International Food and Agribusiness Management Review
Volume 21 Issue 1, 2018; DOI: 10.22434/IFAMR2016.0139

Received: 15 August 2016 / Accepted: 18 October 2017

Competitiveness of local food: an empirical analysis of the tomato market dynamics

RESEARCH ARTICLE

Xin Fang[①a], Hui Huang[b], and PingSun Leung[c]

[a]Associate Professor and [b]Assistant Professor, Department of Financial Economics and Information Systems, Hawaii Pacific University, 900 Fort Street Mall, Suite 600, Honolulu, HI 96813, USA

[c]Professor, Department of Natural Resources and Environmental Management, University of Hawaii at Manoa, 3050 Maile Way, Gilmore 111, Honolulu, HI 96822, USA

Abstract

Local food has become the foci of food self-sufficiency and sustainable development. This work explores the dynamic interactions between local and imported food in Hawaii, which is a typical small, open economy and an ideal market for a local food system study. Retail scanner data of three major grocery chain stores are used to construct a time series of prices and quantities for local and imported grape and cherry tomatoes in one year (52 weeks). Vector Autoregressive model and impulse response functions are used to investigate the correlations and Granger causalities. Empirical results provide implications for the competitive status of local suppliers and the dynamics of the local food market.

Keywords: VAR model, market dynamics, shocks, local food, imported food
JEL code: Q10, Q13

[①]Corresponding author: xfang@hpu.edu

1. Introduction

Local food systems have been attracting increased attention due to their role in promoting sustainable development. Because of the small scale of operations, local producers are unable to achieve economies of scale (Low and Vogel, 2011) and the high cost of local production could contribute to high food prices in the local community (Pretty *et al.*, 2005). The inflated costs divert diet choices towards lower priced, energy-dense food items (Salois, 2012). This diet bias is more severe for underrepresented groups who are more sensitive to food prices (Powell and Chaloupka, 2009), thus creating an inequity within the local community. As a major concern, the long-distance shipping of imports imposes great pressure on the ecosystem by increased fossil fuel consumption and greenhouse gas emissions (Coley *et al.*, 2009). With increasing volumes of imported products, leakage in the system becomes greater and restricts regional economic and labor multipliers (Martinez, 2010; Swenson, 2009). Moreover, changes in energy prices, trade policies, world food supply and demand, and climate change all threaten food security of the local community (Feenstra, 1997; Martinez, 2010). Local agriculture has the potential to improve the structure of the food system, leading to community food security, fewer food deserts, and improvements in consumer health that are linked to eating more fresh and unprocessed foods (Adams and Salois, 2010). In addition, local farmers' green efforts from promoting locally produced products can provide economic or social benefits in terms of reduced energy consumption and pollution (Amato, 2007).

Shoppers prefer locally-grown food for the freshness, taste, quality, and convenience, as well as the sense of being environmentally friendly and supportive of local farmers (Eastwood *et al.*, 1999; Govindasamy *et al.*, 1998; Keeling-Bond *et al.*, 2009; Kezis *et al.*, 1984; Wolf, 1997; Wolf *et al.*, 2005; Zepeda and Leviten-Reid, 2004). However, the demographics of consumers, such as income, education, and ethnicity which are closely related to consumer preferences, play an important role in consumption choices and market demand (Brooker and Eastwood, 1989; Brown, 2003; Eastwood, 1996; Eastwood *et al.*, 1999; Govindasamy *et al.*, 1998; Keeling-Bond *et al.*, 2009; Zepeda and Li, 2006).

Several empirical studies show consumers' willingness to pay a price premium for local food products, including seafood, lettuce, milk, eggs and tomatoes (Davidson *et al.*, 2012; Geslani *et al.*, 2015; Keahiolalo, 2013; Loke *et al.*, 2015, 2016; Ulupono Initiative, 2011; Xu *et al.*, 2015a,b). The questions that remain unanswered are: does the ability to command a price premium create a competitive advantage for local food over imported food? What implications can we derive from the interactions between local and imported food for the local farmers' competitive strategies and sustainability of the local food system?

The local tomato market in Hawaii is a suitable context to explore the research questions stated above given its geographic location. Local tomatoes 'are picked ripe and have a shinier and brighter red outside, thinner skin, redder and juicier inside, and taste sweeter than Mainland tomatoes', and consumers are willing to pay about \$2.50 per pound for the 'local' feature (Ulupono Initiative, 2011). Local tomatoes seem to have a dominant status in Hawaii, accounting for about 77% of the market supply (Xu *et al.*, 2015a). A cost study could be helpful to identify the profit levels and a demand system estimation would shed light on price-cost margins, that is, the market power of local suppliers. In the absence of sufficient data, however, we propose a study of the market dynamics to provide insights into competition patterns. By evaluating the status of local suppliers, we could draw implications regarding the sustainability of the local food industry and provide policy or strategic suggestions for local farmers. There are no organic tomatoes from local suppliers in the dataset. Given that the feature of 'organic' could be as appealing as 'local' or, alternatively, imported nonorganic tomatoes might be comparable with local tomatoes that are also nonorganic, we divide the imported categories into imported organic and imported nonorganic to better determine the intercorrelation between local and imported tomatoes. We expect imported organic tomatoes to be a better substitute and a closer competitor for local tomatoes, therefore stronger interactions between these two categories are predicted.

Compared to national brands, local food producers are characterized by small-scale operations, but are less affected by transportation cost fluctuations (Martinez, 2010). Competition among imported food and local food producers might exhibit a unique pattern. Limited empirical work has been done to investigate the dynamic interactions between local and imported goods and for a particular type of food. Prices, as well as volumes sold, of local and imported food are linked through the market, and the local market might also be subject to outside shocks, such as seasonality and transportation costs.

The interactions between local and non-local suppliers can shed light on consumers' attitudes towards local food, with reference to the substitutability between local and imported food as measured by the cross-price elasticity. Consumers take a critical part in creating sustainable solutions through responsible consumption (Knight, 2004). Green market retail campaigns and brands could potentially increase sustainable consumption, although their effectiveness is not proven (Sullivan *et al.*, 2013). Xu *et al.* (2015a) find local tomatoes are quite substitutable to import tomatoes, which suggests local tomatoes might not be so differentiated in the view of consumers. Our findings would further reveal consumers' recognition of the 'local' feature by examining the response of local tomatoes' prices to strategic changes made by the imported (organic or nonorganic) tomatoes.

The Vector Autoregressive (VAR) Model chosen in our proposed study would provide a theory-free approach where the endogeneity problem between price and quantities could be solved (cf. De Crombrugghe *et al.*, 1997; Wang and Bessler, 2006). Although the interpretation in terms of causal relationships in VAR Model is controversial, most researchers regard VAR as useful method of summarizing time series 'facts' and assess dynamic influences of structural shocks on observables (Hamilton, 1994; Holtz-Eakin *et al.*, 1988). This study intends to draw a picture of the dynamic interrelationship between local and imported food and provide insights into pricing and competitive strategies for local farmers in response to the strategies of non-local competitors. The results would also uncover the degree of differentiation and market power of local farmers, as well as their reactions to the outside shocks, such as weather, seasonality, and transportation costs.

