Empirical Investigation of Wholesalers' Market Power with Organic Fresh Produce

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We look into the dynamics of farmgate-to-wholesale price markup and dependence between farmgate and retail prices of several highly perishable organic produce items over the period 1995–2003. To assess wholesalers' market power, seasonal average markup and a measure of concordance between discrete categories of farmgate and wholesale price are used. Trends in the dynamics of these two factors are studied using the multivariate Mann-Kendall nonparametric test for trend. We find evidence of growing market power of the wholesale sector: an increasing price markup across the commodities and decreasing association between the two prices.

The last two decades have seen significantly increased interest in organic food, or food grown using the principles and techniques that predated the introduction of agro-chemicals and modern intensive farming techniques. By 2003, fresh produce had become the most popular category among organic consumers, accounting for about 42 percent of organic food sales (OTA 2004).

One of the most common ways to deliver organic fresh produce to consumers is through wholesale market channels. According to the Fourth National Organic Farmer's Survey, 70 percent of respondents producing vegetables sold them through wholesale market channels, as did 50 percent of fruit producers (Walz 2004). Emerging organic markets are characterized by high price premia; organic food distributors enjoy a significantly higher price margin than do their conventional counterparts (Dimitri and Richman 2000). Yet, as is common with agriculture, the number of wholesalers (the buyers) has always been lower than the number of farms (the sellers). In addition, organic farmers tend to specialize in supply of particular commodities through extensive investments in sunk assets, including organic-certification costs. These assets represent barriers for prompt switching to the production of another commodity and cause organic product supply to be inelastic. High buyer concentration coupled with inelastic supply of organic fresh produce give rise to concerns about organic wholesalers exercising considerable market power (Rogers and Sexton 1994).

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We investigate empirically the dynamics of wholesalers' market power for a case of highly perishable organic fresh produce. Organic farmers may be defending a rather vulnerable position to an increased market power of the distribution sector with this kind of product because of the pressing need to sell it as soon as possible once the harvesting is over. As agricultural products are transformed through packaging, distribution, and related services, the evidence of direct relationships among prices at different distribution levels becomes difficult to evaluate (Ward 1982). Those agricultural products that require considerable transformation before final consumption should show weak farmgate-to-wholesale price relationships. In contrast, the price linkage should be stronger for perishable goods requiring minimal transformation.

A tendency toward price rigidity is often mentioned to be characteristic of concentrated industries. With this conjecture in mind, we look into the dynamics of farmgate-to-wholesale price markup and the growing season-wide dependence between farmgate and retail prices of several highly perishable commodities—broccoli, cauliflower, cilantro, lettuce, spinach, and tomatoes—over the period 1995–2003. To assess wholesalers' market power, seasonal average markup and a measure of association—Kendall's concordance—between discrete categories of farmgate and wholesale price are used. Trends in the dynamics of these two factors are studied using the multivariate Mann-Kendall nonparametric test for trend (Hirsch and Slack 1984; Hensel and Hirsch 1992).

The approach taken in this study has two strong points. While not being highly precise or conclusive, it allows analysis with the minimal amount of information available to the analyst (only two price series). Apart from the minimal data requirements, it also appears to be fairly robust to measurement error introduced by data aggregation and multiple price shocks. Based on the test results, we find evidence of growing market power of the wholesale sector: an increasing price markup across the commodities and decreasing covariation between the two prices over the period studied.

The following section of this paper comments on the data, Section 3 introduces the empirical methodology, Section 4 presents estimation and inference results, and Section 5 concludes with a discussion of findings and implications of the study.

Data Description

The dataset used for this study was provided courtesy of a partnership between the USDA Risk Management Agency and the University of Georgia's Department of Agricultural and Applied Economics. Farmgate and wholesale prices for a wide range of organic produce commodities were collected by a marketing agency through weekly telephone interviews of brokers and farmers throughout the United States, as deemed appropriate for the particular commodity. The list of sources is confidential and cannot be revealed. We based the methods for assessing how representative the data were on statistical testing and qualitative comparison of the states in the source list with geographic distribution of production acreage and brokers (Lohr 2005).

