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Title of the Paper

An Empirical Comparison of Price Transmission between Conventional and Organic Products: The Case of Fresh Carrots

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Abstract:

In a competitive market, a rise in output prices at the wholesale level is expected to be passed through to consumers via retailers, Asymmetric price transmission exists when an increase in the producer price moves faster and more completely to consumers than do a reduction in the producer price. The research question is how product heterogeneity and differentiation can affect the price transmission in the carrots markets. Carrots are primarily consumed fresh and are the 7th most consumed fresh vegetable in the U.S. and carrot consumption has been increasing over the past few decades. we investigate price linkage of carrots at terminal and retail levels for two different quality of this product, organic and conventional. According to the VECM model results, the speed of price adjustment in the conventional carrot market is 0.354 in absolute value, while for the organic carrot market is 0.026. This result is an indication of asymmetric price transmission with respect to speed, and shows price adjustment in the organic carrot market is relatively slow pointing to inefficiency in this market. These results have important policy implications, and in case of price shocks, could have differential welfare consequences for consumers and producers.

Introduction:

There is a general belief that most agricultural markets are perfectly competitive, meaning that a homogeneous product is produced by and for many sellers and buyers, who are well informed about prices. The market is characterized by free entry and exit, with producers obligated to be price takers. In a competitive market, a rise in input costs or output price at the wholesale level is expected to be passed through to consumers via retailers. Similarly, a reduction is also expected to be reflected fully in the price paid by consumers at retail level. In the economic literature, the price linkage between two markets is known as price transmission. This relation may be symmetric or asymmetric. For example asymmetry exists when an increase in producer price moves faster and more completely to consumers than do a reduction in producer price.

Previous research articles discussed that there are some reason that asymmetric price transmission happens. Six factors affecting the asymmetric price transmission are listed by Conforti (2004), transaction/transportation costs; market power; increasing returns to scale in production; product heterogeneity and differentiation; exchange rates; and, border and domestic policies.

Despite the fact that, all of these factors have received a wildly attention in the price transmission literature, (Goodwin and Holt, 1999; Girapunthong et al. 2003, Tiffin and Dawson, 2000, among others), product heterogeneity and differentiation has been ignored and there are only some recent studies that consider this issue. Surathkal et al (2014) examined price relationship in beef market, accounting for product differentiation in cuts and quality grades.

The question of this research is how product heterogeneity and differentiation can affect the price transmission in agricultural markets. Specifically our focus will be on the organic and conventional products. This study contributes to the literature by considering price transmission in the organic and conventional carrots as two differentiated products. In the case of price changes in the carrot markets, adjustments in prices of organic and conventional carrots may be different. Study of organic agriculture products provides insights and helps develop programs for producers and agribusinesses for potential different consequences of price shocks in conventional and organic markets.

The Carrot Market:

Carrots are primarily consumed fresh and are the 7th most consumed fresh vegetable in the U.S. (Naeve, 2015) .Carrot consumption has been increasing over the past few decades. Economic theory suggests that wide-ranging factors directly influence movement in per capita carrot consumption, including immigration trends, changing family sizes and lifestyles, rising disposable incomes, and shifts in America's tastes and preferences (USDA, 2007). Consumption of fresh carrots was about 8.5 pounds per person in 2014, In contrast, consumption of frozen carrots averaged .7 pounds per person (Vegetable and Melon Outlook, 2015). Based on the USDA 2014 survey, 25,379,000 (CWT) was produced in the U.S that is equivalent to 671,656,000 in terms of dollar value and the amount of yield was 342 (CWT / ACRE).

The United States was the third-leading producer of all carrots, just behind Russia, with each producing about 7 percent of world output, China produced 34 percent of the world's carrots. (USDA, 2007). California accounted for 76 percent of fresh-market output, while Washington produced 34 percent of the carrots destined for processing. Over 2003-05, U.S. growers produced an annual average of 3.5 billion pounds of carrots for all uses, with three-fourths sold into the fresh market. (USDA, 2007). Also Approximately 9.2 percent of the carrot supply produced was exported in 2013 (Naeve, 2015) and based on FAO database, the U.S. was the second top exporter of carrots and turnips after china, exporting more than 117 thousand tones, equivalent to more than 142 million dollars. Based on most recent production and price averages, the estimated gross value for fresh market carrot production is $6,400 per acre. The costs of carrot production vary and depend on the production location and the level of mechanization.

Methodology:

In this research, we investigate the impacts of a price change in terminal market on the retail level prices of each market separately, focusing on the short-run dynamics of price adjustment and price transmission. One of the appropriate models to capture the short-run dynamics of price adjustment is a vector error correction model (VECM). This model will not only allow estimate of short-run speed of adjustment for the price series but also preserve the long-run relationships among the variables (Saghaeian et.al 2007). To check the stationary of the price series and market integration between these two markets, Augmented Dickey-fuller test and Johnsen's

cointegration test is used, respectively. Such that, after testing stationary level of variables, if they are integrated of order (1), the cointegration between them will be investigated. As Engle and Granger (1987) discussed, two I(1) series are said to be cointegrated if there exists some linear combination of the two which produces a stationary trend or integrated of degree zero. In other words, cointegrated series are related over time. To do that Johansen cointegration test has been applied. As Mohamed-Arshad and Abdel-Hameed (2014) discussed in their paper, Johansen (1988) used the Vector Error Correction Model (VECM) as a starting point for estimation.

