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Market Power in Direct Marketing of Fresh Produce: Community Supported Agriculture Farms

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Keywords: Community Supported Agriculture; New Empirical Industrial Organization; Market Power; Fresh Produce; Organic Agriculture.

JEL Classification: D42, L12, Q13.

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Introduction

With rising land prices, competing land uses, and low prices for agricultural products, farm operators must find ways to maintain their economic viability. This is especially true in the Northeastern U.S. where input costs are affected by increased land prices, higher assessed values, and taxes. Northeast farmers typically face higher prices for commercial inputs as well. To improve viability, some farmers focus on product and market diversification, reduce chemical input use, introduce new food products, and apply innovative marketing techniques. Organic production is attractive due to the organic price premium and lower chemical input costs. Moreover, when marketed directly to consumers, organic production allows farmers to capture a greater percentage of the food dollar. Despite gains from direct marketing, viability of the farm may still be a problem for organic farmers. The costs of production may not be covered due to fluctuating market prices and higher labor costs. Organic agriculture is perceived to be more susceptible to pests due to the inability to intervene by applying synthetic fertilizers, insecticides, and herbicides. Perception of this higher degree of risk has led some producers to seek a new social and economic basis for agriculture, namely Community Supported Agriculture (CSA) (Lamb 1996; Padel and Lampkin 1994).

CSA is a marketing approach that connects consumers with farmers through direct purchase of shares of farm product. Most CSAs provide fresh organically grown produce, but there are CSAs that provide shares of fresh herbs, flowers and animal products.[1] To become a shareholder, consumers agree to purchase a share of the farm's produce prior to the season, usually during the winter or early spring. The farmer then produces the crop and provides a weekly bundle of produce to the consumers throughout

the growing season, typically from May through October, although some CSA farms provide winter shares as well. Having sold shares prior to the season, the farmer can then focus on production throughout the growing season. The CSA principle is straightforward: by purchasing shares prior to the season, the consumers share the risks of farming as well as the rewards (Stern, 1992; Karr, 1993).

The CSA concept brings together consumers and farmers with similar ideologies. CSA shareholders are typically consumers who are interested in where their food comes from and how it is produced (Cooley and Lass, 1998). Through CSA, the shareholders develop a stronger appreciation for farms and for the linkages between farms and the environment (Van En, 1988; Lamb, 1996). The CSA operator has a desire for the farm to be self-sufficient, vital, and a healthy part of the community (Karr, 1993). If there is a demand for fresh, locally grown, organic food in the community, CSA farmers can encourage reliance on locally produced food rather than a dependence upon imported produce. One objective of CSA farms is to capture this demand and establish a base of shareholders that will return each year, which further reduces their annual marketing efforts.

A loyal customer base and a differentiated product may enable CSA farms to exercise, at least to a degree, monopoly power. In this study, we investigate whether and to what extent CSA farms exercise market power in their pricing decisions. We estimate the degree of market power using a structural econometric model. The finding of market power would suggest that CSAs have been successful in improving the profitability of family farms, or they at least have that capability.

Conceptual Model

We assume that a typical CSA farm maximizes profit and has the ability to exercise monopoly power in selling shares. CSA farms can be considered monopolies because of their geographic isolation from other farms (few farms in each region have such an operation). Moreover, the nature of their products, i.e., fresh organic vegetables produced from a known source, is such that consumer loyalty and "brand" recognition make consumers captive to a given farm. In fact, many consumers value the non-market benefit of feeling they are supporting local agriculture and sharing the risks and rewards of farming in addition to the tangible benefits of fresh produce during the season. Many CSA farms enhance the sense of community by hosting additional events for their shareholders during the season and by offering reduced-price shares. These reduced-price shares may be in exchange for labor, or may be offered to low-income buyers. As such, produce purchased at the grocery store is a poor substitute for the produce provided in a CSA share.