Only highly perishable produce was selected for this study. Specifically, the commodities selected are broccoli, cauliflower, cilantro, lettuce, spinach, and tomatoes.[1] Only prices observed during the active growing season—which spans roughly February to October (November, for some commodities), depending on the geographical location—were considered. To synchronize farmgate and wholesale prices, series of weekly price observations were regrouped into ten-day periods. As a result, 27 or 30 observations per year/season were made available for estimation. Regrouping weekly data into ten-day periods obviates the irregularly-spaced data problem with the initial series. However, the regrouping introduced another measurement-error component to the already-present errors because of the spatial aggregation and potential source self-selection. Some selected information on the price series along with other data is presented in Table 1.

Empirical Methodology

While economic theory is clear about the fundamental causes and consequences of monopsony and oligopsony power, determining from the market data whether a firm or collection of firms exercise market power tends to be a complicated modeling exercise. The key pieces of information—profits and costs—are quite unlikely to be available to the investigator, so prices and indirect information are used. Despite the complications, several empirical studies observed that prices were more rigid in concentrated industries, suggesting that collusion is associated with a greater tendency toward price rigidity in presence of cost shocks (Means 1935; Hay and Kelley 1974; Just and Chern 1980; Carlton 1986; Carlton 1989).

The mere fact that prices in either input or output markets fail to follow supply or demand shocks is not of course proof of collusive behavior. Attempts to expand during periods of high demand (Bills 1989), "menu costs" (Slade 1998), and many other factors can dampen price fluctuations caused by changing factor prices. But growing insensitivity of wholesale prices to farmgate prices does not support a hypothesis of competitive pricing.

Rather informally, consider the farmgate-to-wholesale price markup averaged over a number of wholesalers. It is an average of the farmgate-to-wholesale price spreads standardized by the farmgate price: $(p^w - p^F)/p^F$. The average markup depends on three factors: the sector's market power in the principal input market (i.e., setting p^F), the sector's market power when bargaining with retailers (setting p^w), and costs of other inputs such as fuel and electricity prices that affect costs of transportation and refrigerated storage. It should be noted at this point that wholesalers are quite unlikely to exercise a significant market power in the output market. Unlike the farms and the retail sector, wholesalers can be bypassed by retailers and processors if the former begin to charge exorbitantly. Wholesalers are unlikely to have much flexibility with transportation and storage costs, since these are driven by gasoline and electricity prices, which are beyond their control. As a result, if wholesalers' market power were on the rise during 1995–2003, an analyst should expect a gradual loss of response to changes in farmgate prices, a year-after-year decrease in wholesale price variability during the active growing season, and a moderate increase in the markup (a threat of getting bypassed should arguably keep the markup from growing too large). In fact, these three indicators are those used, in a variety of forms, in antitrust litigation (Abrantes-Metz et al. 2005).

Variance is a tempting indicator of the wholesale price's rigidity; however, it seems to have rather limited usefulness when dealing with aggregated prices. Indeed, averaging spatially and temporally heterogeneous prices suppresses their variability, and the re-grouping, while necessary, adds more distortion to the price-variability picture. Under these circumstances, observed fluctuations of both price series are more of a hindrance than help. As a result, variance has been excluded from further consideration in this study.

Dynamics of the farmgate and wholesale prices can be used after some measures are taken to filter out multiple unrelated shocks and aggregation/rearrangement effects. Specifically, it is suggested that prices be converted into several ordered categories. To this end, deviation of each price observation from the growing season's average can be obtained and classified into a specific category. Categories can be defined in a variety of ways; the percentage-

[1] These fresh produce commodities are classified as either "highly perishable" or "perishable" according to *The Packer* magazine http://www.thepacker.com/rbcs/handbookarticles/properis.htm.

Table 1. Data Summary.

Commodity	Price, 1995 $ per unit	Price, 2003 $ per unit	Change, 1995 to 2003 $	%
Broccoli				
—farmgate	1.27	1.25	-0.02	-1.6
—wholesale	1.72	1.97	0.25	14.5
Cauliflower				
—farmgate	1.24	1.13	-0.11	-8.9
—wholesale	1.78	1.83	0.05	2.8
Cilantro				
—farmgate	0.51	0.54	0.03	5.9
—wholesale	0.72	1.28	0.56	77.8
Lettuce, Romaine				
—farmgate	0.67	0.55	-0.12	-17.9
—wholesale	0.90	1.18	0.28	31.1
Spinach				
—farmgate	0.77	0.59	-0.18	-30.5
—wholesale	1.04	1.16	0.12	11.5
Tomatoes, Roma				
—farmgate	0.52	0.80	0.28	53.8
—wholesale	0.72	1.29	0.57	79.2
Gasoline, $ per gallon [a]	1.15	1.60	0.45	39.1
Electricity, ¢ per kWh [a]	4.66	5.12	0.46	9.8

[a] Source: Energy Information Administration, U.S. Department of Energy.

based categories that were used in calculations in this study appear in Table 2.

