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Competitive Behavior in the U.S. Green Skin Avocado Market

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Abstract

This study examined imperfect competition in international fruit markets. We conducted an empirical exercise to assess the intensity of competition in the US green skin avocado import market during the 2004 to 2013 period. A model using the (inverse) residual demand method as proposed by Goldberg and Knetter (1999) was specified and estimated. Findings reveal the existence of imperfect competition in the US green skin avocado market over the sample period. Estimation results show that the Dominican Republic, acting as an exporter exercises market power and maintains its marketing margin throughout the year.

Keywords: residual demand, Dominican Republic, avocado, inverse demand, imperfect competition, green skin avocado

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Introduction

Global avocado production and trade are highly concentrated, with the top five producers and exporters accounting for over 50% and 70% of the production and trade, respectively. World avocado production grew from 3.2 million metric tons (MMT) in 2003 to 4.4 MMT in 2012. In 2012, the top five producers and their share of the total production were Mexico (30.2%), Indonesia (6.8%), Dominican Republic (6.7%), U.S. (5.6%), and Colombia (5%) (FAOSTAT 2014a). Mirroring the noticeable rise in global production that occurred between 2002 and 2011, global avocado exports more than doubled during this period from 426,848 metric tons (MT) in 2002 to 951,573 MT in 2011 (last year data were available). During the 2009–2011 period, Mexico was the leading avocado exporter, accounting for 39.8% of the global trade, followed by Chile (14.8%), the Netherlands (re-exporter, 9.1%), Peru (7.5%), and Spain (6.9%) (FAOSTAT 2014b). On the import side, global avocado imports also followed an upward trend from 406,555 MT in 2002 to 951,573 MT in 2011. During the 2009–2011 period, the U.S. was the largest avocado importer, accounting for 43.3% of the total imports, followed by the Netherlands (10.9%), France (9.5%), Japan (4.1%), and Canada (3.6%). Together, these five countries accounted for 71.3% of the global avocado imports during the 2009–2011 period (FAOSTAT 2014b).

In 2013, U.S. total avocado imports exceeded 562,000 MT, with an estimated value of $1.08 billion (current prices in U.S. dollars). At 96% of volume traded in 2013, the Hass avocado cultivar represented the most popular avocado cultivar imported into the U.S., far outdistancing the green skin avocado cultivar (2.6%) and organic (1.5%) (USDA, FAS 2014).

Despite its low relative importance in U.S. domestic production and trade, the green skin avocado is an important component of the Florida agricultural economy, with an estimated wholesale value upwards of $35 million and an economic impact of close to $100 million for the year 2013 (Evans and Lozano 2014). Historically, the U.S. green skin avocado market has been supplied by Florida, the Dominican Republic, Mexico, and Chile (USDA/FAS 2014). In recent years, Mexico and Chile have turned their focus to the Hass cultivar because of its popularity in global markets and long postharvest life (Chilean Hass Avocado Committee 2015). This has resulted in a reduction in the supply of U.S. imports of green skin avocado from Mexico and Chile. This situation has allowed the Dominican Republic to increase its exports of green skin avocados to the U.S. (it now supplies 98% of the U.S. imported green skin avocados). Between 2004 and 2013, Dominican Republic green skin avocado export volume to the U.S. increased by 65.8% (USDA/FAS 2014). This has raised concerns regarding the extent to which Dominican Republic avocado exporters may exert market power when supplying the U.S. market, especially during the U.S. production off-season. There is also concern about using the perfect competition model to analyze the U.S./Dominican Republic green skin avocado trade.

Our study examined imperfect competition in international fruit markets. In particular, we conducted an empirical exercise to assess potential oligopolistic behavior in the U.S. green skin avocado market. Results provided insights regarding the competitive structure and pricing behaviour of the Dominican Republic as an exporter of green skin avocados. To our knowledge, no previous studies have focused attention on imperfect competition in the U.S. green skin avocado export market using an empirical industrial organization approach.

This paper is organized as follows: section 2 provides additional details about the U.S. green skin avocado market; section 3 describes the conceptual framework; section 4 presents the empirical model, data sources, and estimation procedures; section 5 presents the results of the empirical estimation; and section 6 contains a summary of the findings and concluding remarks.