The paper will be organized as follows: we first discuss the relevant literature, followed by the data source and variables used in the estimation. We then describe the econometric modeling and provide tests and rationale for the methodology chosen. After analyzing the parameter estimates, we draw conclusions and discuss policy implications and extensions.

2. Literature review

The current trend of 'buy local' is consistent with the findings about consumers' desire to support the local economy and consumer's choice of locally grown products because of high quality and its value relative to the costs (Andreatta and Wickliffe, 2002; Darby *et al.*, 2006; Eastwood *et al.*, 1999; Wolf, 1997). Bonini and Oppenheim (2008) found that 87% of consumers in eight major global economies think about the environmental and social impact of their purchases, with around one third of these consumers purchased or plan to purchase a green product. A typical grocery store consumer tends to pay $0.64 more for a product labeled as grown in their home state (Darby *et al.*, 2006). However, consumers' preferences are based on their knowledge and experiences that influence how much they value the products (Day, 1994; Woodruff and Gardial, 1996; Zeithaml, 1988). Branding and logos are observed to be critical in food marketing, and shoppers tend to buy state-labeled products (Eastman *et al.*, 1999; Guthrie *et al.*, 2006).

Some studies show consumers could be skeptical of the quality of green products and environmental claims over these goods. The study of Sullivan *et al.* (2013) look at the demand for Hawaiian avocados, which makes up about 27% of the total demand for tropical fruits in 2005. The findings indicate that about 49% of local avocados do not make it to market due to insufficient efforts of marketing and unawareness about consumer preferences (Krishnakumar *et al.*, 2007). Hawaii imported about two million avocados in 2005 (National Agricultural Statistics Service, 2005). The significant reliance on imported avocados is found to meet consumer demand, even though local producers are able to satisfy the needs. Supply chain and marketing strategies are claimed to be insufficient for local food sellers.

Demand for a product during sales depends on the time since the last sale and past prices (Pesendorfer, 2002). Intuitively, current demand tends to be higher if previous price is higher (Pesendorfer, 2002; Warner and Barsky, 1995) and a stock of goodwill, representing consumers' brand loyalty, habit information or product awareness, would accumulate (or erode) when a seller charges low (or high) prices (Slade, 1998). The inventory conditions would be related to the price changes as well. It is found that high inventory leads to low prices, more frequent price reductions, as well as the probability of sales (Aguirregabiria, 1999; Levin *et al.*, 2009; Pesendorfer, 2002). Therefore, the literature suggests potential intertemporal correlations between prices and quantities in several dimensions: prices and quantities of one seller would be correlated over time through state of demand or expected demand and inventory conditions (Sobel, 1984). Cross-seller correlations, however, such as the interaction between prices and quantities among different sellers, would depend on market competition between local and imported tomato suppliers and their strategies.

We examine the competitiveness of local suppliers in the market of grape and cherry tomatoes in Hawaii from a different perspective by adopting a dynamic analysis about the interactions of prices and quantities for local and imported tomatoes. Research on competition among local and imported food is a study of differentiated market, where product sales depend on demand conditions and prices respond to intertemporal demand (Nevo and Wolfram, 2002). Demand of differentiated markets have been extensively studied with different demand function specifications (Berry, 2004; Berry *et al.*, 1994; Hausman *et al.*, 1994; Pinkse *et al.*, 2002; Slade, 2004). Among those studies, own-price elasticities are used to derive price-cost margins as an indicator for market power, while cross-price elasticities are used to assess the interactions among competitors by estimating the movement of consumers' demand when price changes, therefore showing the impact of one product's demand in terms of another.

Localized competition with differentiated competitors has been studied in spatial models. Some researchers assume symmetry of cross-price elasticities (cf. Deaton and Muellbauer, 1980), but others use unrestricted approaches (cf. Hausman *et al.*, 1994). Models of monopolistic competition as described in Chamberlin (1933) suggest global but symmetric competition, while one-dimensional-spatial models (Gabszewicz and Thisse, 1979; Hotelling, 1929; Salop, 1979) predict fluctuations in prices of more distant competitors have no effect on own sales, conditional on neighbor prices. In the work of Pinkse *et al.* (2002), restrictions of symmetry have also been removed, and competitors could engage in multi-dimensional local competition or asymmetric global competition. The interactions between local and imported tomatoes in our proposed model do not have to be symmetric, especially when competition from imported organic and imported nonorganic are divided. The competition between different pairs of the three categories could be different. Competition among local producers would be absorbed, thus not analyzed. Based on the models and empirical evidence in the literature, we predict sales and prices of local food might not only depend on the rival prices, but on the 'locality' or identity of the sellers.

VAR is selected for the intertemporal analysis for the presence of simultaneities and bi-directional influences. Granger causality tests will be run to check potential causal relationships between interested variables, as done in similar dynamic panel studies (Awokuse, 2005; Holtz-Eakin *et al.*, 1988; Śmiech and Papież, 2013). Moreover, research on VAR has made it possible to identify unobservable structural shocks and examine the dynamic effects of these shocks on observable data (Hamilton, 1994). In our study, VAR model is used to investigate the competition between local and non-local suppliers and their responses to outside shocks with no restrictions imposed.

3. Data

We use one year (52 weeks from 26 December 2010 to 24 December 2011) of Nielsen ScanTrack weekly data of grape and cherry tomatoes from three major grocery chain stores in Honolulu, Hawaii. In the dataset, loose weight tomatoes are not included due to the inconsistency of stock-keeping units across purchases or stores. The tomatoes sold at other locations or farmers' market are not counted in either. Annual household income of grocery store shoppers is found to be higher than for those who shop at direct outlets for food (Darby *et al.*, 2006). The same study reported, that the amount consumers spend on produce does not differentiate by retail outlet type, with buyers at a farmer's market pay slightly more for the same type of product. Nevertheless, our study should still be able to represent the tomato markets in Honolulu, as the Ulupono Initiative (2011) gives an estimate that 60% of sales of tomatoes are made in supermarkets, suggesting supermarkets are the major channel of tomato sales. To help consumers identify local tomatoes, in the supermarkets, shelf tags such as 'Hawaii Grown', 'Local' and 'Locally Grown' are displayed. We also search the websites of the producers contained in the dataset to verify the origin of tomatoes as local or nonlocal. Price and quantity information are obtained according to the stock-keeping units on weekly basis. With the sales data, we construct a panel including six time series: local price, imported organic price, imported nonorganic price, local volume, imported organic volume and imported nonorganic volume, respectively. The price series are formed by calculating the average price weighted by volume of sales, including promotions that are recognized as price cuts and recorded in the data. Volume series are the sum of quantity sold in one week.

