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International Market Demand for California Raisins: A Time Series Analysis

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Abstract

This study focuses on the export demand for California-grown raisins from the world's largest importers: Japan, China, Germany, and Canada. It aims to estimate the price cointegration relationship between California's wholesale price and how export demand changes transmit to the local market and impact farm-level economic returns. It uses local raisin's quarterly wholesale prices from 2012 to 2024, and the international trading prices from USDA Global Agriculture Trade System (GATS) data sets from the same periods. Our results show that the prices of the last two quarters suggest the upcoming quarter's supply and demand situation in the local market. It reveals that California's local raisins wholesale market is integrated into the world's raisins trading, especially with the large trading partners of Japan, Germany, and Canada. Additionally, the VAR model and the data used in this study do not support a longer-run price cointegration among selected countries and between California's wholesale market and these destination countries.

Keywords: California raisins trade, VAR analysis raisins, USDA GATS, U.S. raisin export, raisins global demand

1. Introduction

Considering the perishability of most food products, the debate over the benefits of selling U.S.-grown food to international markets is multifaceted and involves various economic, logistical, and environmental factors (McKendree et al., 2019; Crespi & Marette, 2009). Exporting food allows producers to tap into international markets, reaching consumers beyond their domestic borders. This expansion can increase farm-level sales and revenue, mainly for dried fruits. To measure trade benefits, agricultural economists have used econometric methods to quantify world market demand shocks and examine how these shocks are transmitted through the supply chain to affect the wholesale market. This study focuses on the export demand for California-grown raisins from the world's largest importers: Japan, China, Germany, and Canada. It aims to estimate the price cointegration relationship between California's wholesale price and how export demand changes transmit to the local market and impact farm-level economic returns.

California's Central Valley is the world's second-largest producer of raisins, next to Turkey. The State's most updated statistics show that the industry produced 1.07 million tons of output in 2021, contributed 397.8 million to the State's economy, and supported 40,000 to 50,000 workers to harvest, cut bunches, and lay raisins to dry in the sun (USDA Agricultural Marketing Resource Center, 2023). Compared with Turkish raisins, California raisins are more affordable with premium quality (USDA FAS, Gain report, 2024). Understanding the price relationship between local and world export prices is paramount for the 1,500 raisins growers that produce 100% of U.S. Raisins in Central California. Raisins are an essential agricultural commodity; their farm-level prices depend not only on the microeconomic environment, such as consumer preferences and price willingness-to-pay, but can also be influenced by factors such as export demand from key trading partners and the impact of historical pricing patterns across years. Growers' ability to understand how price variations from major international buyers can change their raisings' price margins is critical for them when planning production,

exportation, and risk management.

To promote California raisins in the world market, California's Raisin Administrative Committee (RAC) uses export promotion to stimulate sales to export destinations. Studies show that these export promotion programs are highly profitable to California raisin growers (Kaiser et al., 2003; Kaiser, 2010). From 2005 to 2008, California Raisin export promotion added 65,624 metric tons to the United Kingdom and 62,696 additional metric tons to Japan. The program resulted in a 55.1% total export increase across all countries. Whether or not raisin producers can benefit from such efforts depends primarily on two factors. First, does the change in the world market price have a ripple effect on the local market through price cointegration? Second, what is the direction of the price change? Is there a causal price relationship between the local market and the export destination countries? Our paper provides new insights related to both factors.

California's raisin export sector faces challenges such as competition from other raisin-producing countries, changing trade policies, and environmental concerns. Opportunities also exist in significant markets with increasing demand for healthy snacks and developing new product innovations to appeal to diverse consumer preferences. This study will focus on the impacts of macroeconomic factors. It will conduct a time series analysis using the vector auto-regression model (VAR) to address the need for more research on international trade-related demand for raisins in the selected countries. Specifically, this study aims to understand the trends of raisin trade across the years, identify appropriate world market pricing strategies, and analyze potential world market expansion opportunities.

Despite the industry's effort to reach the global market, there are limited economic studies on raisin export and international trade. Under the Federal Raisin Marketing Order 989, The Raisins Administrative Committee (RAC) conducted export promotion activities in other countries to increase California raisin exports. The program includes stimulating sales by helping the industry better access the foreign market (USDA's Market Access Programs), providing marketing promotion funds to enter other countries' markets (Industry Marketing Promotion Fund), and creating consumer loyalty to California raisins (Merchandise Incentive Program).