The U.S. Avocado Market

U.S. avocado production occurs in the states of California, Florida, and Hawaii. California is the main U.S. producer of avocados, accounting for 84% of the total production during crop year 2013/14, followed by Florida (15.9%), and Hawaii (0.1%) (USDA/ERS 2014b). In terms of cultivars, California grows mainly the Hass cultivar, while Florida grows the green skin cultivars (California Avocado Commission 2015, Crane et al. 2013).

Figure 1 depicts U.S. domestic avocado production and trade from 2004 to 2013. Fluctuations in production are due to abiotic and biotic factors (i.e., avocado trees exhibit an alternate bearing cycle, with a large crop of small avocados one year, followed by a small crop of large avocados the next year). In addition, the value of U.S. avocado production at the farm gate level reached $350 million in 2013/14, a decrease of about 37% compared to the 2010/11 crop season (USDA/ERS 2014b).

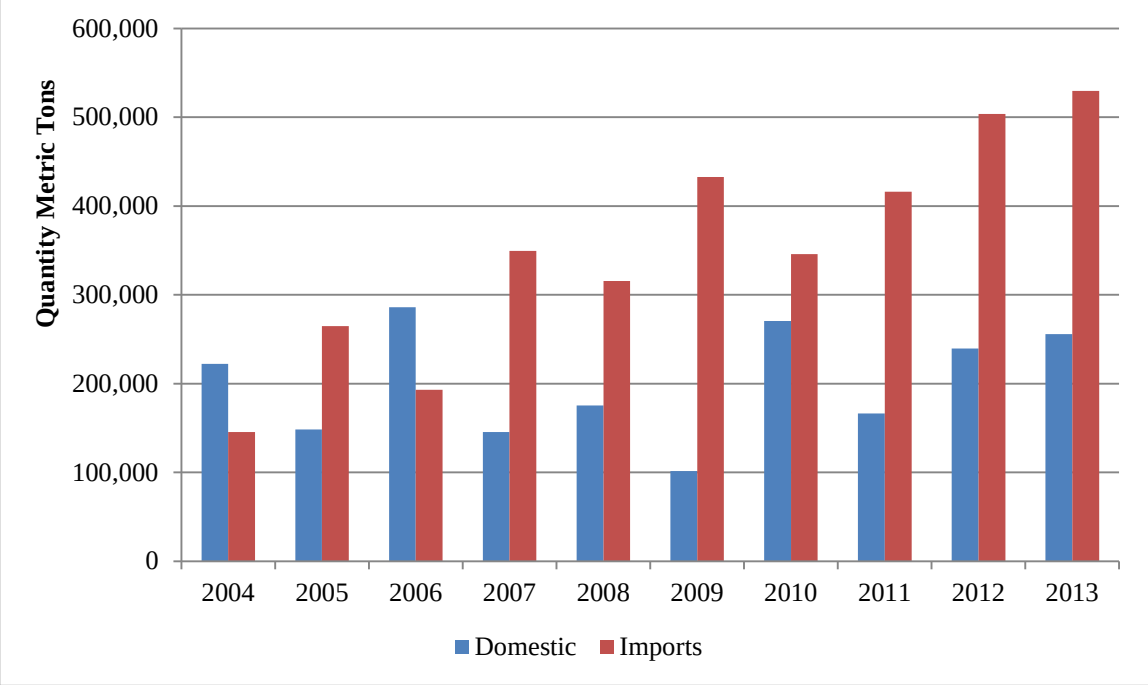

Figure 1. U.S. domestic avocado production and imports, 2004–2013
Source: USDA/FAS (2014).

Over the 2004–2013 period, Mexico emerged as the main U.S. fresh avocado overseas supplier, with a 72.4% share of the total volume of U.S. avocado imports, followed by Chile (21.9%), the Dominican Republic (4.2%), and others (1.5%) (USDA/FAS 2014). Almost all of the U.S. fresh avocado imports from Mexico and Chile are the Hass cultivar. In contrast, U.S. fresh avocado imports from the Dominican Republic are the green skin avocado cultivars, which are similar to

those produced by Florida growers. Between 2004 and 2013, U.S. imports of Dominican Republic green skin avocados increased steadily by almost 70%, from 8,477 MT in 2004 to 14,387 MT in 2013. Over the same period, the value of green skin avocado imports more than doubled, from $7.46 million in 2004 to $15.46 million in 2013 (USDA/FAS 2014).