Assume that a CSA farm seeks to solve the following maximization problem:

$$\max_{q} \pi = p\left(q, \mathbf{Y}\right)q - C(\mathbf{r}, q, \mathbf{E}) ;$$

where $p(q,\mathbf{Y})$, the inverse demand facing the farm, is a function of q, the number of shares sold, and $\mathbf{Y}$, a vector of exogenous demand shifting variables. $C(\mathbf{r},q,\mathbf{E})$ is the total cost of producing the agricultural goods sold, where $\mathbf{r}$ is a vector of input prices and $\mathbf{E}$ is a vector of exogenous factors that affect farm production. Shares are sold during the winter and each share allows a consumer to pick up a quantity of fresh produce each week through the summer. Having sold shares prior to planting, the farmer can plan production accordingly.

We obtain the first-order conditions for the profit maximization problem and solve for the share price to determine the supply relation:

$$p = -\frac{\partial p(q, \mathbf{Y})}{\partial q} \lambda q + \frac{\partial C(\mathbf{r}, q, \mathbf{E})}{\partial q}; \tag{1}$$

where the parameter λ is an index of departure from perfect competition and varies between 0 (perfect competition) and 1 (monopoly). Although we assume each farm is in a position to exercise monopoly power, we estimate λ to examine the extent to which farms choose to exercise market power. If the farmer has altruistic feelings towards her shareholders, she may seek to forgo some or all of her monopoly rents in the interests of her shareholders.

The value of the market power parameter is obtained by estimating simultaneously the supply relationship and the demand equation. There are two methods to identify the parameter λ. The first method is a production theoretic approach following the work of Appelbaum (1982) where the demand equation and supply relation are estimated together with factor demand equations. The second method identifies the market power parameter through rotation of the demand curve (Bresnahan, 1982; Lau 1982). Bresnahan (1989), Sexton and Lavoie (2001), and Sheldon and Sperling (2003) provide overviews of these two approaches. Applications to agricultural product markets are provided by Buschena and Perloff (1991), Love and Murniningtyas (1992), and Azzam and Park (1993). According to Sexton and Lavoie (2001), the choice of the identification principle depends on the specific application and the types of data available. The demand rotation method requires the presence of an exogenous variable that interacts with price to determine demand. For example, changing socio-economic

characteristics of the market faced by a CSA will cause the demand curve to shift allowing identification of both demand and marginal cost parameters (Sheldon and Sperling, 2003).

Assume that the demand equation takes the following linear functional form:

$$q = \alpha_0 + \alpha_1 p + \alpha_2 p * Y_1 + \boldsymbol{\alpha_3 Y_2} + \varepsilon_d \,. \tag{2}$$

Thus, Y_1 is the exogenous variable that rotates the demand curve and will allow λ to be identified. The vector $\mathbf{Y_2}$ includes other exogenous variables that affect demand.

Assume that marginal costs of production for CSA shares also take a linear form:

$$MC \;=\; \beta_0 + \beta_1 q + \boldsymbol{\beta_2 r} + \boldsymbol{\beta_3 E}\,; \tag{3}$$

where **r** and **E** represent the input price vector and a vector of other exogenous factors that affect CSA share production. Using equations (2) and (3), the supply relationship (equation (1)) can be re-written as:

$$p = \lambda q * + \beta_0 + \beta_1 q + \boldsymbol{\beta_2 r} + \boldsymbol{\beta_3 E} + \varepsilon_s \,, \tag{4}$$

where $q* = -\dfrac{q}{\alpha_1 + \alpha_2 Y_1}$.

Equations (2) and (4) form a system of equations that can be estimated simultaneously.

Data

Survey data were obtained by mail from Northeastern CSA farms during 1995, 1996 and 1997.[2] Detailed data were obtained about farm and farmer characteristics, revenue from CSA shares, other sources of farm revenue, farm costs, and the CSA share of farm costs. There were a total of 82 respondents during the three-year period; some farms participated in all three years of the survey.[3] Table 1 presents summary characteristics of

the CSA farms that responded. These are small farms by conventional measures and all were vegetable crop farms. The average amount of cropland was between 18.7 (1997) and 23.2 acres (1996). The amount of cropland used for the CSA operation was typically about half the total available. CSA farmers are relatively young, on average about 38 years of age, and educated with the majority having a college degree. Experience, an additional measure of human capital, was measured by the total number of years of farming experience (all farm experience) and the number of years of experience on their current farm. The latter measure is closely correlated with the number of years of experience producing organically. These farmers typically had between 11 and 12 years of experience farming, with between six and eight of those years on their current farm.