Previous studies have investigated the impact of such export promotions and measured the return on investment (Kaiser et al., 2003; Kaiser, 2010). Kaiser et al. (2003) revealed that California raisins export promotion is highly effective in Japan and the U.K. Another Kaiser (2010) study examined 12 export destinations countries and found that Japan, U.K., Scandinavia, and Taiwan had the most significant response to the promotion programs meaning that the export promotion programs to these countries are effective of increasing the demand for California raisins on quantity exported. Specifically, their study revealed that the incremental export to Japan and the U.K. due to export promotion in these two markets represents 55.1% of the total export increase. The study compared the benefits of the program and the costs to show that when exporting California raisins under the export promotions program, the average rate of return was more significant than 1 to Singapore, South Korea, Philippines, Malaysia, and Thailand, meaning that the program was highly influential in term of generating export revenues. The study also demonstrated that if the Raisin Administrative Committee invested $1.00 in export promotion, the revenue generated would increase by $1.2, suggesting that the program was highly profitable for the industry to invest in. The above studies indicate that raisins export increases demand and generates revenues. However, the linkage between export volume and wholesale price that farmers are getting paid still needs to be established.

Agribusiness studies have also examined food industry development, export marketing, and international expansion and addressed the more significant price linkage between major food importers from the global market and specific commodity producers (Mafimisebi, 2012). Even though such studies have not investigated raisin-related trade, some studies have analyzed almonds, another vital commodity that generates billions of revenues for California's economy. One study verified the linkage between past months' local wholesale prices of almonds and export prices in Europe, East Asia, and the overall world market (Xu et al., 2022). When the U.S. export price of almonds to the world increases in the current month, its export price to East Asian countries, including Japan and China, will automatically adjust and grow in the following month. The almond study did not establish such a relationship for the longer run price cointegration relationship. Other researchers pointed out that the increasing export of California commodities is pulled by the accelerated demand from China (Reisman, 2019; Krieger, 2015). Both studies affirmed that enhanced consumption demand from China's growing middle class is the primary reason for the spike in California almonds demand.

A critical goal of our study is to address the needs of growers to help them form better price expectations and assist in better production decisions (Just & Rausser, 1981; Zheng et al., 2012). If farmers can understand the impact of export prices on local wholesale demand, they can better predict future prices and adjust production

and marketing strategies. To this end, Haile and Kalkuhl (2016) pointed out that grain producers with better market information can forecast the next season's price better. To raisins growers, the ability to use published trading data to form unbiased predictions for the upcoming month's price in the local market is paramount. With this ability, growers can apply the price signals to improve production, marketing, and cost management decisions.

2. Methods

This study uses local raisins' quarterly wholesale prices (in metric tons) from 2012 to 2024, obtained from the USDA and California Department of Food and Agriculture website (https://www.cdfa.ca.gov/Statistics/). It analyzes the international trading prices from USDA Global Agriculture Trade System (GATS) data sets from the same periods. The GATS data set provides the unit value of exports from the United States to Japan, China, Canada, and Germany. There are no data gaps for the research period from the system. The data did not show seasonality because raisins are dried products, and the trading volume is relatively stable across years. The selected countries represent the four most prominent buyers of California raisins across the years.

Figure 1 below shows trends in the quarterly export value from 2012 to 2024 for the four selected trading partner countries. First, the graph shows a decreasing trend of exports to China and Germany, two of the largest buyers of raisins from the U.S. Compared to before 2015, when both countries imported over 5 million worth of raisins, the import value dropped slightly to over 1 million after 2021. Second, export value to the neighboring country of Canada has remained relatively stable across the years, with the recent years' exports going down compared to before 2018. Thus, the exports to Canada did not make up for the loss of exports to China and Germany. Third, export to Japan, the top importer of U.S. raisins, fluctuates across years, with recent purchases showing a downward trend after 2022.