U.S. consumption of avocados has been on the rise, with per-capita avocado consumption increasing by 87%, from 1.34 kilograms (kg) in 2004 to 2.32 kg in 2012 (USDA/ERS 2014a). While domestic production has remained relatively steady over the past decade, there has been a noticeable increase in imported avocados. Between 2004 and 2013, U.S. avocado imports grew by 394%, from 145,303 MT in 2004 to 571,827 MT in 2013 (USDA/FAS 2014).

Commercial avocado production in Florida is restricted mainly to the Miami-Dade County, with 7,000 acres. The Florida avocado industry is worth $24.4 million at the farm gate level. With 80% of the crop sold outside the state, the Florida avocado industry has a per annum economic impact of $100 million (Evans and Lozano 2014, USDA/ERS 2014b).

About 60 green skin avocado cultivars are commercially grown in Florida. These cultivars are classified into three main groups: West Indian, Guatemalan, and Mexican. Maturity season varies according to the group/race, with the fruit weighing from a few ounces to five pounds each (Crane et al. 2013). The main nutritional difference between Hass and green skin avocados is their fat content. For each golf ball-sized portion, a Hass avocado contains 4.6 grams of fat compared to 3 grams of fat for a green skin avocado (AICR 2015).

The popularity of the Hass avocados in most of the importing countries explains in part why it is the dominant cultivar grown in the major avocado producing countries (Chilean Hass Avocado Committee 2015). In addition it is known that this variety has much longer shelf life and thicker skin than green skin avocados and as such can withstand long distance shipment. These factors may help to explain why countries such as Mexico and Chile have focused their production and trade on Hass avocados.

Figure 2 depicts the monthly average for U.S. domestic production and imports of green skin avocado imports from 2004 to 2013. Because of differences in growing seasons in Florida and the Dominican Republic, green skin avocados are available year-round in the U.S. The green skin avocado marketing season runs from June to March in Florida and year-round in the Dominican Republic with the bulk occurring from October to March (Figure 2). Florida green skin avocado growers enjoy a market advantage from June to November, while Dominican Republic green skin avocado growers have the advantage from December to March. In 2012, U.S. retail sales of green skin avocados were almost $70 million, with about 75% of the retail sales occurring on the U.S. East coast, specifically in the Northeast (28%), and Southeast (47%) regions (Hass Avocado Board 2015).

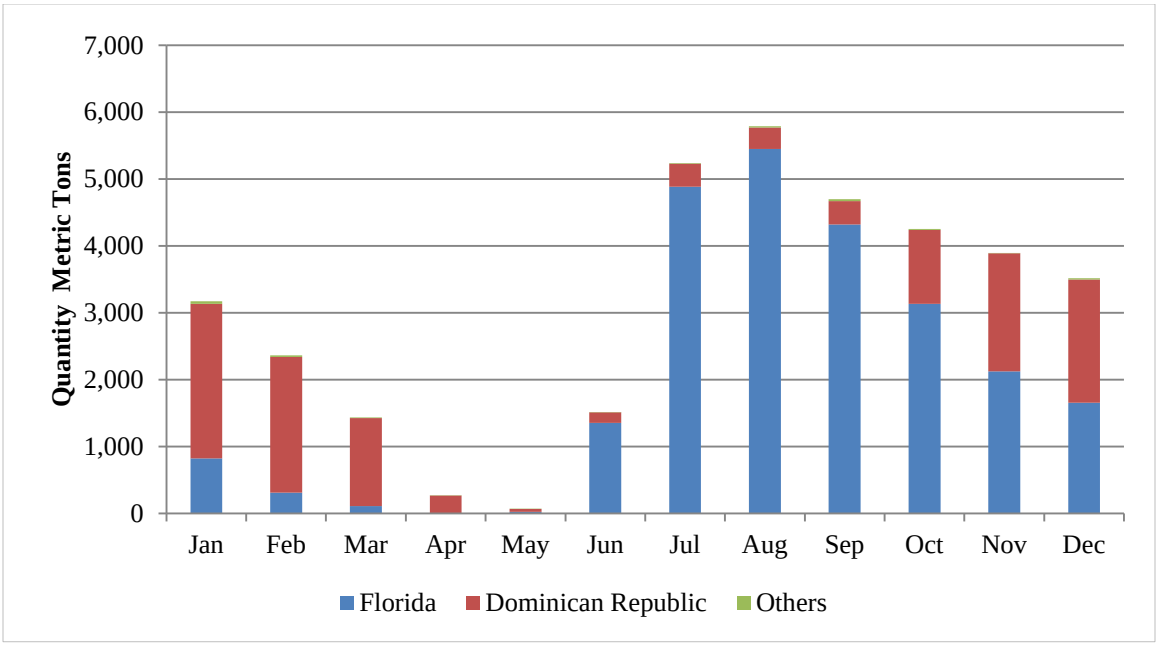

Figure 2. Monthly average for U.S. production and imports of green skin avocados, 2004–2013
Source: USDA/FAS (2014).