CSA farmers may make all decisions themselves, or may seek the guidance of a "core group." The core group is a subset of CSA shareholders that meet with the farmer to discuss and advise on issues of share content, price, and other CSA organizational matters. Core groups may take a passive or advisory role in CSA management by meeting with the farmer to discuss shareholder concerns or desires. Or, the core group may take a very active role in organization, promotion, and management of the CSA. Almost half of the Northeast CSA farms in this sample (48 percent) had a core group.

The different types of shares offered by the CSA farms that responded are also listed in Table 1. The predominant type of share was the full non-working share, i.e., a share that typically feeds three to four individuals with no CSA farm work commitment required of the shareholder.[4] A half share contains about half of the produce of an individual share, which typically feeds one or two people. Some farms also offered other share types; relatively few "other" shares were sold. These shares were quite varied in

content ranging from senior shares (a share of reduced quantity and price for senior citizens) to institutional shares that may serve a large group of people.

A standard measure of output was determined for all farms by transforming the seven types of shares into equivalent numbers of full shares. The number of shares for each type of working share sold was weighted by that share price relative to the price of a full working share for each farm. Similarly, the numbers of non-working shares were weighted by their share prices relative to the price of a full non-working share. These weighted shares were then summed to determine the total number of *full-share-equivalents*, which is used as a unit of output. Share prices were assumed to reflect differences in both quantity of product and the variety of product in shares. On average, CSA farms produced a total of 75 *full-share-equivalents* in 1995 weighing about 374 pounds.[5] In 1996, a total of 77 full-share-equivalents averaging about 330 pounds were sold on average. In the final survey year, 1997, 88 full-share-equivalents were sold with an average estimated weight of about 324 pounds.

A summary of CSA farm revenues, costs and net incomes appears in Table 2. Revenues were calculated based on sales of CSA shares. Many farms sold produce through other outlets such as farmers' markets. CSA respondents were asked to list specific costs associated with farm production and the percent of expenses that should be allocated to the CSA operation. In each of the three survey years, average net income was positive ranging from $2,724 in 1995 to $8,820 in 1997. On a per-share basis, the CSA farms surveyed earned about $36 per share in 1995 and about $95 per share in 1996 and 1997. The CSA farms in this sample apparently improved their net income position over the three years of this study.

Estimation and Results

Estimation of the demand function required socio-economic characteristics of the markets served by each CSA farm. We defined each market as the community in which the CSA farm was located. Community characteristics were measured using 1990 U.S. Census data for minor civil divisions or MCDs (e.g., townships) where available. If MCD data were not available for a specific farm location, Census designated place data were used. The data collected included population density, median household income, and percentage of high school and college graduates. These community characteristics and variables related to the operation of the CSA, which are included in the supply relationship equation, are described in more detail in Table A of the appendix. Table B of the appendix provides descriptive statistics for the variables used in estimation. Given the cross-sectional nature of these data, we assume a common demand and cost structure across markets and farms respectively. Thus, the estimated parameters represent the parameters of common demand and cost functions for all CSA farms.

The model was estimated using pooled time series and cross-sectional data. All income, revenue and cost data were deflated to 1995 using the Consumer Price Index; tests conducted supported pooling all observations. We tested for the presence of heteroskedasticity as well; results of the chi-square test led us to conclude heteroskedasticity was not an issue with our model. The estimation of a structural model (demand and supply relationships) allows estimation of the degree to which CSA farms exert monopoly power. Identification was obtained by interacting share price and median income in the demand equation. Estimation of the demand and supply relationship system

was done using a two-step procedure. The demand relationship was estimated and the parameters were used to create the variable q^* (see equation (4)). This variable and quantity (q) were included in the final supply relationship. Both q^* and q are endogenous and two-stage least squares was used to estimate the final supply relationship.

