Market Power in the Florida Orange Juice Processing Industry

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This study examines the market power dynamics in the Florida orange juice processing industry through an empirical bilateral oligopoly model. The results indicate a balance of power between processor-retailers and orange growers, with neither party exercising complete dominance. However, processor-retailers have a stronger ability to negotiate price concessions from growers. The rejection of perfect competition suggests limited market competition in the orange juice industry. The prevalence of Huanglongbing (HLB) disease is found to increase production costs for orange growers. The impact of weather events, specifically hurricane Irma, is observed in orange prices, and seasonality is evident with lower prices in October and November. These findings shed light on the imbalanced power dynamics and challenges orange growers face in price negotiations. Overall, this research contributes to a better understanding of the market power dynamics and provides insights for stakeholders of the Florida orange juice processing industry.

During 2020-2021, 57% of US citrus went to the processing market. Up to 80% of citrus processed in the US are oranges (USDA-NASS, 2021). Florida alone produced 81% of all US oranges diverted to processing (USDA-ERS, 2021). Of the total production of oranges in Florida, 95% went to processors (Florida Department of Citrus (FDOC), 2021). In the 2019-2020 season, 90% of total US orange juice production occurred in Florida, representing 56% of the total US domestic availability of orange juice (FDOC, 2021).

The structure of the Florida citrus industry has changed significantly over the past one-and-a-half decades. At the state level, orange orchards have been infested by Huanglongbing (HLB)- a bacterial disease commonly known as citrus greening, first discovered in 2005. This disease has decimated the industry, significantly reducing fruit quality and yield. About 90% of the Florida citrus acreage and 80% of trees were infected by HLB in 2017, causing a 74% decline in production (Singerman and Useche, 2017; Court et al. 2017). Consequently, the growers have been facing severe losses, and the entire industry has been downsizing. The number of citrus growers in Florida has fallen from 7,389 in 2002 to 2,775 in 2017, and the number of juice processors have fallen from 41 in 2003/2004 to 14 in 2016/17 (Singerman and Rogers, 2020). As of 2023, there are only five processors left in Florida (Florida Citrus Mutual, 2023). Therefore, it is unsurprising that the possibility of market power exists for orange juice processors. Such concerns are justified because oranges are perishable, and outside options for orange farmers are limited. That said, while orange processing is concentrated economically, orange farming is concentrated organizationally.

Most Florida orange farmers belong to various associations, one of which is a prominent trade organization focused on protecting the interests of growers-Florida Citrus Mutual. Historically this organization has been recognized for its economic and political influence. Some grower associations are also members of Citrus World - a cooperative that boasts a membership base of fourteen grower associations. Given the collective nature of these farmers' associations, it is plausible that the farmers too might exert market power to influence the market price of oranges.

This research aims to estimate the relative market power of orange farmers and an integrated processor-retailer. The theoretical and empirical framework extends Azzam's (1996) original work on the bilateral oligopoly model. This analysis is timely and of significant policy concern for two reasons. For one, HLB infestation has already left Florida orange farmers extremely vulnerable, making buyer power of processors an important issue in terms of its potential impact on farmer welfare and the economic vitality of rural communities. Second, the extent to which processors can exert seller power in the juice market will increase prices and impact consumer welfare, especially given the current high food prices.

Although interest in the consolidation of marketing channels and their effects on orange juice prices dates back to the early 2000s, limited research has explored the market power dynamics of the orange juice industry. Binkley et al. (2002) found no compelling evidence that consolidated markets engaged in non-competitive pricing in the 48 US states during 1989-1990. They reported that increased brand competition reduces the average market price of orange juice. Only two studies have utilized the New Empirical Industrial Organization (NEIO) literature to explore market power issues in the orange juice industry (Wang, Xiang, and Reardon 2006; Luckstead, Devadoss, and Mittelhammer 2015). Wang, Xiang, and Reardon (2006) reports that Florida processors become more competitive following weather shocks –"freeze". Later Luckstead, Devadoss, and Mittelhammer (2015) finds that Florida and São Paulo orange juice processors exert market power in the US, but Florida exerts greater market power.

Unlike the extant literature, this study focuses on the strategic behavior between processor-retailers and orange farmers in a bilateral oligopoly setting. Our analysis pays special attention to the interaction of market power when setting orange prices. In particular we estimate the relative dominance of market power in setting orange prices. Do the processor-retailers completely dominate the farmers or vice versa? Do they dominate each other equally? Or is the balance of power tilted towards one side, but falls short of complete dominance?