The summary statistics are shown in the Table 1. Prices of local tomatoes are lower than those of imported organic tomatoes, though slightly higher than imported nonorganic ones. We tentatively attribute part of price difference to transportation costs and production costs, respectively. From the time series plots (Figure 1 and 2), we observe some seasonal changes and periodical price cuts for grape and cherry tomatoes, however, the patterns for the three categories are different. Local grape and cherry tomatoes' prices are low frequency series compared to the imported ones. Also, fewer fluctuations are observed for local tomato sales in the dataset.

Table 1. Descriptive statistics of grape and cherry tomato data set.

Grape and cherry tomatoes	Price per pound	Weight (pounds)	Market share (weight)
Local	6.520	722.6	29.52%
Imported organic	6.942	212.1	9.88%
Imported nonorganic	6.472	1,498.0	60.61%

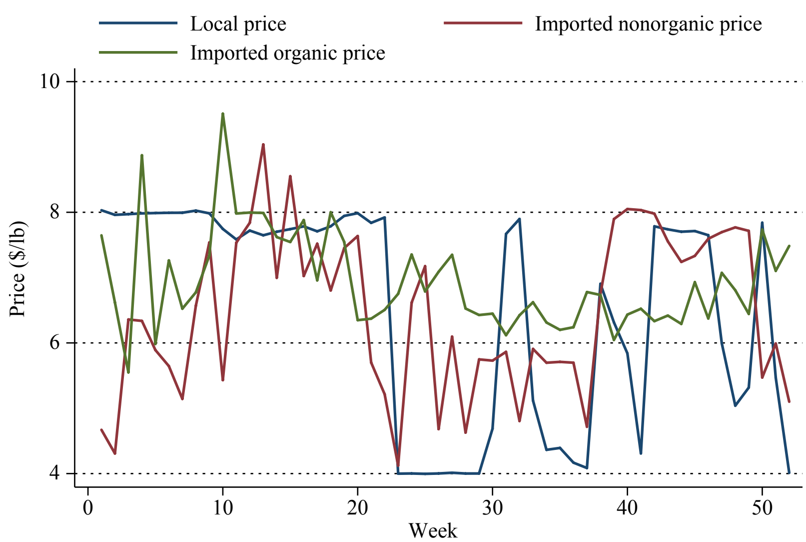


Figure 1. Price series for grape and cherry tomatoes.

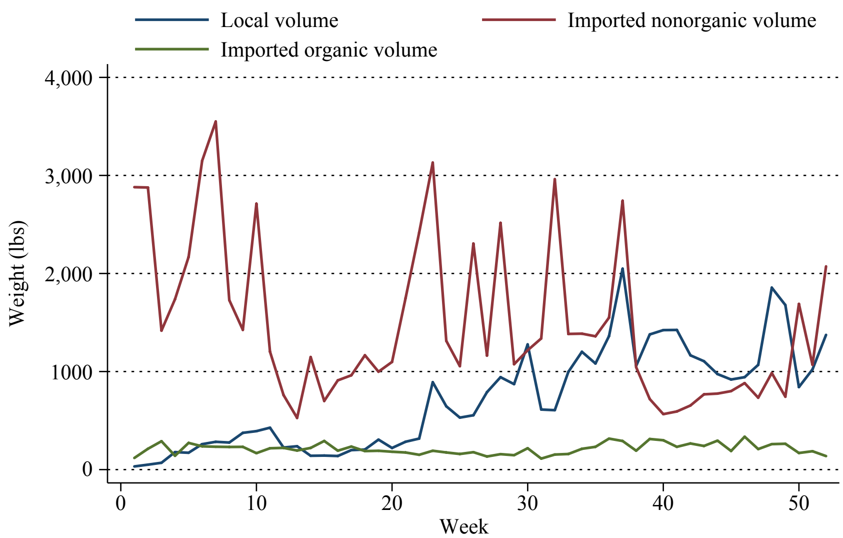


Figure 2. Volume series for grape and cherry tomatoes.

4. Models

4.1 Univariate characteristics of the price and volume series

Before directly investigating variables' influences on one another, the first task is to examine the time series properties of each of the four series and to confirm whether the quantity and price series are stationary. The tests are performed by using the most common approach, that is, the augmented Dickey-Fuller test (Dickey and Fuller, 1979, 1981). Johanson cointegration test is conducted to confirm that a first differenced VAR model is suitable. We also determined according to Schwarz information criterion that significant price-quantity interactions between local and imported tomatoes last at a maximum of 4 weeks. Details of the tests to validate our model are included in Supplementary results S1.

4.2 Vector Autoregressive-dynamic effects

As the variables are nonstationary, but not cointegrated at levels, we investigate the dynamic relationships among the quantities and prices that are stationary with first difference. To describe the intertemporal correlations between the endogenous variables, we employ a panel VAR model. Economists advocate VAR model as the models provide a theory-free method to estimate dynamic economic relationships and work as an alternative to the 'incredible identification restrictions' in structural models. With no prior-modeling quantity-price relationship assumed in this study, we are able to estimate a model with least restrictions.

The dynamic system of interest consists of price-oriented and quantity-oriented (inverse) demand equations, containing the six previously built series of local price, imported organic price, imported nonorganic price, local volume, imported organic volume and imported nonorganic volume. The reduced form VAR model would be able to evaluate the effects of price and quantity values in previous weeks on the current week, as specified in Equation 1 as follows:

$$Y_{at} = K + \sum_{l=1}^{m} \Phi_l Y_{a,t-l} + \varepsilon_{at} \quad (1)$$

Where

$$Y_{at} = \begin{bmatrix} Price\ of\ Tomato_{at} \\ Volume\ of\ Tomato_{at} \end{bmatrix}$$

a=location of production (local, imported organic, imported nonorganic)
m=maximum lag numbers

These equations can be estimated using ordinary least squares, while the contemporaneous effects of the endogenous variables are absorbed in the variance matrix of the errors (Hamilton, 1994). The lag is selected based on the underlying significance test. Coefficients beyond two lags are no longer significant, therefore, only variables up to two lags are included and the model results are presented in Table 2, with the columns presenting the results for each of the endogenous variables. Impulse Response Functions for each variable are shown in Supplementary results S1, which show consistent impact of shocks of various endogenous variables.

Our first finding, according to the VAR results, is fluctuations in the price sold in the market will correlate with sales. Evidenced by the significant coefficients of lagged volumes (one or two lags), as well as substantial responses of prices to volume shocks according to the impulse response functions, we find that prices of local and imported tomatoes are significantly affected by their inventory or stock shocks, which might be caused by seasonal changes in the past one or two weeks. A positive relationship shows that weak sales (cumulating consumer demand) in the current week will lead to price cuts or promotions in the following week. The explanation lies in the fact that a high inventory condition would be related to the timing of price promotions, which agrees with findings of Levin *et al.* (2009), Aguirregabiria (1999) and Pesendorfer (2002). However, we find no evidence of a significant impact of prices on sales for either local or imported tomatoes.

