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Agricultural Contracts and Alternative Marketing Options: A Matching Analysis

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The increasing use of agricultural contracts and processor concentration raises concerns that processors may offer lower contract prices in absence of local competition. This study examines the price competitiveness of marketing and production contracts depending on the availability of alternative marketing options. A propensity score matching method is used to compare prices using contract data from a farm-level national survey. The results show that the absence of other contractors or spot markets in producers' areas does not lead to statistically significant price differences in agricultural contracts for most commodities, providing evidence that most agricultural processors do not exercise market power by reducing prices when other local buyers are not available.

Key Words: agricultural prices, alternative marketing options, local competition, marketing contracts, production contracts, propensity score matching

JEL Classification: Q13

Some of the key trends in the industrialization of U.S. agriculture include tighter supply chains with greater concentration of production on a decreasing number of farms, more vertical coordination in the production and marketing system, and significant concentration downstream from the farm (Ahearn, Korb, and Banker, 2005). The increased use of agricultural contracts is one of these significant structural changes in organizing the production and marketing of crop and livestock commodities. For instance, in 2003 producers used marketing and production contracts to market 39% of the value of U.S. agricultural production, up from 28% in 1991 and 11% in 1969 (MacDonald and Korb, 2006). According to United States Department of Agriculture statistics, the concentration of the food manufacturing industry has also been increasing with the mean industry four-firm concentration ratio increasing from 35% in 1982 to 46% in 1997. An important policy question is whether the increased concentration in the processing industry and the increased use of agricultural contracts are a desirable result of cost efficiencies in production or the undesirable effect of market power from the agribusiness processors (Ahearn, Korb, and Banker, 2005).

Agricultural contracting is typically studied using the principal-agent economic framework. In this framework, using contracts instead of spot markets can include improved risk management and reduce production and transaction costs. Despite these benefits, the increased use

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of agricultural contracts raises concerns that contractors may exploit market power by deterring other contractors from entering a local market, setting quality standards and timing of input provisions for production contracts, or by reducing the prices paid for agricultural commodities, especially when there is little competition from other local buyers. MacDonald et al. (2004) argue that there is little evidence that contractors interact with each other or control spot market prices. Yet contracting in the livestock industry is particularly controversial where a few meatpackers handle most of the livestock purchases while quantities sold on the spot markets continue to decrease. In response to these concerns, Congress has passed laws and considered proposals in an effort to regulate livestock contracts and require mandatory price reporting.

The literature examining agricultural contracts is relatively small mostly due to the fact that data on commodity contracts are scarce. Most empirical studies examining marketing and production contracts have explained the factors affecting the adoption of various types of contracts (e.g., Davis and Gillespie, 2007; Katchova and Miranda, 2004) or have made comparisons between contract and independent producers (e.g., Key, 2004, 2005; Wang and Jaenicke, 2006; Xia and Sexton, 2004; Zhang and Sexton, 2000). Many studies have examined market power in the processing industries, finding that processors exercise market power but the price distortions are small in magnitude. These studies have typically estimated the new empirical industrial organization structural models with aggregate industry-level data (for an overview see Sexton, 2000). However, because of the spatial nature of agricultural production, transportation costs, and commodity perishability, many farmers are restricted to selling their production within their geographic areas. Therefore, instead of examining competition among the largest processors, this study proposes a new approach to examine price distortions due to processor concentration, where competition from local buyers such as other contractors and spot markets play an important role. In other words, this study examines agricultural contracting from a farmers' perspective using farm-level data rather than from a processing industry's perspective supported by industry data.

The objective of this study is to examine whether agricultural processors exercise market power in price setting by testing for statistically significant price differences in absence of competition from other local buyers. The propensity score matching method is used to compare contract prices, after first matching contracts on their propensity score to ensure comparisons of contracts with similar characteristics. The empirical models are estimated with contract data for several crop and livestock commodities using a farm-level national, representative survey. The analyses are conducted from a farmers' perspective by examining agricultural contracts and comparing their price competitiveness based on alternative marketing options available to farmers. The main contribution of this study is evaluating the consequences of increased processor concentration on agricultural contract prices using an innovative methodology of propensity score matching. The results reveal important insights into the price competitiveness of agricultural contracts and market power in price setting exercised by commodity processors.

Propensity Score Matching Method

The propensity score matching method was first suggested by Rosenbaum and Rubin (1983). While this method has been extensively used in other fields, this is one of the first studies in agricultural economics to apply it to study the price competitiveness of agricultural contracts.[1] The method is designed to estimate the average effects of a program, treatment, or regime, between treated and control units. When data come from observational studies as opposed to experimental studies, the assignment of units to treated and control groups is not random, and therefore the estimation of the

[1] Only three other agricultural economics studies were found that used the propensity score matching method to examine farmland price differences (Lynch, Gray, and Geoghegan, 2005), food aid (Gilligan and Hoddinott, 2007), and credit constraints (Briggeman, Towe, and Morehart, 2009).

effect of treatment may be biased due to the existence of confounding factors. The propensity score matching method reduces the bias in comparisons between the treated and control groups. This is accomplished by comparing outcomes for treated and control units that are as similar as possible. Treated and control groups are matched to eliminate the effects of the confounding factors. Because it is infeasible to match units based on a multidimensional vector of characteristics, these characteristics are summarized using a single-index variable, called a propensity score. After the propensity score is calculated, the units from the treated and control groups are matched based on their propensity score in order to compare the differences in outcomes between the two groups.