Bilateral Oligopoly Model

Given the organizational concentration of Florida orange growers and the economic concentration of juice processors, both sides may wield some influence in determining orange prices. Here we build a bilateral oligopoly model by extending the earlier works of Azzam (1996) which was later adopted by Maude-Griffin et al. (2004) and Yamaura and Xia (2015), among numerous others. We assume that the processors and retailers are one integrated unit that competes imperfectly with farmers to procure oranges. We resort to the assumption of one integrated unit due to a lack of data on prices paid to the processors by the retailers. Additionally, our main research focus of is to examine the relative degree of dominance of farmers over downstream agents in determining farm price of oranges. Processor-retailer j's objective function is:

$$\max \pi_j^r = [p^r(Q^r) - p^f(Q^f)]q_j - C_r(q_j, v),$$

where $p^r(Q^r)$ is the inverse retail demand function, $p^f(Q^f)$ is the inverse orange supply function, q_j is the output of firm j, and $C_r(q_j, v)$ is the total cost function for processing and retailing, where v is a vector of non-farm input prices. The first-order condition can be written as:

$$\frac{\partial \pi_j^r}{\partial q_j} = p^r(Q^r) - p^f(Q^f) + q_j\left[\frac{\partial p^r(Q^r)}{\partial Q^r}\frac{\partial Q^r}{\partial q_j} - \frac{\partial p^f(Q^f)}{\partial Q^f}\frac{\partial Q^f}{\partial q_j}\right] - c_r = 0 \qquad (1),$$

where $c_r = \frac{\partial C_r}{\partial q_j}$ is the marginal cost function. One can re-write (1) as follows:

$$p^r(Q^r) - p^f(Q^f) + \frac{\partial p^r(Q^r)}{\partial Q^r}\frac{Q^r}{p^r}\frac{\partial Q^r}{\partial q_j}\frac{q_j}{Q^r}p^r - \frac{\partial p^f(Q^f)}{\partial Q^f}\frac{Q^f}{p^f}\frac{\partial Q^f}{\partial q_j}\frac{q_j}{Q^f}p^f - c_r = 0\ ,$$

which can be written succinctly as:

$$p^r - p^f + \eta_r k_{rj} p^r - \varepsilon_r m_{rj} p^f - c_r = 0 \qquad (2),$$

where,

$\eta_r = \frac{\partial p^r(Q^r)}{\partial Q^r}\frac{Q^r}{p^r}$ is the inverse demand elasticity facing the processor-retailer *j*,

$k_{rj} = \frac{\partial Q^r}{\partial q_j}\frac{q_j}{Q^r}$ is the conjectural elasticity of the processor- retailer *j*,

$\varepsilon_r = \frac{\partial p^f(Q^f)}{\partial Q^f}\frac{Q^f}{p^f}$ is the inverse supply elasticity facing the processor- retailer unit, and

$m_{rj} = \frac{\partial Q^f}{\partial q_j}\frac{q_j}{Q^f}$ is the cross conjectural elastcitity of the processor- retailer *j*.

The aggregate quantity weighted analog of (2) can be written as:

$$p^r - p^f + \eta_r k_r p^r - \varepsilon_r m_r p^f - c_r = 0 \qquad (3).$$

Under the assumption that the processor-retailers have complete dominance, which means all processor-retailers act as a cartel or there is only one processor-retailer, in the orange market, one can write the equilibrium price as:

$$p^f_{lower} = \theta\ (p^r + \eta_r k_r p^r - c_r) \qquad (4),$$

where, θ is defined as $\theta = (1 + \varepsilon_r m_r)^{-1}$ and the "lower" subscript indicates that p^f_{lower} is the lower limit of price in the orange market.

Likewise, we can derive the equilibrium price of oranges if the orange farmers had complete dominance over the processor-retailer. Farmer i's objective function is:

$$\max \pi_i^f = p^f(Q^f)q_i - C_f(q_i, w),$$

where, $p^f(Q^f)$ is the inverse demand function of orange facing the farmer, q_i is the output of farm i, and $C_f(q_f, w)$ is the total cost function where w is a vector of farm input prices. The first-order condition can be written as:

$$\frac{\partial \pi_i^f}{\partial q_i} = p^f + q_i \frac{\partial p^f}{\partial Q^f}\frac{\partial Q^f}{\partial q_i} - c_f = 0 \qquad (5),$$

where $c_f = \frac{\partial C_f}{\partial q_i}$ is the marginal cost function. One can re-write (5) as follows:

$$\frac{\partial \pi_i^f}{\partial q_i} = p^f + \frac{\partial p^f}{\partial Q^f}\frac{Q^f}{p^f}\frac{\partial Q^f}{\partial q_i}\frac{q_i}{Q^f}p^f - c_f = 0,$$

which can be written succinctly as:

$$p^f + \eta_f k_{fi} p^f - c_f = 0 \qquad (6),$$

where,

$\eta_f = \frac{\partial p^f}{\partial Q^f}\frac{Q^f}{p^f}$ is the inverse demand elasticity facing farmers, and

