probability retention rate of 0.2820, implying that it will keep its 28.20 percent share of the export market. Kazakhstan has a zero-probability retention rate, implying that it will maintain its zero percent export share. Russia has a zero probability of retention, implying that it will maintain its zero percent export share. Ukraine 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 Afghanistan and the U.A.E. exhibit the most stable levels of loyalty to the exports of fresh oranges from Pakistan. On the other hand, other categories of importing countries show a moderate level of loyalty to Pakistan's fresh orange exports. Policymakers should pay attention to these countries to make them loyal to Pakistan's fresh oranges exports. There is a need to work on moderate-level countries to get them at the most stable level of exports for Pakistan's fresh oranges exports. Keeping in view the results of the transition probability matrix, Pakistan can rely on Afghanistan and the U.A.E. for fresh oranges exports.

In terms of value for fresh oranges exported during the study period, Kazakhstan was shown to be the most stable market. Afghanistan and Kazakhstan were determined to be moderately stable markets, while Russia, the UAE, Ukraine, and other categories of importing countries showed no stability. In terms of export value, keeping in view the results of the Transition Probability Matrix (TPM), Pakistan can rely on Kazakhstan and Afghanistan for fresh oranges exports. The market share of Pakistani fresh oranges among major importers has been calculated from 2020–21 to 2024–25 for a period of five years with the use of the TPM. Table 4 shows the estimated shares of fresh oranges in certain chosen nations. Afghanistan will be the principal country in the next five years to import fresh oranges. It has a significant value in terms of quantity and proportion of exports of fresh oranges from Pakistan to Afghanistan.

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. Kazakhstan's growth rate of export quantity was found to be 969.98 percent per annum. All of the importing countries Kazakhstan, Afghanistan, Russia, the U.A.E., Ukraine, and other categories of importing countries have shown an increase in fresh oranges exports. The compound growth rates (CAGR) for export values were analyzed for a period of seven years, from 2013–14 to 2019–20. Kazakhstan's growth rate of export value was found to be 540.39% per annum. All of the importing countries Kazakhstan, Afghanistan, Russia, the U.A.E., Ukraine, and other categories of importing countries have shown an increase in terms of value in their fresh oranges' exports.

Kazakhstan has the most variability in the Cuddy-Della instability index, with a CDVI of 221.7 percent. Russia, Afghanistan, Ukraine, and the United Arab Emirates have the highest levels of variability, with CDVIs of 179.9 percent, 83.73 percent, 82.17 percent, and 81.83 percent, respectively. Other categories of importing countries also had variability, with a CDVI of 48.21 percent. In terms of the Cuddy-Della instability index (CDVI) in value terms, Kazakhstan had the largest variability (CDVI 217.9 percent), while the other category of importing countries had the lowest variability (CDVI 34.66 percent). The variation in CDVI was 202.7 percent, 91.94 percent, 78.54 percent, and 61.56 percent for Russia, Afghanistan, Ukraine, and the United Arab Emirates, respectively. Regulations and directions that can increase citrus production as well as alternative management strategies and policies to improve fresh oranges exports in Pakistan are required.

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