Once actual prices are transformed into categories of the deviation from the season's average, a measure of covariation different from correlation (Pearson's product-moment correlation) is desired. Correlation is no longer meaningful with qualitative ordered categories, but Kendall's concordance is. Concordance is the tendency of two factors to change co-directionally, and it is measured as follows. The data consist of b bivariate random variables $(X_i, Y_i), i = 1,2,\ldots,b$, of which $\binom{b}{2}$ pairs can be formed. A pair (X_i, Y_i) and (X_j, Y_j) is concordant—i.e., X and Y change in the same direction—if $(Y_j - Y_i)/(X_j - X_i) > 0$. If the contrary is true—$(Y_j - Y_i)/(X_j - X_i) < 0$—then the pair is called discordant. Kendall's score, or the *coefficient of concordance*—$\tau, \tau \in [-1,1]$—is computed as

$$(1)\ \tau = \frac{N_c - N_d}{N_c - N_d},$$

where N_c and N_d are the numbers of concordant and discordant pairs, respectively. If $X_j - X_i = 0$ for some (i,j) in the denominator, the pair is not counted as either concordant nor discordant. If $Y_j - Y_i = 0$ in the numerator, the pair is counted as half concordant and half discordant, and both pair numbers N_c and N_d are incremented by 0.5.

In Figure 1, correlation of actual prices, Panel 1(a), is contrasted to the concordance of the prices when the latter are transformed into the ordered categories, Panel 1(b). The filtering effect of the categories is rather illustrative: one can better see the downward trend, which is hardly noticeable with the correlation of actual price values. Figure 2 presents the dynamics of the farmgate-to-wholesale price markup. While the picture is not a clear one and schedules for different commodities are quite different, one can observe an overall upward drift of the markup. Together with the observed downward tendency of the price concordance, this raises suspicion that there might be indeed some sign of non-competitive pricing in the organic fresh produce wholesale industry.

Estimation and Inference

While a glancing visual analysis of graphs in Figure 1(b) and Figure 2 allows tentative confirmation of our suspicion that wholesalers might have increased their market power over 1995–2003, a more rigorous testing procedure is desired. Apart from testing for a time trend, the series also need to be tested against a trend of gasoline and electricity prices. Recall from Table 1 that both gasoline and electricity prices had increased by 2003 from their 1995 values. The overall increase in the markup and decrease in the dependence on the farmgate price may well be attributable to the increased transportation and storage costs rather than to growing market power.

Hirsch and Slack (1984) developed a nonparametric seasonal (multivariate) test for trends which can be carried out by computing the Kendall score within each commodity-specific series of markup or concordance scores.[2] The separate scores are then summed to obtain the test statistic. The vari-

[2] Technically, the test discussed by Hirsch and Slack (1984) and Hensel and Hirsch (1992) was developed to test for trends in series where there is a significant seasonal component. The test is well suited for this study, since each commodity can be thought of as a time series for a particular "season."

Table 2. Price Categories.

Deviation from growing season's average	Category
< ± 1%	0
< ± 1–2%	± 1
< ± 2–5%	± 2
< ± 5–10%	± 3
< ± 10–20%	± 4
< ± 20–50%	± 5
> ± 50%	± 6