$k_{fi} = \frac{\partial Q^f}{\partial q_i}\frac{q_i}{Q^f}$ is the conjectural elasticity of the farmer.

The aggregate quantity weighted analog of (6) can be written as:

$$p^f + \eta_f k_f p^f - c_f = 0 \quad (7).$$

Under the assumption that farmers have complete dominance, which means all farmers as a cartel, in the orange market, one can write the equilibrium price as:

$$p^f_{upper} = \beta c_f \quad (8),$$

where β is defined as $\beta = \left(1 + \eta_f k_f\right)^{-1}$, and the "upper" subscript denotes that p^f_{upper} is the upper limit of price in the orange market.

It is unlikely that either the processor-retailers or the farmers will completely dominate. Instead, it is more likely that both wield some market power in determining the market price of orange. Let $\alpha \in [0, 1]$ denote the degree of dominance of the processor-retailer over the farmers and $(1 - \alpha)$ the degree of dominance of the farmers. Then the market equilibrium price can be written as:

$$p^f = \alpha p^f_{lower} + (1 - \alpha) p^f_{upper} = \alpha\theta\, (p^r + \eta_r k_r p^r - c_r) + (1 - \alpha)\, \beta c_f \quad (9).$$

$\alpha = 0$ implies complete upstream dominance and $\alpha = 1$ implies complete downstream dominance.

Empirical Framework

We assume linear marginal cost functions for the processor-retailer and the farmers for the empirical implementation. Our estimating equation is as follows:

$$p^f = \alpha\theta\,(p^r + \eta_r k_r p^r - \sum_l a_l v_l - a_{inv} inv\,) + (1-\alpha)\,\beta(\sum_m g_m b_m + g_{hlb} HLB) + \gamma W + \delta month + \vartheta t + e \qquad (10),$$

Where α is the primary coefficient of interest, *v* denotes non-farm input prices (labor, capital, other, imported orange juice) facing the processor-retailers, *inv* denotes the level of inventory held by the processor-retailer, *b* denotes input prices (labor, capital, intermediate) facing the farmers, *HLB* is an index for prevalence of citrus greening, *W* is a matrix of weather event dummies (hurricanes), *month* is a matrix of month dummies, *t* denotes time trend, and *e* is normally distributed error term.

An important feature of the juice production process is that the current period output not only depends on the amount of orange procured from farms but also on the level of imports and inventory level. In face of unexpected demand shocks (for example, tariffs) or supply shocks (for example, freezes or hurricanes), the level of inventory held by the juice producers, along with imports, will influence the incentive for processor-retailers to re-negotiate orange prices with the farmers and juice prices in the domestic and foreign markets. We incorporate import prices and inventory levels in the empirical specification, and thus provide a complete representation of the juice production process. We note that *HLB* had reached a near pandemic level by 2011, and ignoring such supply-side shocks in addition to weather events creates specification errors and may lead to incorrect measures of market power. In this study we account for major weather events and *HLB* prevalence in the empirical specification. Estimation of the (10) requires estimates of the inverse demand elasticity (η_r) facing the processor retailer unit, which we borrow from an extraneous source. The model is estimated using maximum likelihood estimator.

Data

To estimate equation (10), we use monthly data series from October 2001 to December 2019. The retail orange juice price (p^r) is in dollars per gallon, from the 4-weeks Nielsen Topline Reports. Farm level price (p^f) is the average final price for oranges that Florida growers receive, in dollars per pounds solids[1]. Both retail and farm output prices were collected from the FDOC. These output prices were deflated by their respective industry's producer price index (PPI). Beverage industry and citrus monthly PPIs were collected at the Federal Reserve Economic Data (FRED) and the USDA-ERS, respectively.

To obtain the processor-retailer input prices, we derive labor (v_1), capital (v_2) and intermediate input (v_3) prices from productivity, cost share, and orange juice price. Factor's productivity and cost shares were retrieved from the total factor productivity tables from the Bureau for Labor Statistics (BLS). Florida processors' import prices (v_4), in dollars per pounds solids, and inventory level (inv), in pounds solids, were collected from the FDOC, Processor Reports and Citrus Reference Book.