The goal is to estimate the difference between the prices received for agricultural contracts that have competition from other local buyers (the treated group) and those that do not (the control group), accounting for the effects of exogenous factors influencing the assignment of contracts into one of these two groups. In order to evaluate the effects of the availability of alternative marketing options on contract prices, all analyses are conducted with data at the contract level for various commodities. For each commodity, we observe n contracts, indexed by $i = 1\ldots n$. In our context, the outcome variable Y is the price received for an agricultural contract of a particular commodity, and the treatment D is whether the farmer has alternative marketing options through other local buyers. The survey question considered two categories of other local buyers: other contractors and spot markets. The treatment D is defined as a binary variable, where $D = 1$ for farmers having other local contractors and $D = 0$ for farmers who do not have other local contractors in their areas. The analysis is then repeated with spot markets instead of other contractors, with $D = 1$ for farmers with spot markets in their areas and $D = 0$ for farmers without local spot markets. The third analysis combines the two categories with $D = 1$ for farmers with either local contractors or spot markets in their areas and $D = 0$ for farmers without any alternative marketing options.

For each agricultural contract for a particular commodity (representing unit i), Y_i^T is the price received when other local buyers are present (the outcome under active treatment) and Y_i^C is the price received when other local processors are not available (the outcome under control treatment). For any agricultural contract, only one of these outcomes is observed, therefore each contract is uniquely assigned into either the treated group (T) or the control group (C). In addition, each contract has a vector of characteristics (i.e., covariates, pretreatment, or exogenous variables) denoted by X_i. These characteristics represent variables that are likely to influence the outcome (price), such as a geographic location and farm and contract characteristics.

More formally, the price outcome Y can be expressed as:

$$(1) \qquad Y_i = \begin{cases} Y_i^C \text{ if } D=0, \\ Y_i^T \text{ if } D=1. \end{cases}$$

The propensity score is defined by Rosenbaum and Rubin (1983) to be the conditional probability of receiving treatment given pretreatment characteristics,

$$(2) \qquad p(X) = \Pr(D=1|X) = E(D|X).$$

This propensity score is used to match treated and control units in order to estimate the difference in outcomes, also known as the Average Treatment Effect on the Treated (ATT):

$$(3) \qquad \begin{aligned} ATT &= E\left(Y_i^T - Y_i^C|D=1\right) \\ &= E\left(E\left(Y_i^T - Y_i^C|D=1, p(X_i)\right)\right) \\ &= E\left(E\left(Y_i^T|D=1, p(X_i)\right)\right. \\ &\quad \left. - E\left(Y_i^C|D=0, p(X_i)\right)|D_i=1\right). \end{aligned}$$

More specifically, the ATT is the difference between two terms with the first term being the outcome for the treated group which is observable and the second term being the outcome for the treated group had it not been treated, representing a counterfactual situation which is unobservable and needs to be estimated. Here, we are interested in the difference between the prices for contracts with alternative marketing options and the prices they would have received have they not had alternative marketing options.

The propensity score $p(X_i)$ is used to match treated and control units as closely as possible based on their characteristics X_i.[2] However, the probability of two units having exactly the same propensity score is zero, since the propensity score is a continuous variable. Various matching methods have been suggested to overcome this problem. The kernel matching and nearest neighbor matching methods are used in this study to match treated and control units and to check if the results are robust with respect to different matching methods. The two matching methods offer tradeoff between quantity and quality of the matches and none of them is a priori superior to the other (Becker and Ichino, 2002).

With kernel matching, each treated observation is matched with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of the treated and control units. The difference between the outcomes for the treated and control units, ATT^K, is calculated as follows:

$$(4)\qquad ATT^K = \frac{1}{n^T}\sum_{i\in T}\left[Y_i^T - \frac{\sum_{j\in C} Y_j^C G\left(\frac{p_j - p_i}{h_n}\right)}{\sum_{k\in C} G\left(\frac{p_k - p_i}{h_n}\right)}\right],$$

where n^T is the number of treated units, p_i is the propensity score of unit i, $G(\cdot)$ is a kernel function, and h_n is a bandwidth parameter. In this study, the default bandwidth parameter is used so all controls are used as matches.

With nearest neighbor matching, each treated unit i is matched with one control unit j that has the closest propensity score. The nearest neighbor matching set of control units is given by:

$$(5)\qquad C(i) = \min_j \left\| p_i - p_j \right\|.$$

The method is applied with replacement (i.e., a particular control unit can be a best match for several treatment units). After matching treated and control units, the difference between the outcome of the treated units and outcome of the matched control units, ATT^{NN}, is calculated as follows:

$$(6)\qquad ATT^{NN} = \frac{1}{n^T}\sum_{i\in T}\left(Y_i^T - \sum_{j\in C(i)} w_{ij} Y_j^C\right),$$

where the weights $w_{ij} = 1$ if $j \in C(i)$ and $w_{ij} = 0$ otherwise. There is no bandwidth imposed for this matching method.

The quality of the matches can also be improved by imposing a common support restriction, when control units are included in the analysis only when their propensity scores fall within the range of propensity scores for the treated units. A drawback of the common support is that high quality matches near the boundaries of common support may be lost and the sample size may be considerably reduced. Analyses with and without common support are used to test for the sensitivity of results. The results reported in the results section do not use the common support restriction.

Two key assumptions are employed by the propensity score matching method. The unconfoundedness assumption states that if the assignment to treatment is unconfounded, that is,

$$(7)\qquad Y^T, Y^C \perp D|X,$$

then the assignment to treatment is unconfounded given the propensity score, that is,

$$(8)\qquad Y^T, Y^C \perp D|p(X).$$

Put differently, the unconfoundedness assumption asserts that characteristics that may affect the outcomes are observable and included in the model. This is an implicit assumption used in the estimation of all economic models.

