

**AN ANALYSIS OF ECONOMIC, HEALTH AND ENVIRONMENTAL
FACTORS INFLUENCING INDIA'S IMPORT DEMAND FOR U.S.
ALMONDS**

Reshmi Ganguly

Associate Professor, Lady Shri Ram College For Women, University of Delhi

DOI: 10.46609/IJSSER.2022.v07i08.022 URL: <https://doi.org/10.46609/IJSSER.2022.v07i08.022>

Received: 27 August 2022 / Accepted: 2 September 2022 / Published: 3 September 2022

ABSTRACT

The purpose of this study was to estimate the impact of the major factors affecting the import demand for U.S. almonds in India. The primary objective was to explore how increase in diabetes in India and global warming in United States will impact this demand. Based on previous literature, a single-equation regression framework was specified for estimation of the almond model. The factors examined in this study were India's Gross Domestic Product (GDP) growth rate, Real Exchange Rate of Rupees, mortality due to diabetes, Cashew nut production, annual average temperature of Los Angeles. The results showed that India's GDP growth rate has positive influence to the import which means an increase in the purchasing power would increase the import of almonds. The Real Exchange Rate has positive effect on import which means that when the real exchange rate increases, the relative price of goods at home is higher and thus import increases. Diabetes mortality showed a positive influence implying Indians are becoming more aware about benefits of almonds consumption in decreasing diabetes. The estimation gave a positive relation between cashew nut production and the almonds demand with the cross elasticity more towards almond consumption. Impact of global warming proved to be very strong as 1o increase in average annual temperature resulted a decrease in almonds import. In fact, this decrease occurs at an increasing rate. The policy that can be suggested to the government is to provide support and encourage domestic producers to increase almond production in India.

Keywords: cashew nut production, diabetes, annual temperature, import of almonds, real exchange rate.

1. Introduction

Over last few years, Almond consumption has increased steadily in India due to strong economic growth, more purchasing power and an increasingly health-conscious middle-class population. The nutritional benefits of almonds with their “immunity Building” characteristics have been widely promoted during Covid 19. This is helping Almonds in displacing cashews as health-conscious consumers’ nut of choice. Almonds are making way into breakfast cereal bars, snack foods, beverages, and confectionaries manufactures, as well as in the personal care industry. India is the California almond industry’s no 1 export market in crop year 2020-21. In fact, almonds imported from US have more than doubled in volume over the last five years, from 167.1 million lbs. in 2016-17 to over 362.1 million lbs. in 2020-21. California produces nearly all of the almonds grown in the United States and is also the world’s dominant almond producer. Indian Consumers favour quintessential California almonds that are uniform in size and ‘eye’ shaped and count with the sweetness desired.

This research aimed to investigate the determinants of import demand for California almonds in India. The motivation for this study was twofold: (1) understanding the factors impacting the import demand for almonds in India (2) evaluating the impact of increasing diabetes cases in India and global warming on import demand for almonds. This study is the first of its kind investigating the import demand for almonds in a country importing California almonds.

2. Literature Review

Import demand for a commodity depends on domestic as well as foreign economic variables. Per capita income and currency exchange rates can affect import (Boansi, 2014). An increase in the per capita income of importing country can positively affect the increase in import demand (Gururaj et al., 2016). India’s GDP growth rate in 2019 was 4.2percent, but from 2010–2018, its growth rate ranged from 6.1percent to 10.3 percent. By comparison, GDP growth for the United States from 2010–2019 ranged from 1.6percent to 2.9percent. The rapid economic growth experienced by India has had a dramatic effect on world food markets. Consumers have sought to diversify their food consumption and almonds have been a primary beneficiary of this consumption trend. While world imports of almonds (shelled plus in-shell) expanded at a significant 42percent over the six-year period from 2014– 2019 based on UN Food and Agriculture Organization (FAO) data, almond imports to India (measured in shelled tonnes) expanded by 69.6percent.