Farm level input price indices, labor (b_1), capital (b_2) and intermediate inputs (b_3), were collected from USDA-ERS, National Tables of Agricultural Productivity in the U.S. An infection index was created to capture the prevalence of HLB infection in Florida, based on confirmed citrus greening cases in Florida counties (UF-IFAS, 2023). While there were no freezes during our sample frame, hurricane dates were collected from the FDOC, Citrus Reference Book. Yearly dummies were created for each major hurricane between 2001 and 2019 (Charley, Frances, Jeanne

[1] *Pounds Solids: is a measure in weight, of the total dissolved sugar solids in a given box of fruit. There are approximately 1.029 pounds solids in 1 gallon of single strength equivalent orange juice.*

in 2004, Wilma in 2005 and Irma in 2017). The demand elasticity for orange juice (-0.85), is borrowed from Brown et.al. (1994). The FDOC Processor Reports indicate that there are monthly movements of oranges from the farmers to the processors from October to June/July. For each of these months, we created a dummy variable.

Table (1): Descriptive statistics of variables used in the estimation

Variables	Obs.	Unit	Mean	Std. Dev.	Min	Max
			At the processor-retailer level			
$\boldsymbol{p^r}$	166	$/Gallon	5.723	0.919	4.290	7.230
$\boldsymbol{v_1}$	166	Index (05/2012=1)	0.958	0.138	0.714	1.237
$\boldsymbol{v_2}$	166	Index (05/2012=1)	0.859	0.165	0.510	1.119
$\boldsymbol{v_3}$	166	Index (05/2012=1)	0.883	0.149	0.638	1.094
$\boldsymbol{v_4}$	166	$/PS	1.208	0.347	0.644	1.805
$\boldsymbol{inv}$	166	PS	593.628	185.913	296.328	1148.824
			At the farm level			
$\boldsymbol{p^f}$	166	$/PS	1.635	1.013	0.373	7.348
$\boldsymbol{b_1}$	166	Index (05/2012=1)	0.908	0.246	0.451	1.429
$\boldsymbol{b_2}$	166	Index (05/2012=1)	0.736	0.317	0.223	1.811
$\boldsymbol{b_3}$	166	Index (05/2012=1)	0.797	0.210	0.350	1.338
infection	166	Index (infected/total citrus producing FL counties)	0.687	0.436	0.000	1.000

Preliminary Results

The estimation results for the empirical bi-lateral oligopoly model are reported in Table 2. The primary parameter of interest, α , is estimated to be 0.77, significant at the 1% level; the 95% confidence interval is given by (0.71, 0.82). Thus, we reject the hypothesis of complete dominance by either the processor-retailer or the farmer. We also reject the hypothesis of equal dominance by the processor-retailers and the farmers. Our findings suggest that processor-retailers use power to extract price reductions from orange growers. k_r is estimated to be 0.88, significant at the 1% level. This leads to the rejection of the hypothesis of perfect competition in the orange juice market.

Three of the estimated parameters of the cost function have incorrect signs, but they are statistically insignificant. The parameter estimate for g_{hlb} is positive and significant at the 1% level. This suggests that HLB had increased the cost of production for orange growers. Examining the hurricane dummies suggests that only hurricane Irma positively impacted orange prices, but that too at the 10% level. The monthly dummies point to important seasonality of orange prices. December is the reference month in our empirical specification. Overall, the monthly dummies suggest that relative to December, orange prices are lower in October and November, and then start rising from January.