Periodic price cuts have been discussed by Doyle (1983), where sellers in the non-durables market would cut their prices periodically to attract consumers who are uncertain about their preferences towards the product. In our study, we find that previous prices, as well as the duration since last promotion would affect the current prices, but this is only true for imported tomatoes. A promotion would immediately follow a higher price in the current week for imported organic tomatoes. For the imported nonorganic tomatoes, current price is positively correlated with previous prices. A possible explanation for this unexpected correlation would be the price rigidity or adjustment cost for prices (Slade, 1998, 1999). Local tomato prices are not serially correlated, showing fewer adjustments compared to imported tomatoes. Since local prices only respond to variations of local volumes, a possible explanation could be the smaller fluctuations in the sales of local tomatoes, which is a signal of stable supply.

Last but not least, local market is relatively isolated as there are no observed dynamic adjustment processes between local vs imported organic or local vs imported nonorganic tomatoes. There are certain interactions between volumes and prices between imported organic and nonorganic markets, for examples, imported nonorganic price move in the same direction as imported organic price in the past week, and imported organic price one week before significantly affect current imported nonorganic volume. Both observations suggest imported organic tomatoes are substitutes for nonorganic tomatoes, although not vice versa. However, such interactions are missing between local and imported tomatoes.

Our 'Granger-causality' tests confirm the above findings. This study tests dynamic specifications of the causality models. Regarding the use of dynamic lagged models to test for market influences, in economic terms the lagged effects in the model are likely to arise from sluggishness in price adjustment, delays in transportation and information transmission, cold storage inventory holdings, and the formation of expectations under price uncertainty (Elston *et al.*, 1999). As for the Honolulu grape and cherry tomato market, a lag length of 4 is selected using weekly data, as this lag length accommodates the possible effects of commodity flows in both markets. Hence, the models were assessed for equal lag lengths in both markets for lengths of 4. For

Table 2. Vector Autoregressive estimates of the dynamics of prices and volumes of local and imported tomatoes.[1]

Variables	**(1) Local price$_t$**	**(2) Imported organic price$_t$**	**(3) Imported nonorganic price$_t$**	**(4) Local volume$_t$**	**(5) Imported organic volume$_t$**	**(6) Imported nonorganic volume$_t$**
Local price$_{t-1}$	0.258	-0.123	-0.0302	-69.80	-5.697	84.74
	(0.222)	(0.127)	(0.199)	(55.13)	(9.472)	(144.3)
Local price$_{t-2}$	0.153	0.157	0.00555	-66.13	-3.240	17.76
	(0.242)	(0.139)	(0.218)	(60.17)	(10.34)	(157.5)
Imported organic price$_{t-1}$	-0.297	-0.480***	0.500*	-6.602	1.127	-354.2*
	(0.312)	(0.179)	(0.280)	(77.48)	(13.31)	(202.8)
Imported organic price$_{t-2}$	-0.0321	-0.123	0.106	-33.37	-0.578	4.568
	(0.299)	(0.172)	(0.269)	(74.37)	(12.78)	(194.7)
Imported nonorganic price$_{t-1}$	-0.204	-0.0915	-0.463	13.82	3.251	12.43
	(0.352)	(0.203)	(0.317)	(87.63)	(15.05)	(229.4)
Imported nonorganic price$_{t-2}$	0.0564	-0.292	0.576*	22.22	19.92	-448.1*
	(0.359)	(0.206)	(0.323)	(89.23)	(15.33)	(233.6)
Local volume$_{t-1}$	0.00259***	-0.000657	0.000116	-0.561**	-0.0127	0.00275
	(0.000955)	(0.000549)	(0.000859)	(0.238)	(0.0408)	(0.622)
Local volume$_{t-2}$	0.00192*	0.000522	0.000373	-0.637**	-0.0234	-0.315
	(0.00105)	(0.000605)	(0.000946)	(0.262)	(0.0450)	(0.685)
Imported nonorganic volume$_{t-1}$	-0.000522	-0.000106	-0.000305	0.0212	-0.00569	-0.279
	(0.000496)	(0.000285)	(0.000446)	(0.123)	(0.0212)	(0.323)
Imported nonorganic volume$_{t-2}$	-0.000297	-0.000447	0.000954**	0.122	0.0250	-0.760**
	(0.000510)	(0.000293)	(0.000459)	(0.127)	(0.0218)	(0.332)
Imported organic volume$_{t-1}$	-0.00357	0.00746***	0.00472	-0.193	-0.842***	-3.007
	(0.00470)	(0.00270)	(0.00423)	(1.169)	(0.201)	(3.061)
Imported organic volume$_{t-2}$	0.000352	0.00400	-0.00257	0.185	-0.370*	3.622
	(0.00480)	(0.00276)	(0.00432)	(1.194)	(0.205)	(3.127)
Constant	-0.170	0.0360	-0.0173	47.20	-2.843	-0.753
	(0.171)	(0.0982)	(0.154)	(42.51)	(7.303)	(111.3)
Observations	49	49	49	49	49	49

[1] *** *P*<0.01; ** *P*<0.05; * *P*<0.1; values between parentheses are standard errors.

the local market, causality is observed in one direction, which indicates that the influence of volume on that of tomato price is significant, whereas the hypothesis of price causality on sales is rejected.

Moreover, there are no causal relationships between local and imported tomatoes, either organic or nonorganic. The local sales may not rely much on competitors' pricing or volumes. The prices of local tomato sellers are only driven by their sales conditions, not subject to the price adjustment of imported tomato suppliers, suggesting that local tomatoes are significantly differentiated from imported counterparts and local tomato sellers do have market power of their products. Other features, such as brand recognition or 'buy local' incentive may have high weights on consumers' behavior. Given that seasonality is less pronounced in Hawaii, and outside shocks which affect imported supply are not transferred to the local tomatoes, the volumes have relatively small fluctuations and prices of local tomatoes adjust less frequently compared to imported tomatoes.

5. Conclusions

Competition of local food markets has not been studied empirically as much as other differentiated product markets for two major reasons: the difficulty of defining a 'local' market (Martinez *et al.,* 2010), and the availability of data to test the empirical hypotheses based on existing demand models. Hawaii, as a state surrounded by the Pacific Ocean, provides a natural setting to overcome the first problem with its geographic isolation.

The VAR model avoids the data requirement on the characteristics of the local food and market shares of each brand, as well as solving the endogeneity problems between prices and quantities. Built on the dynamic relationship in the tomatoes market, the proposed study discovered a distinguished pattern of interrelated demand systems. First, the demand for local and imported organic and nonorganic tomatoes are all quantity oriented, therefore, the inventory changes or supply shocks will feed into their respective price variations, but not vice versa. This finding is confirmed by the causality tests and impulse response functions and suggests that pricing strategies might not be effective in changing sales. Second, some evidence of substitutability of imported organic tomatoes towards imported nonorganic is found. However, imported tomatoes, either organic or nonorganic, are not interacting with local ones. Therefore, local tomatoes seem to be isolated from the competition of imported counterpart, and some market power as well as premiums are received from its 'local' feature.