If the conditional independence assumption holds, Y^C, the outcome for the controls ($D = 0$), can be assigned to the corresponding treated observations ($D = 1$) as their unobserved counterfactuals using certain matching techniques. The weaker conditional independence assumption uses

$$(9)\qquad \begin{aligned} &E(Y^C|D=1, X) = E(Y^C|D=0, X),\\ &P(D=1|X) \in (0,1) \end{aligned}$$

to estimate the average treatment effect. This assumption is commonly used in the econometrics literature (Heckman, Ichimura, and Todd, 1998).

The propensity score matching method has two major advantages. First, the method compares prices for contracts with similar

[2] Balancing tests are conducted to test for the equality of means for the conditional variables for the treated and control units. Stata tests were used for the balancing property before the matching procedure by dividing the sample into strata with similar conditional variables. To the extent that some of the matches may come from different strata, the results may be biased.

characteristics, after first matching on their propensity scores. Second, unlike the traditional Heckman approach, the propensity score matching is a semiparametric approach with step one being a parametric estimation of the propensity score and step two being a nonparametric estimation of the ATT price differences and therefore it does not assume a particular functional form for the price variable. Price comparisons for treated and control contracts are first analyzed using simple *t*-tests without controlling for exogenous factors. Then propensity score matching models are estimated, after matching contracts on their propensity scores.

Data and Simple Comparisons

Data are obtained from the Agricultural Resource Management Survey (ARMS), which is conducted annually by the U.S. Department of Agriculture. The ARMS data include detailed information on marketing and production contracts used by farmers to sell their crop and livestock commodities. Farmers identified the price, quantity, and value for each commodity sold with marketing or production contracts. The main version (version 1) of the survey also includes more detailed questions about the specifications of the contracts such as the quantity and pricing mechanisms, and characteristics of the contractors. Respondents also reported whether they had alternative marketing options, including whether there were other contractors in their areas (these questions were asked in the survey years 2003–2005) and spot markets (data available for 2004–2005).[3,4] The question about the spot market availability was not included in 2003. Therefore, due to data availability, the analyses are conducted with ARMS data for 2003–2005 for the first analysis based on the availability of other contractors and for 2004–2005 for the second and third analysis based on the availability of spot markets and other alternative marketing options (either contractors or spot markets). The ARMS data also include survey weights indicating the number of farms in the United States that each farm in the survey sample represents. All estimations are weighted so that the results are representative of all marketing and production contracts used by U.S. producers. The standard errors account for the sampling weights using the bootstrap method.

Several commodities are considered depending on whether there were a sufficient number of contracts in the data to support the estimations. The criteria for inclusion were commodities that had at least 200 contracts in the data set over the 3 years (2003–2005) and that the contracts were of the same type (production or marketing) and the same measurement unit for the quantity marketed. Based on data availability, the study includes marketing contracts for corn for grain, soybeans, winter wheat, upland cotton, and milk and production contracts for broilers.

Table 1 shows the number of contracts included in the ARMS data for each commodity, the number of “treated” contracts with alternative marketing options (other contractors or spot markets), the number of “control” contracts without alternative marketing options, and the proportion of contracts with alternative marketing options. There are over a thousand contracts in the sample reported for corn, soybeans, milk, and broilers for 2003–2005. The availability of alternative marketing options differs based on the commodities farmers produce. Most farmers producing crops have both other local contractors and local spot markets. About two-thirds of the marketing contracts for corn, soybeans, wheat, and cotton were located in areas with other contractors, and even higher proportion of these contracts (about 83–95%) had local spot markets. About 77% of milk marketing contracts had other local contractors,

[3] The survey question asked producers, “If you had not had this contract, what other marketing options would you have had in your area for marketing this commodity?” Four codes were provided as answers: (1) none, (2) both cash sales and other contractors, (3) only cash sales, and (4) only other contractors. These four codes were regrouped into contracts having other local contractors versus those that do not, and contracts having local spot markets versus those that do not.

[4] A reviewer pointed out that there may be a self-selection bias associated with farmer’s ability and information to find other contractors or spot markets. These unobservable characteristics as well as information about the characteristics of the local markets are not controlled for due to data limitations.

Table 1. Descriptive Statistics for Agricultural Contracts

Commodity	Type of Contract	Number of Represented Contracts[a]	Number of Contracts	Number of Treated Contracts[b]	Number of Control Contracts[c]	Percent Contracts Having Alternative Marketing Options
Contracts with versus without Other Local Contractors[d]						
Corn	Marketing	236,964	1,154	800	354	66%
Soybeans	Marketing	181,650	1,151	802	349	65%
Wheat	Marketing	27,722	281	197	84	69%
Cotton	Marketing	23,056	342	238	104	71%
Milk	Marketing	75,398	1,194	882	312	77%
Broilers	Production	45,961	1,264	561	703	49%
Contracts with versus without Local Spot Markets[d]						
Corn	Marketing	186,133	889	827	62	95%
Soybeans	Marketing	139,859	866	795	71	88%
Wheat	Marketing	21,691	205	184	21	89%
Cotton	Marketing	21,261	303	237	66	83%
Milk	Marketing	52,834	884	241	643	23%
Broilers	Production	30,130	910	28	882	3%
Contracts with versus without Alternative Marketing Options[d]						
Corn	Marketing	186,133	889	851	38	98%
Soybeans	Marketing	139,859	866	815	51	91%
Wheat	Marketing	21,691	205	191	14	92%
Cotton	Marketing	21,261	303	277	26	93%
Milk	Marketing	52,834	884	676	208	78%
Broilers	Production	30,130	910	333	577	39%

[a] The ARMS data include survey weights to make contracts in the sample representative of all agricultural contracts in the United States.
[b] Treated contracts are contracts with local contractors/spot markets.
[c] Control contracts are contracts without other contractors/spot markets.
[d] Because of data availability, the top part of the table include data for 2003–2005 and the bottom two parts include data for 2004–2005.

but only 23% had local spot markets. About half of the contracts for broilers were located in areas with other contractors, while only 3% of them had local spot markets. Because poultry producers have almost nonexistent spot markets, comparisons based on the availability of local spot markets are not done for this commodity.