Conceptual Framework

A considerable amount of research has been devoted to the issue of imperfect competition in the U.S. agricultural market regarding market power (Myers et al. 2010, Reimer and Stiegert 2006, Sexton 2013). Some researchers have found that oligopolistic behavior is present in international agricultural trade (Arnade and Pick 1998, Karp and Perloff 1989, 1993).

The Lerner index, which has been the standard method to measure market power, has limited use in empirical work due to difficulties in the measurement of marginal costs. As a result, researchers in empirical industrial organization have developed several methods to estimate market power without requiring direct estimation of marginal costs. It should be noted that the data requirements to estimate a fully specified oligopoly model can be considerable and the data needed to specify an oligopoly model may not be available.

To overcome the lack of relevant data, and to make the inference of market power feasible in international markets, Goldberg and Knetter (1999) extended the residual demand model to measure market power in international markets from the seller's (exporter) side where the residual demand curve is derived as the difference between the market demand and the competitive fringe's supply curves. Therefore, with the Goldberg and Knetter (GK) method, properties of the residual demand schedule, such as elasticity, depend on properties of the market demand schedule, as well as the supply schedules of other firms in the market.

This approach is based on the identity of the Lerner index with the elasticity of the (inverse) demand faced by the firm; it does not require the estimation of all own and cross price elasticities of demand, conduct parameters, or marginal costs. The estimating equation of the inverse residual demand function using the GK method takes the following general form:

$$(1) \quad \ln P^{ex}_m = \lambda_m + \eta_m \ln Q^{ex}_m + \alpha'_m \ln Z_m + \beta'_m \ln W^N_m + \varepsilon_m$$

where ε_m is the error term, assumed to be independently and identically distributed, and subscript m indexes a specific market. P^{ex}_m is the price the export group charges expressed in the destination currency units; η_m is the residual demand elasticity; Q^{ex}_m refers to the quantity shipped by the respective exporter group; α' and β' are vectors of the parameters to be estimated. The vectors Z_m and W^N_m denote the demand shifters and the cost shifters for the n competitors the export group faces in a specific destination market, respectively. The price charged by the exporter group P^{ex}_m and the demand shifters are expressed in the destination market currency.

The coefficient of η_m, given the logarithmic specification of the model, can be interpreted directly as the residual demand elasticity. If the estimated value of η_m is not significantly different from zero, the exporter group operates in a perfectly competitive market and faces a perfectly elastic curve in the destination market. The demand shifter Z_m consists of a combination of a time trend, real income, and the price level for the destination market. The cost shifter W^N_m for the n competitors includes measures of input prices. These costs can be divided into two parts: a part expressed in the competitor's currency that is not destination-specific, and a part that varies with destination (i.e., the exchange rate of the competitor country vis-a-vis the destination market). Exchange rate movements offer ideal cost shifters in international markets because they move the relative costs of the exporting countries. The estimated parameters may be interpreted as industry averages since market data are available at the country level. Because of its convenience in terms of reduced data requirements, the GK method is sometimes used in empirical applications to test for imperfect competition in international agricultural markets (Evans and Ballen 2014, Mulik and Crespi 2011, Poosiripinyo and Reed 2005, Reed and Saghaian 2004, Song et al. 2009, and Tasdogan et al. 2005). Most study results indicate that oligopoly is the prevalent market structure in avocado markets.