According to the theory of responsible consumption (Knight, 2004), quality, impact on environment and social responsibility as well as 'green' feature of local products can be recognized by the demand side, thus creating product differentiation and market power for local suppliers. Our findings show that consumer preferences could be the major support of local food system development. The resulting differentiation of local tomatoes from off-island competitors makes local farmers price makers and enhances their competitiveness, possibly profits. Consequently, strategies like advertising to increase the recognition of 'locality' of local tomatoes, could further increase the degree of differentiation and contributes to a sustainable competitive advantage of local tomatoes. The empirical results also have implications for the long-term stability of local tomato production. Although the market share of local grape and cherry tomatoes are not dominant, the local tomatoes are more resistant to outside shocks, which contributes to less frequent price adjustments and more stable market for local producers.

Different types of tomatoes have different culinary values and functions, and this paper presents a case study of a particular agricultural product market. While we cannot generalize this finding to the entire tomatoes market or local food system, our finding suggests that it would be paramount to extend this study to other important local food items. Limited by the data, the study is not able to estimate a comprehensive demand system for local and imported food. Supplied with consumer data, e.g. household income, family size, age and education of household head, and residence location, etc., we would be able to derive price-cost margins as well as substitution pattern between local and imported tomatoes and get a better picture of competition in local market. Cost structure estimation for local farms would be viable with firm data to uncover the supply side conditions and sustainability behind the differential price and market shares of local food.

Acknowledgement

This work was in part supported by the USDA National Institute of Food and Agriculture, Hatch project HAW01122-H, managed by the College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. Financial support from College of Business, Hawaii Pacific University is gratefully acknowledged. We would like to thank the reviewers for their constructive comments. We would also like to thank Prof. Ken Schoolland for his suggestions that greatly improved the manuscript.

Supplementary material

Supplementary material can be found online at https://doi.org/10.22434/IFAMR2016.0139.

Supplementary results S1.

References

Adams, D.C and M.J. Salois. 2010. Local versus organic: a turn in consumer preferences and willingness-to-pay. *Renewable Agriculture and Food Systems* 25(04): 331-341.

Aguirregabiria, V. 1999. The dynamics of markups and inventories in retailing firms. *The Review of Economic Studies* 66(2): 275-308.

Amato, D.M. 2007. Going for the green. *Chain Store Age* 83(6): 42.

Andreatta, S. and W. Wickliffe. 2002. Managing farmer and consumer expectations: a study of a North Carolina farmers market. *Human Organization* 61(2): 167-176.

Awokuse, T.O. 2005. Exports, economic growth and causality in Korea. *Applied Economics Letters* 12(11): 693-696.

Berry, S.T. 1994. Estimating discrete-choice models of product differentiation. *The RAND Journal of Economics* 25: 242-262.

Berry, S.T., J. Levinsohn and A. Pakes. 2004. Differentiated products demand systems from a combination of micro and macro data: the new car market. *Journal of Political Economy* 112(1): 68-105.

Bonini, S.M.J. and J.M. Oppenheim. 2008. Helping 'green' products grow. *The McKinsey Quarterly* 3(2): 1-8.

Brooker, J.R. and D.B. Eastwood. 1989. Using state logos to increase purchases of selected food products. *Journal of Food Distribution Research* 20: 175-183.

Brown, C. 2003. Consumers' preferences for locally produced food: a study in southeast Missouri. *American Journal of Alternative Agriculture* 18(4): 213-224.

Chamberlin, E.H. 1933. *The theory of monopolistic competition: a re-orientation of the theory of value*. Harvard University Press, Cambridge, MA, USA.

Coley, D., M. Howard and M. Winter. 2009. Local food, food miles and carbon emissions: a comparison of farm shop and mass distribution approaches. *Food Policy* 34(2): 150-155.

Darby, K., M.T. Batte, S. Ernst and B. Roe. 2006. Willingness to pay for locally produced foods: a customer intercept study of direct market and grocery store shoppers. Available at: http://tinyurl.com/yb8bary3.

Davidson, K., M. Pan, W. Hu and D. Poerwanto. 2012. Consumers' willingness to pay for aquaculture fish products vs Wild-caught seafood – a case study in Hawaii. *Aquaculture Economics and Management* 16(2): 136-154.

Day, G.S. 1994. The capabilities of market-driven organizations. *The Journal of Marketing* 58: 37-52.

De Crombrugghe, D., F.C. Palm and J.-P. Urbain. 1997. Statistical demand functions for food in the USA and the Netherlands. *Journal of Applied Econometrics* 12(5): 615-645.

Deaton, A. and J. Muellbauer. 1980. An almost ideal demand system. *The American economic review* 70(3): 312-326.

Dickey, D.A. and W.A. Fuller. 1979. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association* 74(366a): 427-431.

Dickey, D.A. and W.A. Fuller. 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica* 49: 1057-1072.

Doyle, C. 1983. Dynamic price discrimination, competitive markets and the matching process. The Warwick economics research paper series (TWERPS 229). Department of Economics, University of Warwick, Coventry, UK.

Eastman, J.K., R.E. Goldsmith and L.R. Flynn. 1999. Status consumption in consumer behaviour: scale development and validation. *Journal of Marketing Theory and Practice* 7(3): 41-51.

Eastwood, D.B. 1996. Using customer surveys to promote farmers' markets: a case study. *Journal of Food Distribution Research* 27: 23-30.

Eastwood, D.B, J.R. Brooker and M.D. Gray. 1999. Location and other market attributes affecting farmer's market patronage: the case of Tennessee. *Journal of Food Distribution Research* 30: 63-72.

Elston, J.A., J. D Hastie and D. Squires. 1999. Market linkages between the US and Japan: an application to the fisheries industry. *Japan and the world economy* 11(4): 517-530.

Feenstra, G.W. 1997. Local food systems and sustainable communities. *American journal of alternative agriculture* 12(1): 28-36.

Gabszewicz, J.J. and J.-F. Thisse. 1979. Price competition, quality and income disparities. *Journal of Economic Theory* 20(3): 340-359.

Geslani, C., M.K. Loke, M. Barnes-Mauthe and P. Leung. 2015. Seafood purchasing preferences of Hawaii chefs: comparing actual purchase to stated preferences from conjoint choice experiment. *Journal of International Food and Agribusiness Marketing* 27(1): 50-63.

Govindasamy, R., M. Zurbriggen, J. Italia, A. Adelaja, P. Nitzsche and R. van Vranken. 1998. Farmers markets: consumer trends, preferences, and characteristics. *Parking* 52(28.3): 16.0.

Guthrie, J., A. Guthrie, R. Lawson and A. Cameron. 2006. Farmers' markets: the small business counter – revolution in food production and retailing. *British Food Journal* 108(7): 560-573.

Hamilton, J.D. 1994. *Time series analysis. Vol. 2.* Princeton university press, Princeton, NJ, USA.

Hausman, J., G. Leonard and J.D. Zona. 1994. Competitive analysis with differentiated products. *Annales d'Economie et de Statistique* 34: 159-180.

Holtz-Eakin, D., W. Newey and H.S. Rosen. 1988. Estimating vector autoregressions with panel data. *Econometrica* 56: 1371-1395.