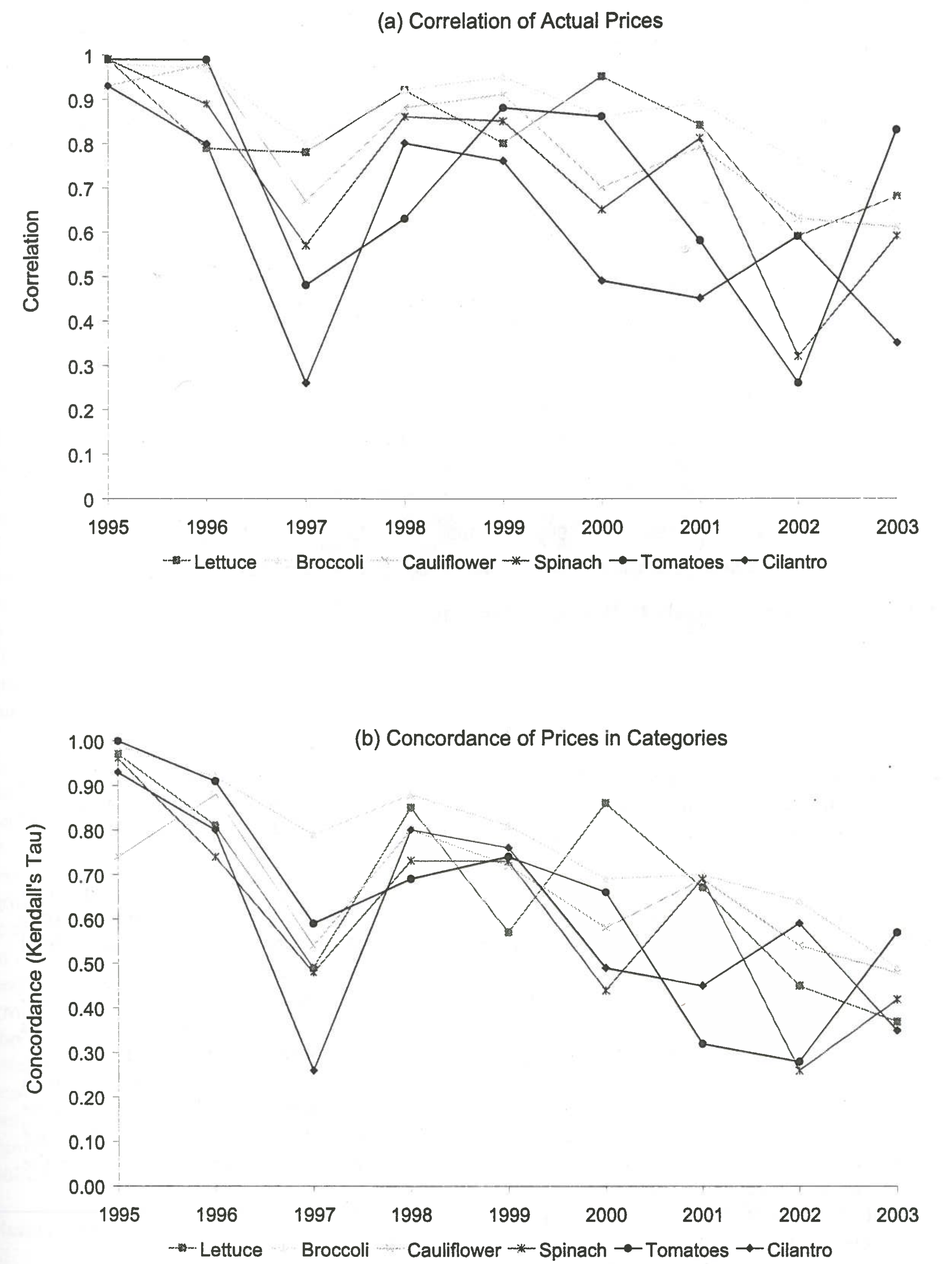

Figure 1. Dynamics of Farmgate and Wholesale Price Dependence.