Empirical Model and Data

The estimated model consists of an inverse residual demand equation, where the Dominican Republic is the exporter group, and Mexico and Chile are the fringe competitors. The empirical specification of the model is as follows:

$$lnPEXP = \beta_0 + \eta\, lnQEXP + \beta_1 lnPCDPI + \beta_2\, lnERUS\_MX + \beta_3\, lnPPI\_MX + \beta_4 lnERUS\_CH + \beta_5\, lnPPI\_CH + \sum_{i=1}^{11} \beta_6\, Di + \varepsilon$$

where *lnPEXP* is the log of real export price for U.S. imports of Dominican Republic green skin avocados (USD/MT), β_0 is the parameter intercept, η is the inverse residual demand elasticity, *lnQEXP* is the log of the quantity of U.S. imports of Dominican Republic green skin avocados (MT), *lnPCDPI* is the log of U.S. per capita disposable income (USD), *lnERUS_MX* is the log of the U.S./Mexico exchange rate (USD/Mexican peso), *lnPPI_MX* is the log of Mexican producer price index, *lnERUS_CH* is the log of U.S./Chile exchange rate (USD/Chilean peso), *lnPPI_CH* is the log of Chilean producer price index, *Di*: monthly dummy variable, where May is the base month, and ε is an iid error term.

The empirical model was estimated using monthly data from January 2004 to December 2013. Data for the (inverse) residual demand were obtained from several sources: Dominican Republic green skin avocado export prices and quantities to the U.S. market were retrieved from USDA/FAS (2014). The U.S. disposable personal income and the consumer price index used to obtain real disposable personal income came from U.S./BEA (2014). Data on the U.S./Mexico exchange rates came from USDA/ERS (2014c). Data about the Mexican producer price index for agriculture came from INEGI-Mexico (2015). Data about U.S./Chile exchange rates came from USDA/ERS (2014c). Information on the Chilean producer price index for avocado growers came from INE-Chile (2015). Monthly dummy variables were used in the model to address seasonality. May is used as the base month because this is the month when the export level is at its seasonal lowest.

To address simultaneity between export price and quantity, the equation was estimated using the instrumental variables method. As suggested by Goldberg and Knetter (1999), instrumental variables for quantity exported (QEXP) include supply shifters. The selected instruments included Dominican Republic labor costs, which consist of hourly wages for agricultural workers (Dominican Republic Central Bank 2014), the U.S./Dominican Republic exchange rate, and the one month lagged value of the U.S./Dominican Republic exchange rate (USDA/ERS 2014c). After estimating the model using Two Stage Least Squares (2SLS), diagnostic tests indicated heteroskedasticity and autocorrelation, so the final model was estimated using the Instrumental Variable Generalized Method of Moments (IV GMM) with robust and Newey-West standard errors based on a Barlett kernel with bandwidth two.

Estimation Results and Discussion

Results for the empirical model using the 2SLS and IV/GMM estimation methods are presented in Table 1. Results from the 2SLS method support employing the instrumental variable technique since the IV results indicate simultaneity bias. The Durbin-Wu-Hausman test rejects the hypothesis that export quantity is exogenous at the 5% level of significance. While the estimated parameter of the residual demand has the expected negative sign and is significant at the 5% level, results from both the Breusch-Pagan/Cook-Weisberg test (BP/CW) and the Cumby-Huizinga test found heteroskedasticity and autocorrelation issues, respectively. Using the IV/GMM estimation procedure, the Hansen J-test indicates over-identification is not a problem, and the Kleibergen-Paap under-identification test shows that the model is identified. The estimated model explains about 48% of the variation in the Dominican Republic export price.

The main parameter of interest is the (inverse) residual demand elasticity, which provides an estimate of the markup that the exporter (i.e., the Dominican Republic) charges above its marginal cost. The estimated parameter (–0.245) has the expected negative sign and is statistically significant. This suggests that the Dominican Republic exporters exercised market power in the U.S. green skin avocado market, with a markup of 25% above their marginal cost. Three explanations can be advanced in support of these findings. First, The Dominican Republic has market power because most of the U.S. imports of green skin avocado come from the Dominican Republic during the U.S. production off-season. Second, Dominican Republic avocado production costs are considerably low compared to export market prices. Third, Dominican Republic avocado exporters have flexibility in allocating their export volume to

Puerto Rico and the EU-27 (e.g., these markets account for more than 25% of the Dominican Republic exported volume) (Republica Dominicana, Ministerio de Agricultura 2015).