Hotelling, H. 1929. Stability in competition. *The Economic Journal* 39(153):41-57.

Keahiolalo, K. 2013. Hedonic price analysis of fresh packaged tomatoes in the Honolulu market: an exploratory investigation. MA Capstone. Department of Economics, University of Hawaii, Manoa, Honolulu, HI, USA.

Keeling-Bond, J.J., D. Thilmany and C. Bond. 2009. What influences consumer choice of fresh produce purchase location? *Journal of Agricultural and Applied Economics* 41(1): 61-74.

Kezis, A.S., U.C. Toensmeyer, F.R. King, R.L. Jack and H.W. Kerr. 1984. Consumer acceptance and preference for direct marketing in the Northeast. *Journal of Food Distribution Research* 15(3).

Knight, A. 2004. Sustainable consumption: the retailing paradox. *Consumer Policy Review* 14(4): 113-115.

Krishnakumar, J., C. Chan-Halbrendt, P. Sullivan and K. Love. 2007. The willingness and likelihood of growers' participation in fresh produce supply chain management: special focus on the Hawaiian avocado industry. IAMA 17th Annual World Forum and Symposium, Parma, Italy.

Levin, Y, J. McGill and M. Nediak. 2009. Dynamic pricing in the presence of strategic consumers and oligopolistic competition. Management Science 55(1): 32-46.

Loke, M.K, X. Xu and P. Leung. 2015. Estimating organic, local, and other price premiums in the Hawaii fluid milk market. *Journal of dairy science* 98(4): 2824-2830.

Loke, M.K., X. Xu and P. Leung. 2016. Estimating local, organic, and other price premiums of shell eggs in Hawaii. *Poultry science* 95(5): 1050-1055.

Low, S.A. and S.J. Vogel. 2011. Direct and intermediated marketing of local foods in the United States. *USDA-ERS Economic Research Report 128*. Available at: http://tinyurl.com/yd7pqy5q

Martinez, S. 2010. *Local food systems; concepts, impacts, and issues.* Diane Publishing, Collingdale, PA, USA.

National Agricultural Statistics Service. 2005. Statistics of Hawaii agriculture 2005. NASS, U.S. Dept. of Agriculture, Washington, DC. Available at: http://tinyurl.com/yat4ckfd.

Nevo, A. and C. Wolfram. 2002. Why do manufacturers issue coupons? An empirical analysis of breakfast cereals. *RAND Journal of Economics* 33: 319-339.

Pesendorfer, M. 2002. Retail sales: a study of pricing behavior in supermarkets. *The Journal of Business* 75(1): 33-66.

Pinkse, J., M.E. Slade and C. Brett. 2002. Spatial price competition: a semiparametric approach. *Econometrica* 70(3): 1111-1153.

Powell, L.M. and F.J. Chaloupka. 2009. Food prices and obesity: evidence and policy implications for taxes and subsidies. *The Milbank Quarterly* 87(1): 229-257.

Pretty, J.N., A.S. Ball, T. Lang and J.I.L. Morison. 2005. Farm costs and food miles: an assessment of the full cost of the UK weekly food basket. *Food Policy* 30(1):1-19.

Salois, M.J. 2012. Obesity and diabetes, the built environment, and the 'local' food economy in the United States, 2007. *Economics and Human Biology* 10(1): 35-42.

Salop, S.C. 1979. Monopolistic competition with outside goods. *The Bell Journal of Economics* 10: 141-156.

Slade, M.E. 1998. Optimal pricing with costly adjustment: evidence from retail-grocery prices. *The Review of Economic Studies* 65(1): 87-107.

Slade, M.E. 1999. Sticky prices in a dynamic oligopoly: an investigation of (s, S) thresholds. *International Journal of Industrial Organization* 17(4): 477-511.

Slade, M.E. 2004. Market power and joint dominance in UK brewing. *The Journal of Industrial Economics* 52(1): 133-163.

Śmiech, S. and M. Papież. 2013. Fossil fuel prices, exchange rate, and stock market: a dynamic causality analysis on the European market. *Economics Letters* 118(1): 199-202.

Sobel, J. 1984. The timing of sales. *The Review of Economic Studies* 51(3): 353-368.

Sullivan, P., C. Chan-Halbrendt and J. Krishnakumar. 2013. Are farmers' market shoppers different from cross-shoppers? The case of Hawaiian avocado purchasers. *Journal of Food Products Marketing* 19(5): 363-375.

Swenson, D. 2009. Investigating the potential economic impacts of local foods for southeast iowa. Leopold Center Pubs and Papers. 66. Department of Economics, Iowa State University, Ames, IA, USA. Available at: http://tinyurl.com/yblpz4bd.

Ulupono Initiative. 2011. Local food market demand study. Available at: http://tinyurl.com/yc8892s4.

Wang, Z. and D.A. Bessler. 2006. Price and quantity endogeneity in demand analysis: evidence from directed acyclic graphs. *Agricultural Economics* 34(1): 87-95.

Warner, E.J. and R.B. Barsky. 1995. The timing and magnitude of retail store markdowns: evidence from weekends and holidays. *The Quarterly Journal of Economics* 110(2): 321-352.

Wolf, M.M. 1997. A target consumer profile and positioning for promotion of the direct marketing of fresh produce: a case study. *Journal of Food Distribution Research* 28(3): 11-17.

Wolf, M.M., A. Spittler and J. Ahern. 2005. A profile of farmers' market consumers and the perceived advantages of produce sold at farmers markets. *Journal of Food Distribution Research* 36(1).

Woodruff, R.B and S. Gardial. 1996. *Know your customer: new approaches to understanding customer value and satisfaction*. Wiley, Hoboken, NJ, USA.

Xu, X., K. Keahiolalo, M.K. Loke and P. Leung. 2015a. Local premium or local discount: the case of packaged fresh tomatoes in Hawaii. *Journal of Agricultural and Applied Economics* 47(3): 345-358.

Xu, X, M.K. Loke and P. Leung. 2015b. Is there a price premium for local food? The case of the fresh lettuce market in Hawaii. *Agricultural and Resource Economics Review* 44(1): 110-123.

Zeithaml, V.A. 1988. Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence. *The Journal of marketing* 52: 2-22.

Zepeda, L. and C. Leviten-Reid. 2004. Consumers' views on local food. *Journal of Food Distribution Research* 35(3): 1-6.

Zepeda, L. and J. Li. 2006. Who buys local food? *Journal of Food Distribution Research* 37(3): 385-394.

Supplementary online material of International Food and Agribusiness Management Review
DOI: https://doi.org/10.22434/IFAMR2016.0139

Competitiveness of local food: an empiric al analysis of the tomato market dynamic?