Before applying the propensity score matching approach, simple t-tests are used to compare contract prices for the treated group of contracts with alternative marketing options and the control group of contracts without other local buyers. In order to eliminate the effects of price outliers, contract prices for each commodity are censored at the 1st and 99th percentiles. The qualitative results are similar without price censoring.

Table 2 shows for each of the commodities the average price for all contracts, the average prices for the treated and control groups of contracts, the price differences between the two groups, the price differences expressed as a percent of the average price for all contracts, and t-tests for the significance of these price differences. The simple t-tests show that most commodities do not have statistically significant contract price differences depending on the availability of alternative marketing options. Significant differences at the 5% level are found for corn contracts, which have 3.8% higher prices when there are other local buyers. These simple

Table 2. Comparing Contract Prices Using *T*-tests

Commodity	Unit	Average Price ($ per unit)	Average Price for Treated Contracts[a]	Average Price for Control Contracts[b]	Price Differences	Percent Price Differences[c]	*t*-statistics
Contracts with versus without Other Local Contractors							
Corn	Bushel	2.46	2.50	2.40	0.09	3.8%	2.49
Soybeans	Bushel	6.46	6.44	6.51	−0.07	−1.1%	−0.73
Wheat	Bushel	3.43	3.43	3.42	0.01	0.2%	0.09
Cotton	Pound	0.54	0.55	0.52	0.02	3.8%	0.74
Milk	Cwt	14.57	14.62	14.41	0.20	1.4%	0.49
Broilers	Head	0.26	0.26	0.26	0.00	−1.3%	−0.50
Contracts with versus without Local Spot Markets							
Corn	Bushel	2.49	2.50	2.32	0.18	7.4%	1.87
Soybeans	Bushel	6.56	6.54	6.72	−0.18	−2.8%	−1.30
Wheat	Bushel	3.44	3.46	3.30	0.16	4.6%	1.84
Cotton	Pound	0.53	0.53	0.56	−0.03	−6.0%	−1.44
Milk	Cwt	15.44	15.35	15.46	−0.11	−0.7%	−0.34
Contracts with versus without Alternative Marketing Options							
Corn	Bushel	2.49	2.49	2.41	0.09	3.4%	1.14
Soybeans	Bushel	6.56	6.55	6.59	−0.04	−0.6%	−1.39
Wheat	Bushel	3.44	3.44	3.40	0.04	1.2%	0.64
Cotton	Pound	0.53	0.53	0.54	−0.01	−2.4%	−0.61
Milk	Cwt	15.44	15.56	14.62	0.94	6.1%	1.68
Broilers	Head	0.26	0.27	0.26	0.01	1.5%	0.61

[a] Treated contracts are contracts with local contractors/spot markets.
[b] Control contracts are contracts without other contractors/spot markets.
[c] Percent price differences are price differences between the treated and control groups as a percent of the average prices for each commodity.

t-test results for groups of contracts with and without alternative marketing options provide evidence that most contractors do not exercise market power by offering lower contract prices in absence of competition from other local buyers.

The results from the simple *t*-tests may be biased because the assignment of contracts into the treated group (with other local buyers) and the control group is not random. If confounding factors, such as the geographic location and farm and contract characteristics, affect both the contract's propensity for having alternative marketing options and contract prices, then such factors need to be incorporated in the analysis before contract prices are compared. Several factors are hypothesized to affect the contract's probability of having alternative marketing options and/or contract prices. The geographic region where the farm is located and the year the commodity is marketed may determine the availability of access to other buyers as well as the prices received for the commodities. Five regions are considered: the South, chosen as the reference dummy variable, the Midwest, the Plains, the West, and the Atlantic region. Indicator variables for different years are also included in the models. Contract characteristics such as the quantity marketed with each contract, whether the contract specified premiums tied to commodity attributes, contract length, and whether the contractor is a cooperative or a privately owned processor may affect access to markets and contract prices. Finally, farm characteristics such as farm size and farmer age and education are included in the models. Descriptive statistics of these conditioning variables are provided in Table 3.