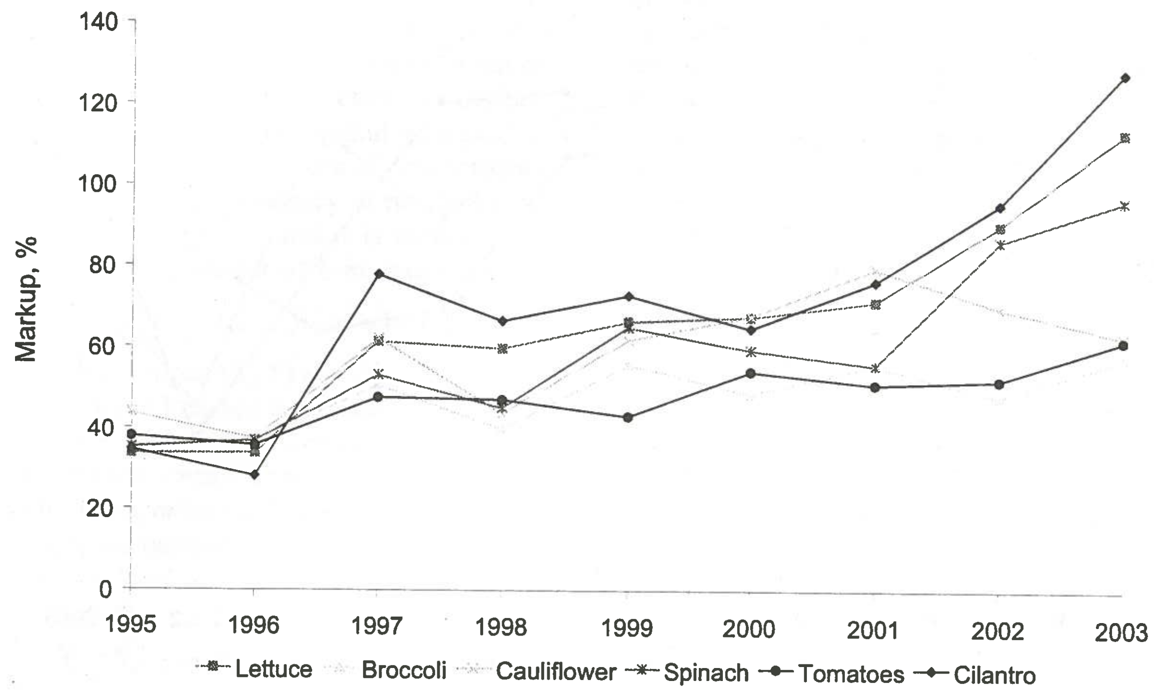

Figure 2. Dynamics of Farmgate-to-Wholesale Markup.

ance of the test statistic is obtained by summing the variances of the Kendall score statistic for each commodity. In this test, the null hypothesis is that each time series is of the form $z_t = \mu_t + \varepsilon_t$, where ε_t is white-noise error and μ_t is the mean for commodity *m*. Under the null, the standardized sum of scores follows the standard normal distribution. The one-tailed alternative is the presence of the trend in question in at least one of the series.

Among the advantages of the seasonal (multivariate) Kendall trend test is that it is a rank-based procedure especially suitable for non-normally distributed data, censored data, data containing outliers, and non-linear trends. The null hypothesis of randomness states that the data are a sample of several independent and identically distributed random variables. The trend-test statistic is used as a measure of trend magnitude, or of its significance; it is, nevertheless, not a direct quantification of trend magnitude. Table 3 presents the test results. We can observe that:

1) When tested against the linear time trend, the null hypothesis of no trend is rejected for both the farmgate-to-wholesale price markup and the concordance measure.

2) When tested against the trends given by fuel and electricity prices, the null is only rejected at a reasonable significance level for the concordance. Since both gasoline and electricity prices drifted upward during 1995–2003 (i.e., each price series has an increasing time trend) and the dependence of τ on these prices is lower than it is on time, apparently neither gasoline nor electricity price is a credible cause of decreasing dependence between the wholesale and farmgate prices.

Conclusions

Our study supports empirically the hypothesis of growing market power of the organic fresh produce wholesale sector. Specifically, we have found evidence of an increasing price markup across the commodities and a decreasing association between the farmgate and wholesale prices. The growing market power of the wholesalers may be the primary reason that farmers begin to avoid mediators in delivering organic fresh produce to consumers. A majority of respondents of the Fourth National Organic Farmer's Survey indicated that they were planning market-channel increases in direct-to-consumer and direct-to-retail markets (Walz 2004).

In spite of the wholesalers exercising some market power, there may be no need for government antitrust intervention in organic agricultural sector. It is not only possible but quite likely that the market will remove the inefficiency of the organic fresh produce wholesale sector by itself, through growing direct relations between farmers and the terminals of the distribution network. As an example of this emerging tendency, the *New York Times* recently reported that Wal-Mart, the nation's largest grocery retailer, had decided to expand its organic food sales (Warner 2006). The company reportedly intends to sell organic food items at a premium of some 10 percent over conventional products. This policy is likely to influence pricing trends and the farmgate-to-wholesale markup, indicating the policy relevance of our research.

Table 3. Results of Testing for Trend.

Trend —series	Statistic	p-value
Time		
—markup	0.128	0.086
—concordance	-0.21	0.012
Gasoline price		
—markup	0.094	0.157
—concordance	-0.191	0.022
Electricity price		
—markup	0.069	0.230
—concordance	-0.161	0.044

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