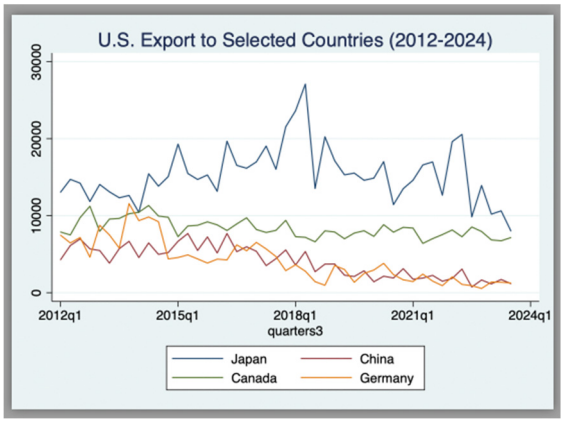

Figure 1. U.S. Export Trend to Selected Countries (2012-2024)

Table 1 provides the mean statistics of the U.S.'s raisins export value to the selected countries. It is worth noticing that in the past decade, the value of U.S. exports to the world market was about 73 million dollars on average, with Japan being the largest importer. On the price side, California raisin producers received the average wholesale price of $1,559 per ton, as published by the California Department of Food and Agriculture.

Table 1. Mean Statistics of selected variables

			95% conf. Interval	
Countries	Mean	Standard Dev.	Lower bound	Upper bound
U.S.	73,953	2,762	68,392	79,513
Japan	15,365	534	14,289	16,441
Canada	8,355	174	8,004	8,706
Germany	4,147	402	3,338	4,956
China	4,040	292	3,452	4,629
CA price	1,559	40	1,479	1,639

The vector auto-regression method (VAR) is applied in this study to estimate the linkage between world market price changes of raisins and how it impacts California's local wholesale market (McKenzie et al., 2002; Zheng et

al., 2012; Mafimisebi, 2012). The selected price series are log transformed to correct any skewness in the distribution of prices that often arises from the non-negativity of market prices. To reduce the mean-square-forecast errors of the VAR model, we applied the Hannan and Quinn Information Criterion (HQIC) to select a lag order for the VAR model. The result reveals that a log of two is optimal. This study also constructed a vector of prices in logarithmic form $P_t = (P_{1t}\ P_{2t}\ \ldots P_{pt})$, which is assumed to be generated by a kth-order vector auto-regression (VAR) model (Motamed et al., 2008; Carter & Mohapatra, 2008):

$$P_t = \beta_1 P_{t-1} + \ldots + \beta_k P_{t-k} + \mu + \varepsilon_t$$

The vector P_t represents the logged local, regional, and world prices over the selected time horizon. It is a vector of constants and represents the error term. Johansen's cointegration test (Johansen, 1995) shows that the five selected time series do not present a cointegrating relationship, so the VAR model is appropriate.

After estimating the coefficients for the above VAR models, the Granger Causality test determines whether one of the selected time series can be used to forecast wholesale price changes in California. The hypothesis is rejected when the probability value is less than the Prob > chi2 value, suggesting a causal relationship between the selected country's export price and the California market.

3. Results and Discussion

This study measures the spread of the standard deviation of the residuals from the predicted best line, the Root Mean Square Error (RMSE), and presents the results in Table 2. The RMSE estimates are negligible, at less than 0.5, for all the selected price series, meaning that changes in the price series chosen from the five selected countries can explain their changes for up to two quarters only. The close-to-zero P-values confirm that all the VAR equations are statistically significant at the 1% confidence level. The R-square value presents the percentage of changes explained by the prices of the previous two quarters. For example, 71% of the price change in California's wholesale market can be explained by the price change in the same market rather than by price shock in the international market. The R-square values are above 50% for all selected price series except for Japan, which is 49%. This result demonstrates that raisin price is highly determined by the local/domestic marketplace rather than by external price shocks.

Table 2**.** VAR model percentage results (2012-2024)

Equation	Parameters	RMSE	R-sq	chi2	P>chi2
CA price***	13	0.10	0.71	112.66	0
U.S. ***	13	0.11	0.87	296.37	0
Japan***	13	0.20	0.49	43.36	0
China***	13	0.33	0.78	161.66	0
Canada***	13	0.09	0.72	117.95	0
Germany***	13	0.36	0.84	230.44	0
Log likelihood	172.26		Number of obs.		45

Note. *** means statistically significant at 1% level.