Propensity Score Matching Results

The propensity score matching methodology involves a two-step estimation. The first step

Table 3. Descriptive Statistics

Units of Measurement	Unit of Measurement	Corn Bushel	Soybeans Bushel	Wheat Bushel	Cotton Pound	Milk Cwt	Broilers Head
Contract Price	Dollars per unit	2.46	6.46	3.43	0.54	14.52	0.26
Contract Quantity	Units	19,677	6,379	9,006	392,151	29,378	450,164
Contract Premiums	Proportion of contracts that pay contract premiums	0.18	0.25	0.29	0.29	0.69	0.61
Contract Length	In months	5.13	4.76	4.00	7.03	6.09	18.21
Cooperative	Proportion of contracts with cooperatives	0.50	0.43	0.34	0.29	0.79	0.07
Farm Assets	Total assets in dollars	1,493,486	1,305,235	1,424,432	1,295,843	1,792,529	1,005,086
Operator Age	In years	51	52	52	56	50	53
Operator Education	Categorical variable from 1 to 5	2.79	2.52	2.55	2.61	2.07	2.31
Midwest Region	Proportion of contracts in this region	0.71	0.75	0.54	0.01	0.23	0.02
Plains Region	Proportion of contracts in this region	0.21	0.12	0.17	0.41	0.03	0.09
West Region	Proportion of contracts in this region	0.01	0	0.08	0.08	0.12	0.01
Atlantic Region	Proportion of contracts in this region	0.05	0.06	0.16	0.07	0.57	0.27
Year 2004	Proportion of contracts in this year	0.46	0.33	0.31	0.56	0.38	0.34
Year 2005	Proportion of contracts in this year	0.32	0.44	0.48	0.36	0.32	0.31
Observations		1154	1151	281	342	1194	1263

is to estimate a probit model for the contract's propensity to have alternative marketing options depending on contract and farm characteristics. The predicted probabilities from the probit model, also called propensity scores, are used to match each treated contract (with alternative marketing options) to one or more control contracts (without alternative marketing options). Two matching techniques are used: kernel matching and nearest neighbor matching. The second step is to estimate the ATT (average treatment effect on the treated) price differences between treated and control contracts. *T*-tests are used to conclude if these differences are statistically significant.

The first step of the propensity score matching models is to estimate a probit model for the propensity of a contract to have other local buyers based on contract and farm characteristics. The overall results and conclusions turned out to be robust with respect to several alternative specifications of the propensity score models. Table 4 presents the results from the propensity score models. Probit models are estimated for each of the six commodities (the columns in the Table 4). The dependent variable is whether or not contracts are located in areas with other local contractors in the first part of the table. In the second part of the table, the dependent variable is whether or not contracts are located in areas with local spot markets, and in the third part of the table, the analysis is based on whether contracts have either contractors or spot markets or neither of these options. The independent variables, described in the previous paragraph, are expected to affect the propensity of a contract to have alternative marketing options. The probit model results show some important differences between contracts with and without local competition. For instance, in comparison with the South, the Midwest and Atlantic regions are more likely to have other contractors for milk, whereas the Atlantic region is less likely to have other contractors for soybeans. The Midwest is also more likely to have spot markets for corn and milk in comparison with the South. The changes from year to year in local market concentration are also taken into account. Not all time dummy variables for every commodity are significant, but the ones that are significant are usually negative, indicating a trend toward less availability of other local contractors over time. In other words, this study confirms the trend of an increasing consolidation of contractors. Contract characteristics such as contract quantity, premiums tied to commodity attributes to reflect grower's effort, contract length, and type of contractor also affect the access to other local buyers for some commodities. If contracts pay price premiums associated with quality, wheat and cotton farmers are less likely to have other contractors in the area, while milk farmers are more likely to have other contractors and less likely to have spot markets in the area. The models are able to predict correctly 64–96% of the outcomes indicating an acceptable goodness of fit. Estimated coefficients and independent variables from the probit models are used to calculate a propensity score (the predicted probability from the probit model) for each contract to have alternative marketing options.

Each treated contract (with alternative marketing options) is matched to one or more control contracts (without alternative marketing options) using kernel matching or nearest neighbor matching. With kernel matching, each treated contract is matched with a weighted average of all control contracts with weights that are inversely proportional to the distance between the propensity scores of the treated and control contracts. With nearest neighbor matching, each treated contract is matched with one control contract that has the closest propensity score. After establishing a group of control contracts with as similar as possible propensity scores to the treated contracts, the contract prices in the two groups can be statistically compared.

The second step of the propensity score matching analysis involves estimating the average treatment effects on the treated (ATT), calculated as the difference between the contract prices for the treated group (with alternative marketing options) and the prices for the control group of contracts without alternative marketing options but with similar propensity scores of having other local buyers. Table 5 presents the results from the ATT price comparisons using kernel matching and nearest