Estimates for the structural model, both demand and supply relationships, are presented in Table 3. CSA farms do appear to exert market power, albeit very little. The estimated market power parameter is 0.02. While the estimated market power parameter was statistically different from zero, it suggests CSA farms exert very little market power, only about two percent of that of a monopolist.[6]

The coefficients of demand-side variables are mostly as expected. Share price has the expected negative sign, but does not appear statistically different from zero. However, including both share price and the interaction of share price and median income leads to a troublesome degree of multicollinearity. The partial effect of price on demand, which combines the price effect as well as the interaction, is negative and results in a price elasticity of demand of –0.245 when evaluated at the means of quantity, price and income. The effect of income on demand was negative, although not statistically different from zero. Income may be a proxy for the amount of spare time available. Thus, the negative effect of income, an elasticity of –0.22 determined using the partial effect, would indicate that has income increases, there is less time to learn to prepare and to cook the large of amount of produce in a share, thus reducing the demand for CSA shares. The standard errors for income, as well as those for all other estimated parameters, did not suffer from multicollinearity as did the estimates for the price and price-income interaction variables.

The percentage of high-school graduates has a negative and significant effect on demand. The coefficient indicates that an increase in the percentage of high school graduates by one percent results in a decrease in demand by 2.44 shares. The coefficient for the percentage of college graduates is positive, but not statistically significant. While multicollinearity does not appear to be a problem between these variables and median income, these two variables may capture some of the income effects on demand. The positive coefficient of the percentage of college graduates may represent the effects of higher income on demand for that cohort. The estimated effect of a higher percentage of residents with a college degree would indicate that having a higher education results in a greater demand for CSA shares. More education may be associated with greater awareness of nutrition and a preference for organic produce and, thus, a greater demand for local fresh organic vegetables. Higher levels of education may also be associated with an appreciation for the issues surrounding family farms and the benefits of agriculture to the community.

Population density is statistically significant and positively affects demand for CSA shares. Population density indicates greater potential demand for the CSA within their market area. Consumers living in more densely populated areas are also likely to have a greater demand for CSA shares because they may have less space for a garden and may enjoy the access to the farm outdoor space. Having a core group increases the demand by about 105 shares, most likely because of stronger interactions between the CSA and the community through additional events and services organized by the core group. Finally, binary variables were included for two of the three years that CSA data were collected (1996 and 1997; 1995 was used as the base year). The estimated effects of

the binary variables for 1996 and 1997 are statistically insignificant confirming our pooling tests for these three years of data.

Two estimated coefficients were statistically significant and the signs were as expected in the supply relationship. The estimated market power parameter was statistically significant and indicates that CSA farmers exerted only about two percent of the market power of a monopoly. In previous research, Cooley and Lass found that CSA share prices provided important consumer benefits. The CSA ideology is that farmers earn a return that covers all costs and provides a living wage. Our results suggest that CSA farmers can ensure that they do cover all economic costs of production, include a fair wage for the farmer. This result is encouraging when we consider that most farmers act as the residual claimant to profits that are typically low or non-existent.

Core group farms have higher share prices by about $155 per share. We find that core group farms are typically larger farms with a more stable shareholder base and possibly a waiting list. Core groups are a group of shareholders who are typically committed to the CSA ideal and value the farmer's commitment and services. They may be more willing to compensate the farmer for her efforts. The core group helps the farmer with organization and promotion of many CSA activities that enhance the CSA. These activities may increase demand, but may also imply additional costs. Two variables in the model represent the effects of changing size and scale, quantity and CSA cropland acreage. The effects of these two variables are *a priori* unknown. The negative estimated effect of CSA quantity (number of shares) suggests that greater output leads to a decrease in marginal costs. A change in the scale of the operation, through increased cropland, has a positive effect on price. As CSA cropland acreage is increased, *ceteris paribus*,

marginal costs shift upward suggesting decreasing returns to scale for these CSA farms. This positive effect makes sense given the importance of the labor input for these organic producers.