Imports gets impacted by exchange rate of currency of importing country against that of US dollar. It increases when there is currency depreciation and decreases when there is an

appreciation in exchange rates (Orden, 2002). If there is a real depreciation, the households in the importing country can get less foreign goods and services in exchange for a unit of domestic goods and services. Thereby a unit of foreign good would give more of domestic goods, resulting in domestic households buying less foreign goods and foreign households wanting to purchase relatively more domestic goods (Zhang, 2008). The nominal value of the rupee has declined from 63.33 against a dollar on December 31, 2014, to 79.41 on July 11, 2022, as per RBI data. There exists a long-run relationship between real exchange rate, exports and imports. Real exchange rate is negatively associated with exports and positively associated with imports (Kemal and Qadir, 2005). A study conducted in 2019 for volume of U.S almonds exported showed an inelastic negative real exchange rate elasticity (Ajibade and Saghaian, 2022).

The prevalence of diabetes is increasing worldwide at an alarming rate. Recent projections by International Diabetes Federation suggest that the total number of people living with diabetes will rise to 643 million by 2030 and 783 million by 2045 (IDF Atlas, 2021). A research study conducted in 2016 in Spain including 55,292 individuals showed that individuals with diabetes had significantly higher risk of death than the population without diabetes, even after adjusting for risk factors that have individually shown a significant association with mortality rates (i.e., age, smoking status, BMI, systolic blood pressure, and total and HDL cholesterol) (2016, Grau et al.). Thus, diabetes in human beings is a major cause of blindness, kidney failure, heart attacks, stroke and lower limb amputation. In 2019, diabetes was the ninth leading cause of death with an estimated 1.5 million deaths directly caused by diabetes (WHO, November 2021). India, the top export market for California almonds, is considered "the diabetes capital of the world" (Dr Mishra, 2020). The current exponential rise of diabetes in India is mainly attributed to lifestyle changes. The rapid change in dietary patterns, physical inactivity, and increased body weight, especially the accumulation of abdominal fat is some of the primary reasons for increased prevalence.

Incorporating almonds into a healthy diet has beneficial effects on adiposity, glycaemic control, and the lipid profile, thereby potentially decreasing the risk for cardiovascular disease in patients with type 2 diabetes mellitus (Chiao et al., 2011). Research published during the 2000s not only dismissed claims that nuts were not healthy because of the fat or calorie content, but also tied nut consumption to heart disease prevention, weight management, type 2 diabetes management, and other health benefits. A study done by scholars from the University of Medicine and Dentistry of New Jersey, West Chester University, Pennsylvania, and Loma Linda University of California, all in the US, and published in the Journal of the American College of Nutrition confirms that almonds can control diabetes if consumed regularly. "A diet

consisting of 20 percent of calories as almonds over a 16-week period is effective in improving markers of insulin sensitivity and yields clinically significant improvements in LDL-C (low density lipoprotein cholesterol) in adults with pre-diabetes," the study said (Wien et al., 2010). In longitudinal studies, almonds have been shown to improve fasting glucose (Lovejoy et al., 2002). As consumers are becoming more aware of the health benefits, demand for almonds is increasing day by day in India.

Almond orchards are thirsty permanent crops that need water year-round. Scientists say climate change has made the American West much warmer and drier in the past 30 years and will keep making weather more extreme. There will be at least 50 percent more extreme heat days in the summer, and at least a 40 percent increase in the number of heat waves (Zhao et al, 2020). California grows 80 per cent of the world's export of almonds and the state's industry is now worth \$6 billion. However, droughts across California are causing farmers to abandon their orchards as there is barely enough water to sustain them. This has become a contributor to the potential hikes in prices. Prices have been escalating since 2009 but steeper increases are noticed more during the drought period 2011–14 (Joe et al., 2019). A recent study of U.S almond exports showed that one of the significant factors that impacts the volume of export is the price of U.S almonds (Ajibade and Saghaian, 2022).

In recent times, there is a global trend that looks favourably at vegan and plant-based diets. People who embrace a plant-based vegan diet prioritize alternative sources of protein, instead of those derived from animals, resulting in soaring demand for nuts and nut-infused foods. The cashew, along with almonds, walnuts, macadamia nuts and others, are tree nuts. In 2013, Researchers from US medical schools and research institutes, including the Harvard Medical School and the Harvard School of Public Health, among others, looked at the association of nut consumption with total and cause-specific mortality among 76,464 women and 42,498 men from 1980 to 2010. They observed that consumption of nuts was inversely associated with total mortality in both men and women, independently of other predictors of death (Tan and Mattes, 2013). In recent times, Indians are munching more cashew nuts than ever before, compelling manufacturers and processors to shift their focus to the domestic market from shrinking exports.