The VAR model reports significant short-run price variations across selected countries and the interactions of these price series (Table 3). First, almost all export chosen prices are statistically significantly affected by the variations in price changes in the previous quarters, except Germany, whose export prices correlate with China and Japan. Specifically, California's raisins wholesale price is highly and positively correlated with the last quarter's local price (alpha=1%). Second, the automatic price adjustment from Japan, Canada, and Germany is positively linked with the California wholesale market. The linkage with Japan is the strongest, with the impact lasting for up to two quarters, and with Canada and Germany, it is relatively weaker and only comes from the previous quarter. Third, there is a significant price connection between the U.S. and China (two quarters lagged at alpha=5%) and a negative price relation between the U.S. and Japan (one quarter lagged at alpha=1%). This confirms the price correlation relationship between these two major Asian importers and the U.S. export prices. Fourth, even though the causality is unclear, within the one-quarter time frame, the price to China decreases when the export price to Japan increases. In the two-quarter window, the export prices to Japan and China move

in the same direction, and both go up. Fifth, the export prices to Canada move in the same direction as the U.S. export prices in the one-quarter time frame (alpha=1%) but in the opposite direction in the two-quarter time frame (alpha=5%). Lastly, when the export prices to Germany rise, the prices to Japan seem to fall (two-quarters lagged), but the prices to China seem to increase (two-quarters lagged).

Table 3. VAR model coefficient estimates (2012-2024)

Variables	Periods	Ca price	U.S.	Japan	China	Canada	Germany
California price	1	0.485***	0.051	0.282	0.620	0.026	-0.336
	2	0.116	0.060	0.084	0.059	-0.061	-0.194
U.S.	1	-0.227	0.778***	0.027	-0.210	0.668***	0.809
	2	-0.113	0.018	-0.200	0.613	-0.354**	-0.352
Japan	1	0.200**	-0.185*	0.519***	-0.154	-0.319***	0.074
	2	0.249**	-0.083	-0.076	-0.737**	0.066	-0.978***
China	1	-0.062	-0.091	-0.244**	0.210	-0.068	0.123
	2	-0.049	0.151**	0.360***	0.571***	0.026	0.441**
Canada	1	0.210	-0.200	0.100	-0.266	"-0.258*	0.254
	2	0.313*	-0.273	0.253	-0.704	-0.144	0.263
Germany	1	0.038	0.051	-0.025	0.132	0.059*	0.232
	2	0.096**	0.062	0.012	0.093	0.057*	-0.011

Notes. * means statistically significant at 10% level, ** at 5% level, and *** at 1% level.

The Granger-causality test is conducted to identify the causality of the price impact, and the results appear in Table 4. First, the export prices to the five selected export destinations have a positive and causal relationship with California wholesale prices, meaning that the export prices to these countries can cause price changes in California's wholesale market, and California's raisin trade cannot be separated from the world market. Thus, even though the wholesale prices in California are mainly affected by the local market and the prices in the last two quarters, the local market is remarkably integrated with the world market. Second, Japan, Canada, and Germany are three countries that cause price variations in California's local market. When the export prices to Japan and Germany rise, that will pull up the export prices and further improve wholesale prices in California. Third, raisin trade prices among our major trading partners of Japan, China, Canada, and Germany are also intercorrelated, meaning that these countries are connected to the world market.

Table 4. Granger Causality Test Results (2012-2024)

Equation	Excluded	chi2	D.F.	Prob>chi2
Ca price	U.S.	3.046	2	0.218
	Japan***	13.801	2	0.001
	China	2.539	2	0.281
	Canada*	5.221	2	0.073
	Germany***	8.480	2	0.014
	All***	24.860	10	0.006
U.S.	U.S.	0.642	2	0.725
	Japan*	4.864	2	0.088
	China*	5.008	2	0.082
	Canada*	3.557	2	0.169
	Germany*	4.623	2	0.099
	All**	20.916	10	0.022

Japan	U.S.	2.459	2	0.292
	Japan	0.296	2	0.862
	China***	11.159	2	0.004
	Canada	0.748	2	0.688
	Germany	0.101	2	0.951
	All**	22.337	10	0.013
China	U.S.	3.405	2	0.182
	Japan	0.884	2	0.643
	China**	6.148	2	0.046
	Canada	2.115	2	0.347
	Germany	2.155	2	0.340
	All***	11.795	10	0.299
Canada	U.S.	0.257	2	0.879
	Japan***	15.476	2	0.000
	China***	16.292	2	0.000
	Canada	1.570	2	0.456
	Germany**	8.137	2	0.017
	All***	71.276	10	0.000
Germany	U.S.	1.520	2	0.468
	Japan	1.373	2	0.503
	China**	7.405	2	0.025
	Canada**	6.442	2	0.040
	Germany	0.415	2	0.813
	All***	42.027	10	0.000

Notes. * means statistically significant at 10% level, ** at 5% level, and *** at 1% level.