Xin Fang[Ⓘa], Hui Huang[b], and PingSun Leung[c]

[a]Associate Professor and [b]Assistant Professor, Department of Financial Economics and Information Systems, Hawaii Pacific University, 900 Fort Street Mall, Suite 600, Honolulu, HI 96813, USA

[c]Professor, Department of Natural Resources and Environmental Management, University of Hawaii at Manoa, 3050 Maile Way, Gilmore 111, Honolulu, HI 96822, USA

[Ⓘ]Corresponding author: xfang@hpu.edu

Supplementary results

1. Stationary and Cointegration Tests

The test statistics indicate a rejection of the null hypothesis for all four time series; that is, the series are non-stationary at levels. With nonstationary data, we follow the procedure of Holtz-Eakin, Newey, and Rosen (1988) to first difference the series and rerun univariate ADF test. All six series except organic volume and imported nonorganic price pass the test at the 5% significance level, which indicate the time series are stationary at first differences. The organic volume and imported price series are found to be stationary at 9.64% and 19.30% significance levels respectively.

Table S1. Univariate ADF Test Results at Levels and First Differences

	At levels with a constant and trend		First differences with a constant and trend	
	t-statistic	p-value	t-statistic	p-value
Local Price	-2.501	0.3276	-4.118	0.0059
Imported Organic Price	-2.169	0.5072	-4.858	0.0004
Imported Nonorganic Price	-1.749	0.7287	-3.143	0.0964
Local Volume	-2.285	0.4420	-4.165	0.0050
Imported Organic Volume	-1.926	0.6411	-2.811	0.1930
Imported Nonorganic Volume	-1.890	-4.178	-3.651	0.0258

We also run Johanson cointegration test for the nonstationary data at levels. This test is based on maximum likelihood estimation and two statistics: maximum eigenvalues and a trace-statistics. We use the lag of four from the underlying VAR we have. From the test results, we cannot reject the null of having no rank (rank = 0) and therefore there is no cointegration. [1]

[1] Extended ADF and cointegration tests could be run, while we believe that the current test results will be robust to various forms of specification.

Table S2. Johansen Tests for Cointegration

Rank	Trace Statistic	5% Critical Value
0	93.0520	94015
1	63.1272	68.52
2	39.6841	47.21
3	19.7125	29.68
4	5.4644	15.41
5	0.8787	3.76
6	-	-

2. Impulse Response Functions

Only shocks of local volume would impact local prices, low sales will lead to lower prices in the following week and the effect will go away within 5 weeks.

Figure S1. Response of Local Price

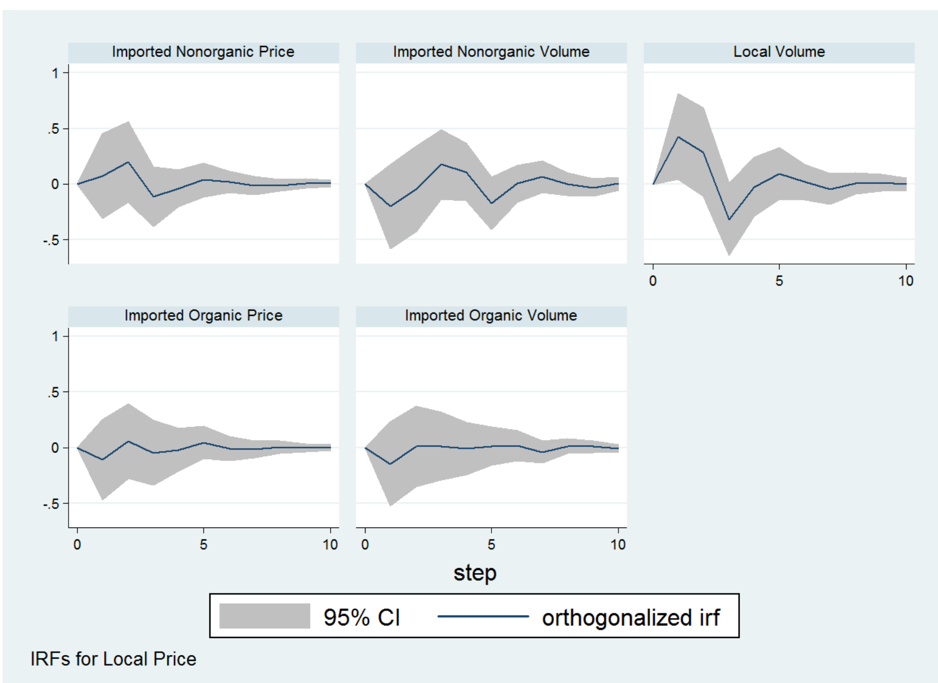
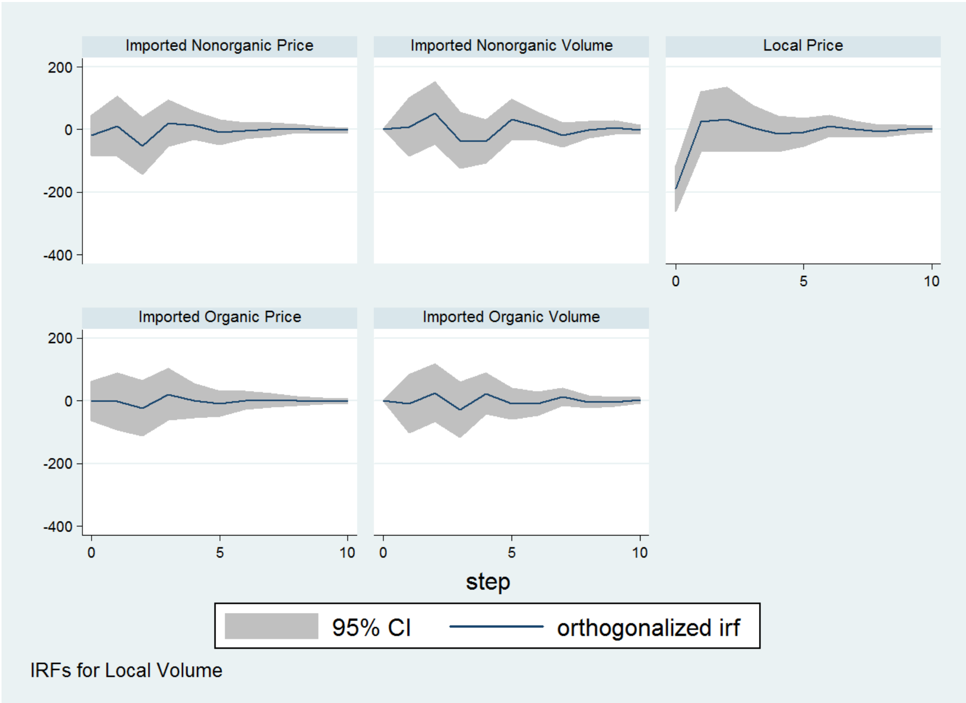


Figure S2. Response of Local Volume



Similar to the local tomatoes, low volume sales will lead to a price cut in the following week for imported organic tomatoes. And a high volume of sales/low inventory is a signal for sellers to raise prices in the following week.