3. Analytical Framework and Data Description

3.1 The Theoretical Model

Economic theory postulates that the quantity of a good demanded is a function of its own price, cross prices (prices of substitutes and complements), income, and other variables, such as tastes and preferences. Similarly, standard specifications of import demand functions are based on a

simple linear model in which imports compete with domestic absorption capabilities in reaction to growth in income, relative prices, exchange rate and behaviour of exports. Following the literature in this area, this paper considered both economic and non-economic factors that can impact India's import demand for U.S almonds.

$$(IMQ) = f(GDP, RER, CaProd, DM, AvTempLS)$$

where *IMQ* is the quantity of US almonds imported annually by India; *GDP* is the gross domestic product of India (used as a proxy for income); *RER* is India's real exchange rate; *CaProd* is the amount of Cashew nut annually produced by India; *DM* stands for annual mortality due to diabetes in India; *AvTempLS* refers to average annual temperature of Los Angeles. While the earlier literature postulates and supports the functional form stated in equation, their analysis is regarding export demand function for almond exporting countries. Here the analysis is from the perspective of the country importing almonds.

3.2 The Empirical Model

To increase the resilience of the regression model and to avoid the problem of classical assumption tests, the model was transformed to a combination of double-logarithm and polynomial model to estimate India's import demand for U.S. almonds. The logarithmic functional form gave more flexibility in the interpretation of estimated coefficients. and provided an advantage because the coefficients are elasticities. In addition, the variables in a logarithm format have reduced outlier effects. For the variable which enters the model in polynomial form, the analysis not only shows its impact on the dependent variable but also measures the change in the rate of the impact. Proxy variable used in the model helps to satisfy the linear regression model assumption of non-collinearity between explanatory variables and disturbance term.

The explanatory variables included in the model can be broadly divided into economic, health and environmental variables. Gross Domestic Product variable captures the purchasing power of consumers. Real exchange rate measures the competitiveness of domestic market as compared to US market. To determine the impact of health factor, recorded mortality figures attributed to diabetes has been included in the analysis.

Cashew nuts are considered here to check whether it acts as a substitute or a complement to almonds demand in India. Both almonds and cashews are among the most popular nuts in any Indian household. Almonds can replace cashews in many kinds of dishes, from savoury to sweet treats and its variation can also substitute for raw cashews in other forms. For example, almond flour can be used as a cashew flour substitute in baking to make gluten-free cookies or non-dairy

bread. Similarly, both have their own benefits and overall, they are among the healthiest nuts to consume. Thus, the study just tries to measure the relative demand for almonds as compared to cashews in India.

The accelerating pace of climate change, combined with global population and income growth, threatens food security everywhere. Agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Thus, average annual temperature of Los Angeles (as a proxy of California temperature) is considered as an explanatory variable in the model to determine the impact of global warming on Import demand of US Almonds in India.

The empirical import demand function for U.S. almonds in India is specified as the following:

$$\log(Q_t) = \beta_1 + \beta_2(GDP_t) + \beta_3 \log(RER_t) + \beta_4 \log(DM_t) + \beta_5 \log(CPROD_t) + \beta_6(ATEMP_t) + \beta_7(ATEMP^2)^t + U_t$$

where Q_t is the quantity of almonds imported by India from U.S annually in millions of dollars, GDP_t is the annual growth rate of gross domestic product for India, RER_t is India's Real Exchange Rate, DM_t is the annual mortality due to diabetes in India, $CPROD_t$ is the annual cashew nut production in India in thousand million tons, $ATEMP_t$ is the Average Annual Temperature of Los Angeles in degree Fahrenheit and the square of this same variable appears as a separate explanatory variable $ATEMP^2$, U_t is the population error term and t is the year t.

3.3 Data Description

The time-series data used are annual data for 20 years (2000 to 2019). As covid period disrupted the demand-supply chain so pre-covid years are included in the analysis. Data for quantity of almonds imported, mortality due to diabetes and quantity of cashew nut produced annually were from the website of Indiastat. Gross Domestic Product growth rate and Real Exchange rate were from World Bank Open Data for India. Annual Data for average temperature in Los Angeles were from Los Angeles Almanac.