4. Conclusions

Raisins are California's most significant agricultural commodities, and their trade in local and international markets has considerably contributed to the state's economy. Recent increases in production and surges in demand, both domestically and worldwide, have created new market opportunities to enhance farm-level economic returns. In response to farmers' requests and to aid them in understanding price linkages between key trade partners and California wholesalers, this study analyzes the movement of selected price series using the VAR model. The goal is to assist California growers in learning how changes in the world market can affect farm-level profitability and the duration of these impacts. Several crucial findings can provide marketers and policymakers with valuable insights into the topic. First, the wholesale price of raisins is influenced by previous trading in the local market. Our results indicate that the prices from the last two quarters suggest the upcoming quarter's supply and demand situation in the local market. When prices are low in the previous two quarters, they are unlikely to improve in the next quarter. The automatic price adjustment in the local market follows the same pattern, allowing farmers to use the prices from the past two quarters as an effective estimate when forecasting the next quarter's price. However, this stable price pattern does not indicate longer-run price expectations outside of the two-quarter timeframe.

Second, there are essential price influencers from the international market. Our study reveals that California's local raisins wholesale market is integrated into the world's raisins trading, especially with the large trading partners of Japan, Germany, and Canada. Significant and positive price adjustments have come from these selected trading countries. When the world market price fluctuates, the local wholesale price in California will automatically adjust in the same direction and to a statistically significant magnitude. Given this finding, when predicting short-run California's wholesale prices, it is crucial to consider the U.S. export prices of the previous

two quarters because the local price is broadly and positively correlated to the export price. The price relationship between the local market and significant international trading destinations is within expectations given that the U.S. is the leading raisin supplier, and global price shocks reflect in the local markets and cause farm-level price adjustments.

Third, for the four trading partners selected in this study, the raisin's export prices present a pattern of solid intercorrelation. It confirms our expectation that when looking at price patterns in the domestic and world markets, it is essential to include major trading countries because none of these markets can be separated. This finding is significant to California because it is the only State producing raisins commercially. Thus, even small price fluctuations in the world's marketplace may significantly impact U.S. export prices and bring a ripple effect to California's wholesale market.

Lastly, the VAR model and the data used in this study do not support a longer-run price cointegration among selected countries and between California's wholesale market and these destination countries. Thus, when looking at price synchronization of more than two quarters, we expect a relatively slow price convergence due to unforeseeable reasons. Trade policy changes can be such a reason. For example, the trade tensions between the U.S. and China led to retaliatory tariffs from China on U.S. raisins and resulted in a 25% tariff rise (Produce Report, 2022). This tariff retaliation explains why price divergence exists in the long run and impacts price integration between the U.S. and selected trading countries.

This study points to future studies to better examine the price relationship between California and other raisin producers, including Turkey, Iran, Greece, and Chili. Future studies may address the export price movements between California and these export competitors to determine whether price elasticities exist and the magnitude of sensitivity levels. Our study is limited because we only included the five most significant trading partner countries, and our results cannot be used to understand price relationships with smaller trading partners.

Our results help evaluate raisins' export situations and understand the impacts of selling to different international trading destinations on California's wholesale prices. Suppose export prices are anticipated to increase wholesale raisins demand. A farm-level analysis can be conducted using our results to determine whether the rising demand will generate revenue high enough to offset the costs. To this end, understanding the linkage between local and world export prices can give the seven thousand California raisin growers reasonable price expectations, help them prepare production, guide marketing, and assist farm-level risk management. When new trade policies regarding raisins that impact domestic or international demand from significant buyers are evaluated, our results can assess export strategies and help California wholesalers accrue more significant economic returns.

Informed consent: Obtained.

Ethics approval:

The Publication Ethics Committee of the Canadian Center of Science and Education. The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Data Statement

The data supporting this study's findings are available on request from the corresponding author.

The datasets generated and analyzed during the current study are available from USDA’s GATS system from https://apps.fas.usda.gov/gats/default.aspx?publish=1

Datasets are also obtained from California Agricultural Production Statistics from: https://www.cdfa.ca.gov/Statistics/

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