Figure S3. Response of Imported Organic Price

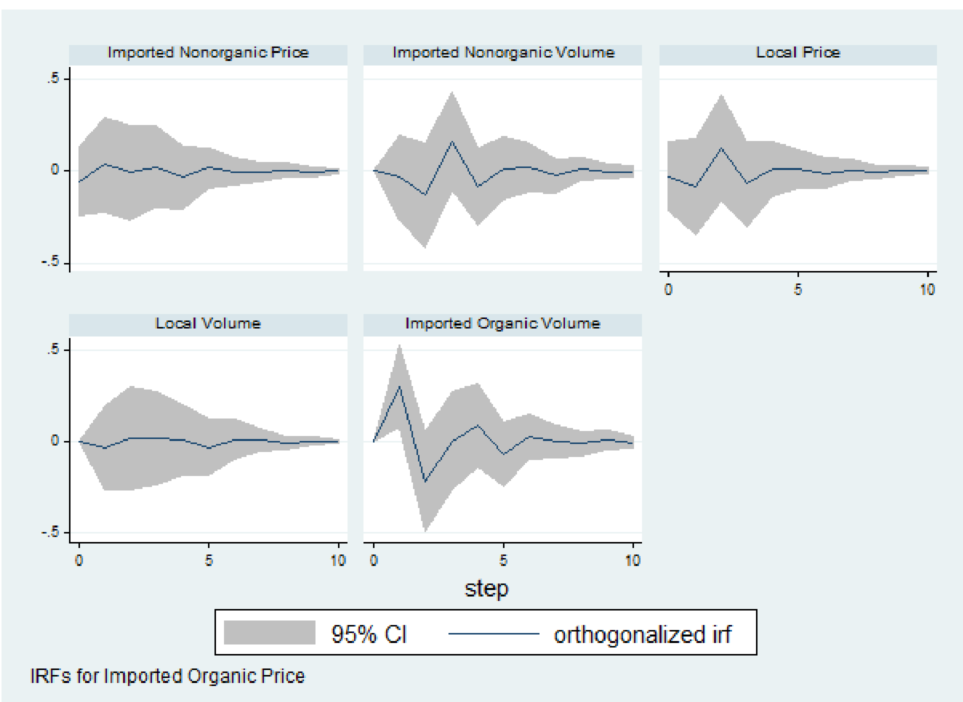
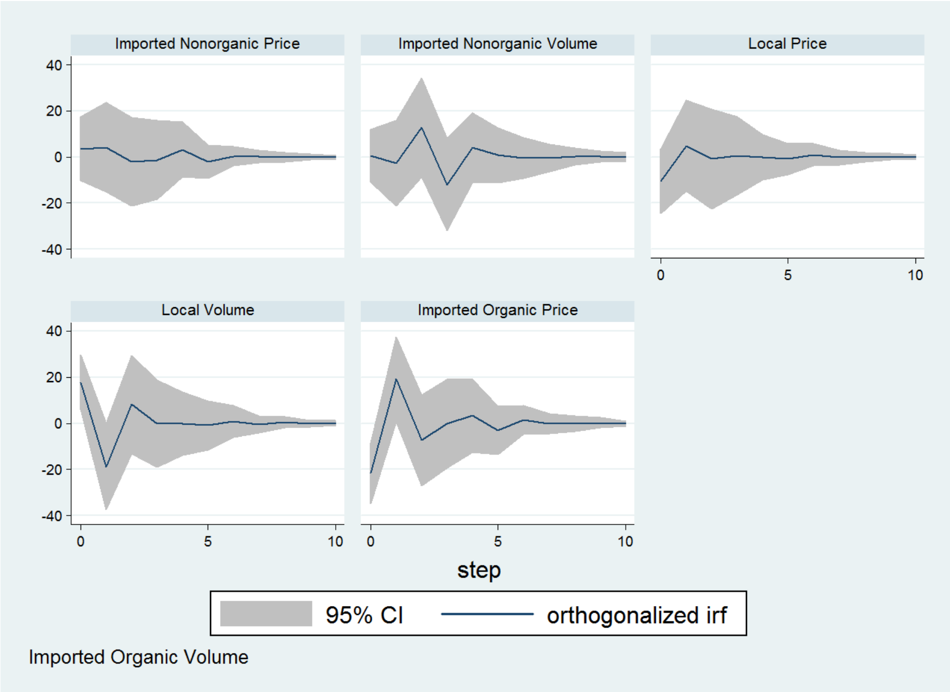


Figure S4. Response of Imported Organic Volume



For imported nonorganic tomatoes, a shock of imported organic price will positively affect their prices, suggesting that imported organic tomatoes are substitutes for the nonorganic ones. This effect will trail off within 5 weeks. Price increase of both organic and nonorganic imported tomatoes will decrease sales in the following week for the organic ones.

Figure S5. Response of Imported Nonorganic Price

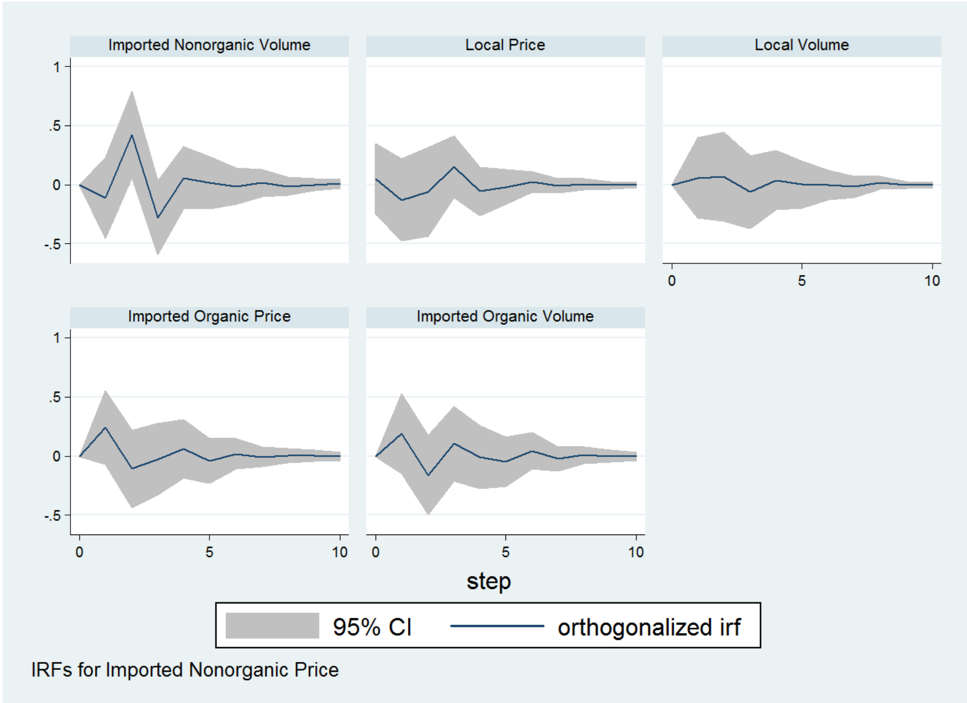


Figure S6. Response of Imported Nonorganic Volume