Table (2): Estimation results

	Coef.	Robust Std. Err.	z	P>z	[95% Conf. Interval]	
α	0.767	0.030	25.940	0.000	0.709	0.824
θ	-0.950	0.834	-1.140	0.255	-2.585	0.684
k_r	0.877	0.113	7.730	0.000	0.655	1.099
a_1	0.932	1.640	0.570	0.570	-2.281	4.146
a_2	-0.439	0.389	-1.130	0.259	-1.202	0.323
a_3	-1.201	0.790	-1.520	0.129	-2.749	0.348
a_4	0.513	0.595	0.860	0.389	-0.654	1.679
a_{inv}	0.691	0.216	3.200	0.001	0.267	1.115
β	0.231	1.313	0.180	0.860	-2.342	2.805
g_1	0.562	0.969	0.580	0.562	-1.338	2.461
g_2	2.261	2.185	1.030	0.301	-2.022	6.544
g_3	-2.258	1.265	-1.790	0.074	-4.737	0.221
g_4	0.162	0.022	7.450	0.000	0.120	0.205
$Cha/Fra/Jea$	-0.089	0.067	-1.330	0.184	-0.221	0.043
$Wilma$	0.022	0.175	0.130	0.899	-0.321	0.365
$Irma$	0.358	0.207	1.730	0.084	-0.048	0.764
t	-0.723	0.542	-1.330	0.182	-1.786	0.339
d_1	0.078	0.068	1.140	0.253	-0.056	0.212
d_2	0.085	0.071	1.190	0.233	-0.054	0.224
d_3	0.127	0.066	1.910	0.056	-0.003	0.257
d_4	0.222	0.076	2.940	0.003	0.074	0.371
d_5	0.249	0.093	2.680	0.007	0.067	0.430
d_6	0.243	0.098	2.480	0.013	0.051	0.436
d_7	0.083	0.089	0.930	0.354	-0.092	0.258
d_{10}	-0.339	0.067	-5.050	0.000	-0.471	-0.208
d_{11}	-0.163	0.081	-2.020	0.043	-0.322	-0.005

Discussion

The primary parameter of interest, α, measures the relative market power dominance between processor-retailers and orange growers. The estimated value of 0.77 suggests that neither party completely dominates the market. This indicates that there is a balance of power, with both processor-retailers and growers exerting influence over price negotiations. Additionally, the rejection of the hypothesis of equal dominance implies that processor-retailers have a greater ability to extract price concessions from orange growers. This highlights the potential challenges faced by growers in negotiating favorable prices for their produce.

The estimated value of k_r, which is the conjectural elasticity of the processor-retailers in the orange juice market, is 0.88, indicating the rejection of perfect competition. This implies that the orange juice market is not characterized by a large number of independent and competing firms. Instead, there may be elements of market power exercised by a few key players. Further analysis is needed to explore the specific mechanisms through which processor-retailers exert their market power and the potential implications for market outcomes and consumer welfare.

One important finding is the significant and positive relationship between the prevalence of HLB and the cost of production for orange growers. This result aligns with the known detrimental impact of HLB on citrus orchards and highlights the challenges faced by growers in terms of increased production costs. It underscores the need for effective strategies to combat HLB and mitigate its economic consequences.

The results indicate that only hurricane Irma had a positive effect, albeit at a 10% significance level. This suggests that specific weather events can influence orange prices. Further investigation into the relationship between extreme weather events and market dynamics would provide a more comprehensive understanding of price fluctuations in the orange juice industry. The inclusion of monthly dummies reveals significant seasonality in orange prices. The findings indicate that orange prices are lower in October and November compared to December, and then start to rise from January onwards. This seasonality pattern could be attributed to factors such as harvest timing, consumer demand fluctuations, and market dynamics during different times of the year. Understanding these seasonal trends can assist stakeholders in better managing their operations and pricing strategies.

Conclusion

The analysis of the empirical bilateral oligopoly model in the orange juice industry has yielded valuable insights into market power dynamics and their implications. The estimation of the relative market power parameter indicates that neither the processor-retailers nor the orange growers dominate the market completely. However, the rejection of equal dominance suggests that processor-retailers possess greater bargaining power, enabling them to extract price concessions from growers. This finding highlights the imbalanced power dynamics in the industry, potentially putting orange growers at a disadvantage during price negotiations. It underscores the need for policies and measures that support the interests of growers and ensure a more equitable distribution of bargaining power between the different actors in the supply chain.

The rejection of perfect competition in the orange juice market further emphasizes the need for attention to market structure and competition policy. Market concentration and the exercise of market power by a few key players have implications for overall industry competitiveness. Regulatory measures aimed at fostering competition and preventing anti-competitive behavior can help improve market efficiency.

The preliminary results provide evidence of the significant influence of factors such as HLB, weather events, and seasonality on orange prices. These findings contribute to our understanding of the challenges faced by orange growers and the complex dynamics within the market. Hurricane Irma had a positive impact on orange prices, albeit significant only at the 10%

level, while the other hurricanes did not have a statically significant effect on prices. This finding may reflect differences in the severity and timing of the hurricanes and highlights the importance of considering the specific nature of supply-side shocks when analyzing the impact of weather events on agricultural markets.