4. Results and Discussion

The linear regression analysis is corrected for autocorrelation of the standard errors that could exist in the dataset. The histogram of the residuals satisfied normality assumption and turned out to be homoscedastic. Scatter diagram of the fitted vs residuals showed the results to be well fitted.

The Results of the Multiple Linear Regression

| Variable | Coefficient | t-statistic | Prob |
|----------|-------------|-------------|------------|
| Const | 309.637 | 3.614 | 0.0031*** |
| GDP | 0.0404707 | 1.848 | 0.04375** |
| lnRER | 0.119743 | 1.790 | 0.0484** |
| lnDM | 0.690884 | 4.095 | 0.00065*** |
| lnCPROD | 3.47995 | 5.452 | 0.0001*** |
| ATEMP | -10.0747 | -3.896 | 0.0009*** |
| ATEMP2 | 0.0758446 | 3.890 | 0.00095*** |
| R square | 0.958128 | | |
| F | | | 0.0000*** |

Note: ** = Significant in the trustworthiness level 95%; *** = Significant in the trustworthiness level 99%;

The result of F test showed that the independent variables altogether significantly influenced the dependent variable with the trustworthiness level of 99%. Based on the result of the regression test, it can be seen that R squared value was 0.9581. The constant value indicates that the average import demand for US almonds in India is 309.637 million dollars. The gross domestic product growth rate showed a positive elasticity with import demand for almonds in India. However, it is inelastic implying that the almonds are considered as a normal commodity in India’s consumer basket. Over this period, increased purchasing power of Indian consumers due to 1% increase in GDP growth rate resulted in .0405 % growth in almond imported to India from U.S.

The real exchange rate estimated results show that import of almonds has a positive relation with exchange rate. This is consistent with prior literature. A 1% increase in real exchange rate makes domestic commodity relatively costlier as compared to foreign commodities and as per result, growth in India’s import of almonds increases by 0.1197%. Indian consumers have become more health conscious as observed from the estimated coefficient of mortality due to diabetes. Annual 1% increase in growth of diabetes mortality increases the growth rate of almonds demand in India by 0.691%.

Interestingly, almonds and cashew nuts proved to be complementary to each other, with import elasticity of almonds with respect to cashew nut production as highly elastic. Thus, on one hand

as cashew nut demand increases in India, there is an increase in demand for almonds also. This can be because overall nut consumption is getting added in daily diets of consumers. On the other hand, elasticity value of 3.477 imply higher increase in almond consumption as compared to cashew consumption. This is consistent with current wave of perceived higher health benefits from almonds.

The impact of global warming on almonds turns out to be very high. For every 1 degree increase in Los Angeles Temperature, the relative decrease in amounts of almonds imported annually to India is \$10.077 million. Estimated value of the square of average temperature shows that this rate of decrease increases by 0.0758. In California, the majority of water is stored in the form of snow in the Sierras. As winter fades, this snowpack melts and replenishes a network of dams and reservoirs (surface water). In recent years, warmer temperatures mean that most water has come in the form of rain and the snowpack is melting earlier and more quickly. Additionally, the state has seen less overall precipitation due to bad droughts (Waymouth, 2017). Thus, resulting in decreasing supply and high prices. Almond prices in US faced a big spike in the wake of a deep California drought, like it reached to \$4 per pound, in 2014. Such high prices definitely impact the import demand in India.

All the explanatory variables are individually significant in the analysis and the sign of the coefficients are as per their prior expectations. The result of White's test of heteroscedasticity test showed the probability at 0.118188 or larger than alpha 0.05 which means there were no heteroscedasticity problems.

5. Conclusions

The most interesting findings in this study is the positive impact of diabetes mortality and annual average temperature of Los Angeles on the amounts of California Almonds imported by India. This indicates that with the future possibility of increasing diabetes cases in India, the demand for almonds is definitely going to rise. On the other hand, with rising temperature in California, India must look for alternative economies for import of almonds. This opportunity can be used by the Indian government to provide support and encourage domestic producers to increase production of almonds in India.

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