The primary farmer's all-farm experience has a negative impact on the share price. Having more farm experience is associated with a lower cost of operation and a lower share price. Current farm experience has a positive effect on share price. Current farm experience is more closely associated with the farmers experience as an organic producer, which may lead to higher marginal costs. Current experience is also more closely associated with the farmer's experience as a CSA farmer, which may also imply higher marginal costs. Consistent with expectations, the effect of education, an additional human capital measure, is to reduce marginal cost. However, the estimated effect is not statistically different from zero.

Summary and Conclusions

CSA is an alternative form of marketing. Most CSA farms are small vegetable farms that provide shareholders fresh organic produce through the growing season. CSAs strive to develop a loyal and stable customer base (shareholders) that will reduce (or ideally eliminate) the need to market their product each year. CSAs thus try to capture a share of the local market for fresh produce and set the price of a share each year. Using pooled cross-section time-series data for a sample of Northeast CSA farms, we found that CSA farms are able to dictate prices, but they appear to exert a small degree of monopoly power in the choice of share prices. CSA farms only exert about two percent of their potential monopoly power. While the estimated market power parameter was statistically

different from zero, we might question whether the magnitude is economically significant. However, exertion of a limited degree of market power exerted increases the profitability of family farms. Our results suggest that CSA farmers can command a fair price for their product, a price that covers all production costs and a fair wage for the farmer. Moreover, CSA farms use sustainable production methods and are committed to building a relationship with the community in which they operate. Our results suggest that CSA farms have the power to price above marginal costs, but for a variety of reasons, they choose to exert very little of that power. Pricing decisions by CSA farms, while dependent upon demand factors, are likely affected by altruistic feelings of the farmer towards shareholders. Thus, our findings suggest that the CSA movement in New England improves the profitability of family farms through minimal exercise of market power and provides a benefit to the community without government intervention. Future research will examine whether those findings hold at the national level.

Table 1. Farm Characteristics for the Average CSA Operation in 1995, 1996 and 1997

	1995	1996	1997
Number of Farms	23	26	33
Total Cropland (acres)	22.20	23.19	18.72
CSA Cropland (acres)	11.96	10.79	7.59
Age of Principal Farmer (years)	39.87	38.48	38.41
Education (proportion of primary farmers with a college degree)	0.74	0.85	0.82
All Farm Experience (years)	11.43	11.04	11.73
Current-Farm Experience (years)	6.22	7.00	8.24
Core Group (proportion of CSA farms with a core group)	0.48	0.42	0.48
	CSA Share Prices ($ per share)		
Non-working Shares:			
Full	416.32	412.88	352.98
Individual	326.00	298.29	270.56
Half	243.75	247.00	273.35
Working Shares:			
Full	260.67	248.89	246.39
Individual	N/A	205.00	136.25
Half	135.00	131.67	132.50
Other (Senior, Institutional)	307.50	358.33	266.43
Number of *Full Share Equivalents*	75.11	77.36	88.07
Pounds of Product per Full Share	374.17	329.85	324.20

Table 2. Costs and Revenue for the CSA Operations.

	Average $ - 1995		Average $ - 1996		Average $ - 1997	
	per Farm	*per Share*	*per Farm*	*per Share*	*per Farm*	*per Share*
Reported Revenue	$33,398	$444.77	$35,568	$460.18	$32,182	$349.65
Reported Costs	$30,674	$408.50	$28,254	$365.56	$23,362	$253.82
Net Income	$ 2,724	$ 36.27	$ 7,313	$ 94.62	$ 8,820	$ 95.83

Table 3. Estimated parameters of the structural model of Northeast CSA market power.