In conclusion, the empirical analysis of market power in the orange juice industry reveals important insights into the dynamics between processor-retailers and orange growers. The results emphasize the need to address the challenges faced by growers, promote greater balance in pricing practices, and foster competition within the industry. By doing so, we can support the economic viability of orange growers, ensure the availability of high-quality orange juice, and enhance market efficiency.

References

Azzam, A. M. 1996. "Estimating the Degree of Dominance in a Bilateral Oligopoly." *Applied Economics Letters* 3:209–11.

Binkley, J. K., Canning, P. N., Dooley, R., & Eales, J. S. (2002). *Consolidated markets, brand competition, and orange juice prices* (No. 1474-2016-120893).

Brown, M. G., Lee, J. Y., & Seale, J. L. (1994). Demand relationships among juice beverages: a differential demand system approach. *Journal of agricultural and applied economics*, *26*(2), 417-429.

Court, D.C., A.W. Hodges, M. Rahmani, and T.H. Spreen. 2017. Economic Contributions of the Florida Citrus Industry in 2015-16. Gainesville, FL: University of Florida, Food and Resource Economics Department, Economic Impact Analysis Program.

Durham, C., & Eales, J. (2010). Demand elasticities for fresh fruit at the retail level. *Applied Economics*, *42*(11), 1345-1354.

Federal Reserve Economic Data -FRED. "Economic Research Division" 2023. Federal Reserve Bank of St. Louis. Available online at: https://fred.stlouisfed.org . Retrieved on March 2023.

Florida Citrus Mutual (2023). "Who We Are". Available online at: https://flcitrusmutual.com/about/. Retrieved on March 2023.

Florida Department of Citrus. "Economic & Market Resources." 2023. Lakeland,. Available online at: https://www.floridacitrus.org/grower/florida-department-of-citrus/economic-market-resources/. Retrieved on March 2023.

Luckstead, J., S. Devadoss, and R. Mittelhammer. "Imperfect Competition between Florida and Sao Paulo (Brazil) Orange Juice Producers in the US and European Markets." Journal of Agricultural and Resource Economics 40(2015):164–178.

Maude-Griffin, R., R. Feldman, and D. Wholey. 2004. "Nash Bargaining Model of HMO Premiums." Applied Economics 36:1329–36.

Moss, C. B., Grogan, K. A., Farnsworth, D., & van Bruggen, A. H. C. (2015). The economic cost of huanglongbing (citrus greening) to Florida's orange industry: estimates of producer and consumer surplus. *UF Food Resources and Economics Department. Available from: http://www. imok. ufl. edu/hlb/database/pdf/10V_Moss_14. pdf. Accessed*, *1*.

Singerman, A. and Rogers, M.E. (2020) “The Economic Challenges of Dealing with Citrus Greening: The Case of Florida,” *Journal of Integrated Pest Management*, Volume 11, Issue 1

Singerman, A., & Useche, P. (2017). Florida citrus growers' first impressions on genetically modified trees.

UF-IFAS. Citrus Research And Education Center- “Citrus Greening” 2023. Available online at: https://crec.ifas.ufl.edu/research/citrus-production/disease-identification/citrus-greening-huanglongbing/ . Retrieved on March 2023.

US Bureau for Labor Statistics-BLS. “Total factor productivity tables” 2023. Available online at: https://www.bls.gov/productivity/tables/ . Retrieved on March 2023.

USDA_ERS. (2021a) Fruit and Tree Nuts Outlook: September 2021, FTS-373. Available online at: https://www.ers.usda.gov/webdocs/outlooks/102267/fts-373.pdf?v=8594 . Retrieved on March 2023.

USDA-ERS., “National tables of Agricultural Productivity in the U.S.” 2023. Available online at: https://www.ers.usda.gov/data-products/agricultural-productivity-in-the-u-s/ . Retrieved on March 2023.

USDA-NASS., Citrus Fruits 2021 Summary. Available online at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ccqc.org/wp-content/uploads/USDA-NASS-Citrus-Fruits-2021-Summary-092021.pdf . Retrieved on March 2023.

Wang, H., Q. Xiang, and T. Reardon. “Market Power and Supply Shocks: Evidence from the Orange Juice Market.” Staff Paper 2006-02, Michigan State University, Department of Agricultural, Food, and Resource Economics, 2006.

Wang, H., Xiang, Q., & Reardon, T. (2006). *Market power and supply shocks: Evidence from the orange juice market* (No. 1099-2016-89519).

Yamaura, K., & Xia, T. (2016). Measuring bilateral market power in international markets of vertically differentiated agricultural commodities. *Journal of Agricultural & Food Industrial Organization*, *14*(1), 33-42.