equation(1)

$$Y_t = \mu + \sum_{i=1}^{P} A_i Y_{t-i} + \varepsilon_t$$

Where εt is an independent identical error term (i.i.d). The VAR model can be parameterized in a Vector Error Correction Model (VECM) form can be found by solving the change in Yt in equation (2):

$$\Delta Y_t = \mu + \sum_{i=1}^{P} \Gamma_i \Delta Y_{t-i} - \Pi Y_{t-i} + \varepsilon_t \qquad \text{equation (2)}$$

The long run information is found in the matrix Π, which the rank of this matrix determines the number of cointegrating relationships. If the rank of Π equals P (the size of the Yt matrix) then Yt themselves are stationary. If the rank is less than p but greater than zero then some independent unit roots exist. If p equals zero, then all unit roots are independent. If the rank r is 0 < r < P then P can be decomposed using a reduced rank regression into$\Pi = \alpha\beta'$. In order to test the rank of Π, the trace and the maximum eigenvalue test statistics are used.

Data:

The data used in this study are weekly prices of organic and conventional carrots. The sample period chosen for this study extend from first week of Jan 2012 to last week of Dec 2014. Prices at both retail level and terminal market level have been used. Since frequency of data is

important to investigate the relation between prices, the weekly data has been chosen for this study.

For retail prices, national level prices have been selected. However prices at national level in terminal market were not available, hence prices at Chicago are used as a representative of terminal markets. The data is repotted by agricultural marketing service of the United States Department of Agriculture database. In this study, the logarithms of prices have been used instead of level of prices. As Dawson and Tiffin (2000) and Banerjee et al. (1993) discussed, in order to find co-integration relation between variables it is common to use logarithms, the reason is with trending data, the relative error might decline over time and this is inappropriate. Furthermore, in order to avoid from spurious regression, using Augmented Dickey-Fuller (ADF) stationary test have been done.

Results and discussion:

According to the ADF test, the retail and terminal market price series are stationary at first difference. The results of co-integration test based on two rank tests, trace and maximum eigenvalue indicate the null hypothesis of no cointegration in the long run has been rejected. Therefore certainly there is a relationship between the wholesale and the retail prices over time in each of these two markets. In other words prices will converge to each other in the long-run.

The result of stationary test is shown in table (1), number of lags has been chosen by Schwarz info criteria. Unit root test has been done by including trend and intercept. However the results without including trend or nor trend neither intercept are also same and only critical value changed in each of these specifications. To makes it simple and short, we only reported the results for organic carrots; the same procedure has been done for non-organic carrots.

Table 1- Stationary Test for Organic carrots

Null Hypothesis: first difference of variable has a unit root

Variable	ADF test Statistic	t- statistic	probability
D(Terminal Prices)	With Trend and Intercepts	-12.352*	0.000
D(Retail Prices)	With Trend and Intercepts	-11.38*	0.000

Test critical Value at 1% level = -4.019
(*) Significant at 1% level

It is obvious retail level price series for organic carrots and terminal market price series are stationary at first difference. Therefore they are both I(1). Next step is investigating the existence of cointegration.

The results of cointegration test are reported in table (2). The model that has been chosen to report here, is with no deterministic trend, however doing this test with including trend also had the same outcomes.

Table 2- Johansen co-integration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No of CE(S)	Eigenvalue	Trace statistic	0.05 critical value	Probability
None*	0.207	41.295	20.261	0.000
At most 1	0.371	5.788	9.164	0.2077

(*) denotes rejection of the hypothesis at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No of CE(S)	Eigenvalue	Trace statistic	0.05 critical value	Probability
None*	0.207	35.5066	15.892	0.000
At most 1	0.371	5.788	9.164	0.2077

(*) denotes rejection of the hypothesis at the 0.05 level

The results of co-integration test based on two rank tests, trace and maximum eigenvalue indicate the null hypothesis of no cointegration in long run has been rejected. Therefore certainly there is a relationship between prices over time

As mentioned earlier, the all variables are stationary at the first difference, and a long run relationship exists between them. Therefore VECM is an appropriate model. The results of VEC model is reported in table 3.

TABLE 3. The empirical Estimates of Speed of Adjustment

Variable	$Organic\ Carrots$	$non-organic$
Error correction term	-0.354***	-0.026***
	(-3.831)	(-6.246)
Model diagnostics		
R-squared	0.30	0.30
Akaike AIC	-1.16	-2.80
Schwarz SC	-1.06	-2.75

*** indicates significance level at 1% - Numbers in parenthesis are t- Statistics

Source: Research findings

According to the VECM model, the speed of price adjustment in conventional market is 0.354. in absolute value, while for the organic market is 0.026. The empirical estimation of the speed of adjustment indicate, prices in conventional market adjust faster than prices in the organic market in response to a price shock, this result is an indication of asymmetric price transmission with respect to speed.

Our result would have a vital importance for policy makers, such that, if a price policy is set to support consumers in a market, say conventional market, we cannot except to have the same welfare change in consumers of organic market for the same product.

At the end, since prices in conventional market adjust much more quickly to the long-run equilibrium, this could be interpreted as a signal of more concentration and market power in the

organic market with slower price adjustment (0.026). However, our result might not be directly test for market power and further research is suggested.

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USDA, Marketing Research Service