Table 4. Propensity Score Models

	Corn	Soybeans	Wheat	Cotton	Milk	Broilers
Contracts with versus without Other Local Contractors						
Contract Quantity	−3.E-07	−2.E-06	3.E-06	1.E-07	2.E-06*	−4.E-08
	(2.E-06)	(5.E-06)	(6.E-06)	(2.E-07)	(8.E-07)	(1.E-07)
Contract Premiums	−0.022	−0.328	−0.903**	−0.661*	0.443*	0.257
	(0.204)	(0.200)	(0.350)	(0.262)	(0.184)	(0.164)
Contract Length	−0.016	0.022	0.029	−0.045	0.006	−0.005**
	(0.019)	(0.023)	(0.034)	(0.030)	(0.007)	(0.002)
Cooperative	0.096	0.191	−0.391	0.160	−0.324	−0.449*
	(0.169)	(0.189)	(0.344)	(0.308)	(0.228)	(0.207)
Farm Assets	2.E-07**	1.E-07*	1.E-07	5.E-08	2.E-09	1.E-07
	(6.E-08)	(5.E-08)	(9.E-08)	(7.E-08)	(1.E-08)	(6.E-08)
Operator Age	−0.010	−0.016*	−0.017	−0.011	0.008	−0.006
	(0.006)	(0.007)	(0.011)	(0.011)	(0.009)	(0.005)
Operator Education	−0.140	0.099	−0.386	0.384	0.191	0.034
	(0.097)	(0.107)	(0.202)	(0.221)	(0.119)	(0.056)
Midwest Region	0.102	−0.110	0.584	−0.358	1.063**	0.237
	(0.250)	(0.175)	(0.413)	(1.057)	(0.279)	(0.415)
Plains Region	0.058	−0.141	0.621	−0.183	0.241	−0.121
	(0.293)	(0.277)	(0.433)	(0.354)	(0.330)	(0.190)
West Region	0.007		0.096	0.427	0.311	−0.413
	(0.560)		(0.465)	(0.384)	(0.239)	(0.406)
Atlantic Region	0.270	−0.398*	−0.119	0.255	0.878**	0.086
	(0.299)	(0.203)	(0.412)	(0.525)	(0.230)	(0.124)
Year 2004	−0.714**	−1.244**	−0.418	−0.487	−0.603**	−0.900**
	(0.239)	(0.229)	(0.308)	(0.455)	(0.223)	(0.139)
Year 2005	−0.851**	−1.107**	−0.855**	−0.444	−0.308	−0.752**
	(0.257)	(0.214)	(0.318)	(0.460)	(0.199)	(0.210)
Constant	1.642**	1.848**	2.697**	1.071	−0.623	0.663
	(0.548)	(0.533)	(0.992)	(0.933)	(0.610)	(0.381)
Observations	1154	1151	281	342	1194	1263
Log Likelihood	−680	−657	−143	−176	−586	−790
Chi Square Statistic	29	58	37	21	54	68
P-value	0.01	0.00	0.00	0.08	0.00	0.00
R Square	0.08	0.12	0.17	0.15	0.09	0.10
Percent Correctly Predicted	0.69	0.70	0.73	0.70	0.74	0.66

	Corn	Soybeans	Wheat	Cotton	Milk
Contracts with versus without Local Spot Markets					
Contract Quantity	−1.E-07	−3.E-06	6.E-06	5.E-07*	−4.E-07
	(3.E-06)	(6.E-06)	(1.E-05)	(2.E-07)	(7.E-07)
Contract Premiums	−0.083	0.445	0.113	−0.421	−0.359*
	(0.299)	(0.351)	(0.367)	(0.292)	(0.178)
Contract Length	0.039	0.120*	−0.049	0.012	−0.002
	(0.035)	(0.049)	(0.041)	(0.024)	(0.010)
Cooperative	1.240**	0.021	−0.610	0.268	−0.257
	(0.248)	(0.315)	(0.463)	(0.258)	(0.262)
Farm Assets	−2.E-09	3.E-08	2.E-08	−4.E-08	2.E-08
	(5.E-08)	(7.E-08)	(1.E-07)	(5.E-08)	(1.E-08)

Table 4. Continued

	Corn	Soybeans	Wheat	Cotton	Milk
	Contracts with versus without Local Spot Markets				
Operator Age	−0.025	−0.031**	0.017	0.031**	−0.014
	(0.013)	(0.011)	(0.014)	(0.011)	(0.009)
Operator Education	−0.098	0.084	0.872*	−0.303*	0.302**
	(0.132)	(0.148)	(0.420)	(0.152)	(0.097)
Midwest Region	0.870**	0.119	0.223		0.855*
	(0.300)	(0.269)	(0.545)		(0.400)
Plains Region	0.399	−0.202	1.024	0.452	−0.148
	(0.360)	(0.402)	(0.603)	(0.325)	(0.440)
West Region			0.007	−0.034	0.030
			(0.637)	(0.388)	(0.345)
Atlantic Region	0.574	0.348	−0.150	0.504	−0.226
	(0.435)	(0.308)	(0.579)	(0.416)	(0.357)
Year 2005	0.359	0.424	0.704*	−0.519	−0.048
	(0.320)	(0.301)	(0.314)	(0.328)	(0.222)
Constant	1.939*	1.764	−1.795	−0.048	−0.367
	(0.868)	(0.916)	(1.362)	(0.760)	(0.673)
Observations	880	866	205	295	884
Log Likelihood	−129	−251	−53	−109	−388
Chi Square Statistic	67	42	20	33	52
P-value	0.00	0.00	0.08	0.00	0.00
R Square	0.23	0.20	0.25	0.21	0.18
Percent Correctly Predicted	0.93	0.92	0.90	0.77	0.78

	Corn	Soybeans	Wheat	Cotton	Milk	Broilers
	Contracts with versus without Alternative Marketing Options					
Contract Quantity	4.E-07	−9.E-07	1.E-05	2.E-07	1.E-06	4.E-09
	(3.E-06)	(6.E-06)	(1.E-05)	(2.E-07)	(1.E-06)	(1.E-09)
Contract Premiums	0.057	0.501	−0.057	−0.743**	0.418*	−0.031
	(0.331)	(0.347)	(0.336)	(0.352)	(0.249)	(0.163)
Contract Length	0.027	0.119*	0.024	0.019	−0.287	−0.001
	(0.0466)	(0.061)	(0.042)	(0.029)	(0.302)	(0.003)
Cooperative	0.751**	0.095	−0.956*	−0.146	−0.287	−0.265
	(0.231)	(0.341)	(0.521)	(0.317)	(0.302)	(0.239)
Farm Assets	−2.E-09	−4.E-09	2.E-07	−4.E-08	3.E-08	1.E-07**
	(4.E-08)	(7.E-08)	(2.E-07)	(5.E-08)	(3.E-08)	(6.E-08)
Operator Age	−0.016	−0.017*	0.014	0.035**	0.014	−0.009
	(0.016)	(0.011)	(0.016)	(0.012)	(0.010)	(0.006)
Operator Education	0.099	0.413**	1.053**	−0.161	0.364**	−0.028
	(0.107)	(0.151)	(0.425)	(0.175)	(0.155)	(0.071)
Midwest Region	0.740**	0.095	0.732		1.554**	0.723*
	(0.343)	(0.298)	(0.484)		(0.325)	(0.370)
Plains Region	0.904*	0.277	1.360**	0.375	0.064	0.125
	(0.464)	(0.516)	(0.686)	(0.381)	(0.392)	(0.224)
West Region			−0.272	0.918*	0.363	−0.627
			(0.678)	(0.476)	(0.263)	(0.552)