Variable	*Demand (Quantity)*	*Supply Relationship (Price)*
Constant	187.98*	332.342*
	(2.45)	(5.17)
Market Power	--	0.021*
		(1.96)
Quantity	--	-0.667
		(-1.31)
Price	-0.109	--
	(-0.66)	
Median Income	-0.001	--
	(-0.72)	
Price×Median Income	1.72×10^{-6}	--
	(0.47)	
% High School Grads	-2.444*	--
	(-2.21)	
% College Grads	0.976	--
	(0.60)	
Density	0.029*	--
	(3.61)	
CSA Cropland	--	2.089
		(1.38)
Education	--	-6.273
		(-0.12)
All Farm Experience	--	-5.383
		(-1.24)
Current Farm Experience	--	6.563
		(1.28)
Core Group	104.861*	155.334*
	(5.90)	(2.62)
Year 1996	8.420	24.146
	(0.42)	(0.47)
Year 1997	13.830	-50.226
	(0.72)	(-0.99)
R^2	0.487	0.260
F	7.59*	2.81*

* Indicates variables that are statistically different from zero at the five percent level of significance.

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Appendix

Table A: *Variable descriptions.*

Variable	*Description*
Quantity	The total number of shares sold expressed as full shares, also called *full-share-equivalents*. The variable is calculated as a weighted average of different share types where the weights are the share prices relative to the price of a full non-working share.
Price	The price of a full non-working share ($/share).
Median Income	The median income is the town-level median income from the 1990 U.S. Census (dollars).
Price×Median Income	This is an interaction term. The full non-working share price is multiplied by the town-level median income. This variable allows identification of the market power parameter in the structural equation model.
High School Grads	The percentage of the town population with a high school degree as their highest level of education attained.
College Grads	The percentage of the town population with a college degree as their highest level of education attained.
Density	The number of people per square mile.
CSA Cropland	The number of acres of cropland used for the CSA operation.
Education	A binary variable that takes the value of one if the farmer has a college degree and zero otherwise.
All Farm Experience	The number of years of farming experience of the farm operator.
Current Farm Experience	The number of years of experience of the farm operator on the current farm.
Core Group	A binary variable that takes the value of one if the CSA has a core group. A core group is a subset of the shareholders who meet with the farmer to discuss share content, share price, and other CSA management/social issues.
Year 1996	Binary variable: 1 if 1996 data, 0 otherwise.
Year 1997	Binary variable: 1 if 1997 data, 0 otherwise.

Table B. Descriptive statistics for variables used in estimation.

Variable	***Mean***	***Standard Deviation***
Quantity (number of *full-share-equivalents*)	81.04	92.02
Price ($ per full share)	386.72	180.26
Median Income ($)	33,407.37	12,803.07
High School Grads (percent)	63.18	10.78
College Grads (percent)	22.09	9.33
Density (people per square mile)	980.05	1,223.02
CSA Cropland (number of acres)	9.83	18.80
Education (proportion of primary farmers with a college degree)	0.80	0.40
All Farm Experience (years)	11.43	7.27
Current Farm Experience (years)	7.28	6.04
Core Group (proportion of CSA farms with a core group)	0.46	0.50
Year 1996 (proportion of observations from 1996)	0.32	0.47
Year 1997 (proportion of observations from 1997)	0.40	0.49

Endnotes

1. A national survey of CSA farms found that over 94 percent produced organically (Lass, et al.).

2. Respondents were from the following states: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

3. Response rates were: 46 percent, 35 percent and 33 percent, in 1995, 1996 and 1997, respectively.

4. On many CSA farms, shareholders can obtain reductions in the price of a share by working on the farm.

5. CSA respondents were asked to estimate the weight of produce contained in a full share in a typical week by month. Because the weights per share were estimates, we felt that share prices were the most accurate variables available to use as weights in creating the number of *full-share-equivalents*.

6. Initially, we estimated the model in reduced-form, i.e., price as a function of all exogenous variables. Using this method, the presence, but not the extent, of market power can be determined. In perfect competition, price equals marginal cost. Thus imposing a set of zero restrictions on exogenous demand shifters constitutes a test of perfect competition. Using a chi-square test on those restrictions, we rejected the hypothesis of perfect competition at the one percent level of statistical significance, concluding that the finding of market power is robust. In fact, the market parameter estimates varied little with changes in model specification ranging from a low of around 2 percent to just over 4 percent. While we are admitting to a limited specification search exercise, there are no other cross-sectional, firm-level analyses to guide us.