Table 1. Estimation results of the inverse residual demand for U.S. imports of Dominican Republic green skin avocados

	2SLS		IV/GMM	
	Coefficient	**S.E.**	**Coefficient**	**Robust S.E.**
Constant	8.421	3.816	7.343**	3.363
lnQEXP	–0.264**	0.131	–0.245**	0.124
lnPCDPI	0.026	0.065	0.011	0.076
lnERUS_MX	–0.201	0.549	–0.013	0.429
lnPPI_MX	0.402	0.305	0.399	0.296
lnERUS_CH	–0.277	0.591	–0.177	0.468
LnPPI_CH	–0.119	0.077	–0.106	0.099
June	0.252	0.199	0.221	0.163
July	0.315	0.289	0.261	0.256
August	0.064	0.278	–0.006	0.248
September	–0.098	0.276	–0.188	0.243
October	0.208	0.422	0.086	0.373
November	0.313	0.486	0.184	0.443
December	0.296	0.489	0.162	0.464
January	0.563	0.517	0.434	0.490
February	0.763	0.502	0.671	0.455
March	0.869**	0.424	0.779*	0.399
April	0.319*	0.174	0.290	0.215
BP/CW[1]	0.000			
Cumby-Huizinga[1]	0.000			
Anderson cann.LM stat[1]	0.004		Kleibergen-Paap LM stat[1]	0.028
Sargan test[1]	0.059		Hansen J stat[1]	0.190
Durbin-Wu-HaU.S.man[1]	0.018			
R-square	0.470			0.481

Note. [1] p-value
*** significant at the 1% level
**significant at the 5% level
*significant at the 10% level

Our estimate of the degree of market power falls on the low side of previous estimates of the inverse residual demand elasticity for agricultural commodities in export markets, ranging from a low of –0.02 for pork exports from Denmark (Felt et al. 2010) to a high of –0.93 for wheat exports from the U.S. (Carter et al. 1999).

Studies on fruit exporter market power are scarce. One such study is by Arnade and Pick (2000), who when evaluating seasonal oligopoly power in the U.S. pear and grape markets, found statistically significant average exporter markup estimates of 0.25 for pears in 1991–1993 and 1.03 for grapes in 1991–1993. Although a direct comparison with previous studies is inadvisable because of the different commodities, methodologies, and timeframe, the Arnade and Pick (2000) study suggests the magnitude of the exporter markup for fruit in the U.S. market.

The estimated coefficient for the U.S. per-capita disposable personal income has the expected positive sign but is not statistically significant. The coefficients of the exchange rates, and producer price indices, respectively, were not statistically significant for the cost shifters for the competing exporters (Mexico and Chile). That is, the cost variables for Mexico and Chile do not influence the export price of Dominican Republic green skin avocados to the U.S. market.

The monthly dummy variables take into consideration seasonal changes in demand based on production and import patterns. The estimated coefficients measure real price differences for the first month of the marketing year (May). The coefficient for March is the only monthly coefficient that was statistically significant, and that was at the 10% level. Therefore there is no evidence of market power seasonality during the Dominican Republic green skin avocado exporting season.

Summary and Conclusions

Imperfect competition in international agricultural markets is an issue since researchers have found evidence of oligopoly in agricultural export markets. In this paper, we assessed the intensity of competition in the U.S. green skin avocado import market during the 2004 to 2013 period. A model using the (inverse) residual demand method as proposed by Goldberg and Knetter (1999) was specified and estimated.

Findings reveal the existence of imperfect competition in the U.S. green skin avocado market over the sample period. Estimation results show that the Dominican Republic, acting as an exporter, exercises market power. This is consistent with the fact that Dominican Republic green skin avocado exporters to the U.S. market have limited competition from other overseas avocado suppliers such as Mexico and Chile. During the sample period, Dominican Republic green skin avocado exporters averaged a 25% marketing margin. We surmise that this is possible because of the low cost of Dominican Republic green skin avocado production compared to the U.S. market price and because the bulk of the Dominican Republic green skin avocado exports is shipped during the U.S. avocado production off-season.

A direct implication of the results is that consumers of green skin avocados in the U.S. are likely to be paying slightly higher prices for imported green skin avocados than would have been the case if the U.S. green skin avocado market would be served by more suppliers. It also implies that local producers benefit, as an inordinate amount of downward pressure is not placed on prices due to increased supplies coming from the Dominican Republic.

We found that the Dominican Republic green skin avocado exporters' market power is not constrained by other overseas avocado suppliers such as Mexico and Chile. The fact that the

seasonal (monthly) dummies were insignificant, except for March that was statistically significant at the 10% level, implies that the Dominican Republic maintains a marketing margin throughout the year.

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