Table 4. Continued

	Corn	Soybeans	Wheat	Cotton	Milk	Broilers
Contracts with versus without Alternative Marketing Options						
Atlantic Region	1.377**	0.386	0.737	−0.043	0.845**	0.265**
	(0.413)	(0.343)	(0.681)	(0.438)	(0.267)	(0.132)
Year 2005	−0.005	0.225	−0.309*	0.200	0.289	0.093
	(0.372)	(0.312)	(0.368)	(0.392)	(0.319)	(0.171)
Constant	1.504*	0.485	−1.861	0.035	−1.771**	−0.011
	(0.786)	(0.829)	(1.586)	(0.808)	(0.789)	(0.359)
Observations	880	866	205	295	884	909
Log Likelihood	−75	−204	−33	−58	−398	−590
Chi Square Statistic	36	37	15	25	57	18
P-value	0.00	0.00	0.23	0.009	0.00	0.11
R Square	0.13	0.20	0.36	0.26	0.14	0.03
Percent Correctly Predicted	0.96	0.94	0.93	0.91	0.77	0.64

Note: Standard errors are in parentheses.
Single and double asterisks denote significance level of 0.10 and 0.05, respectively.

neighbor matching procedures. The top portion of the table compares contracts with and without other local contractors, the middle portion compares contracts with versus without local spot markets, and the bottom part compares contracts with versus without alternative marketing options (of either kind). The table shows the number of all treated contracts, the number of control contracts that are used as matches for the treated contracts, ATT price differences, ATT price differences expressed as a percent of the average prices, and *t*-statistics for the price comparisons. Kernel matching uses all of the control contracts, whereas the nearest neighbor matching procedure only uses a subset of these contracts that have the closest propensity scores to the treated contracts.

The ATT price differences in Table 5 are measured in dollars and are also expressed as a percent of the average contract price for all contracts and the confidence intervals are provided. The estimated ATT percent price differences are relatively small in magnitude (less than 4.2% of the average commodity price) and not statistically significant except for two commodities. Cotton contracts tend to receive significantly higher prices if located in areas with other contractors. The ATT price difference for cotton is 3.5% of the average price using both matching methods and significant at the 5% and 10% levels using the kernel and nearest matching methods, respectively. These results suggest that cotton processors may be exercising market power by offering lower prices on contracts when there are no other local contractors present.

Corn contracts located near spot markets receive 3.9% higher prices than comparable corn contracts without access to spot markets, and this difference is significant at the 5% level using both matching methods. Spot markets for corn are the most prevalent markets among commodities, with 95% of farmers having access to spot markets in addition to contracting in their areas. Therefore, corn producers with weaker bargaining positions who do not have alternative marketing options at harvest may be willing to enter contracts with lower prices. When either local contractors or spot markets are available, none of the differences are statistically significant from the contracts without alternative marketing options.

Because most of the results in this study show lack of statistically significant differences, the statistical power of the test is calculated. The power of a test shows the probability that a test will correctly identify significant differences when such significant differences exist. Here, the probabilities are calculated given the sample sizes and price variability for different commodities and several percent price differences as effect sizes. The probability to correctly detect statistically significant price differences of 3% is greater than 0.9 for corn, soybeans, and milk and to detect statistically

Table 5. Average Treatment Effects on the Treated Results

Commodity	Matching Method[a]	Number of Treated Contracts[b]	Number of Control Contracts[c]	ATT Price Differences[d]	95% Confidence Intervals	ATT Percent Price Differences	*t*-statistic
			Contracts with versus without Other Local Contractors				
Corn	Kernel	800	354	−0.037	−3.5%, 0.5%	−1.5%	−1.46
	NN	800	256	−0.018	−2.7%, 1.2%	−0.7%	−0.74
Soybeans	Kernel	802	349	−0.004	−1.8%, 1.7%	−0.1%	−0.07
	NN	802	257	−0.028	−2.9%, 2.1%	−0.4%	−0.34
Wheat	Kernel	197	84	0.059	−1.8%, 5.2%	1.7%	0.96
	NN	197	60	0.013	−3.5%, 4.3%	0.4%	0.19
Cotton	Kernel	238	104	0.019	0.2%, 6.9%	3.5%	2.07
	NN	238	81	0.019	−0.3%, 7.3%	3.5%	1.82
Milk	Kernel	882	312	−0.096	−2.5%, 1.1%	−0.7%	−0.72
	NN	882	233	−0.134	−3.3%, 1.4%	−0.9%	−0.77
Broilers	Kernel	561	703	0.003	−1.3%, 3.6%	1.2%	0.93
	NN	561	312	0.003	−3.1%, 5.4%	1.2%	0.53
			Contracts with versus without Local Spot Markets				
Corn	Kernel	827	62	0.097	0.7%, 7.1%	3.9%	2.39
	NN	827	62	0.098	0.2%, 7.7%	3.9%	2.05
Soybeans	Kernel	795	71	0.135	−0.7%, 4.8%	2.1%	1.46
	NN	795	71	0.164	−0.6%, 5.6%	2.5%	1.56
Wheat	Kernel	184	21	0.077	−5.7%, 10.2%	2.2%	0.55
	NN	184	18	−0.133	−15.5%, 7.8%	−3.9%	−0.65
Cotton	Kernel	237	66	0.009	−2.5%, 5.9%	1.7%	0.80
	NN	237	57	0.001	−6.0%, 6.4%	0.2%	0.06
Milk	Kernel	241	643	−0.478	−7.0%, 0.8%	−3.1%	−1.55
	NN	241	152	−0.436	−9.9%, 4.3%	−2.8%	−0.78
			Contracts with versus without Alternative Marketing Options				
Corn	Kernel	851	38	0.043	−2.4%, 5.8%	1.7%	0.83
	NN	851	38	−0.007	−5.3%, 4.7%	−0.3%	−0.11
Soybeans	Kernel	815	51	0.019	−2.9%, 3.4%	0.3%	0.18
	NN	815	50	0.122	−1.9%, 5.6%	1.9%	0.98
Wheat	Kernel	191	14	−0.021	−13.9%, 12.7%	−0.6%	−0.09
	NN	191	14	−0.128	−18.3%, 10.9%	−3.7%	−0.50
Cotton	Kernel	277	26	0.022	−0.1%, 8.4%	4.2%	1.90
	NN	277	25	0.007	−2.3%, 5.0%	1.3%	0.71
Milk	Kernel	676	208	0.095	−1.2%, 2.5%	0.6%	0.65
	NN	676	170	0.082	−1.5%, 2.6%	0.5%	0.51
Broilers	Kernel	333	577	−0.001	−3.0%, 2.2%	−0.4%	−0.29
	NN	333	222	0.001	−5.4%, 6.2%	0.4%	0.13

[a] Matching methods include kernel matching and nearest neighbor (NN) matching.
[b] Number of contracts with other local contractors/spot markets.
[c] Number of contracts without other contractors/spot markets that are used as matches for the treated contracts.
[d] ATT (Average Treatment Effect on Treated) price differences for contracts with and without other local buyers, after matching contracts on their propensity scores.

significant price differences of 5% is greater than 0.9 for cotton and broilers and greater than 0.8 for wheat. In other words, the tests here show sufficient power to detect statistically significant price differences above 3–5% depending on the sample sizes of different commodities. As reported earlier, the tests were able to detect a statistically significant difference of 3.9% for farmers having local spot markets and those that did not.

In summary, the findings show that only a couple of commodities (corn and cotton) have statistical differences in commodity prices above 3–5% that the tests have statistical power to detect. Cotton growers receive prices that are 3.5% higher if other local contractors are present and corn growers receive prices that are 3.9% higher if there are local spot markets and these differences are statistically significant. The rest of the commodities have estimated price differences that are smaller than the 3–5% level needed to detect statistical significance based on the power of the tests. Overall, the results show lack of statistically significant price distortions exceeding 4–5% in agricultural contracts depending on the availability of alternative marketing options.

Several sensitivity analyses are conducted to ensure robustness of the results. Similar overall results are found for different comparison methods (simple *t*-tests and propensity score matching analysis), matching techniques (kernel matching and nearest neighbor matching; with and without the common support restriction for the range of propensity scores of treated and control contracts), data censoring (with and without price outliers), aggregation levels (at the contract level, using clusters for contracts belonging to the same farm, or averaging contract characteristics at the farm level), alternative categories (other contractors and spot markets in two categories or combined into one category), reversing of the treated and control groups, and alternative specifications of the propensity score models. Therefore, the findings are robust to alternative specifications of the models.

Conclusions and Policy Implications

This study examines the price competitiveness of agricultural contracts depending on the availability of alternative marketing options. Specifically, prices for marketing and production contracts are compared for farmers located in areas where other contractors and spot markets are present with prices that farmers would have received in absence of competition from other local buyers. This study addresses the important question of whether processors exercise market power by testing if prices on comparable agricultural contracts are significantly lower when other marketing channels are not available.

The propensity score matching method is used to estimate price differences after matching on the contract's propensity to have alternative marketing options. The two-step method includes estimating a propensity score as a first step and then calculating the average treatment effect on the treated using prices for contracts with similar propensity scores. Contract data for six commodities (corn, soybeans, wheat, cotton, milk, and broilers) are obtained from the Agricultural Resource Management Survey. The findings from the first-step models show that the propensity for access to alternative marketing options depends on the geographic region, year, and contract and farm characteristics. The second-step estimation results presenting the ATT price differences indicate that only a couple of commodities have statistical differences in commodity prices above 3–5% that the tests have statistical power to detect. Cotton growers receive 3.5% statistically significant higher prices if other local contractors are present and corn growers receive 3.9% statistically significant higher prices if there are local spot markets. The rest of the commodities have estimated price differences that are smaller than the 3–5% level needed to detect statistical significance based on the power of the tests. Overall, the results show lack of statistically significant price distortions exceeding 4–5% in agricultural contracts depending on access to alternative marketing channels. These findings are consistent with the explanation that the upward trend in contract use is likely not due to the exercise of price setting market power by processors but may be due to other factors such as increased efficiency associated with the vertical coordination in the production and marketing of agricultural commodities.

The increased use of contracting and processor concentration represents key trends in the industrialization of agriculture. For example, commodities such as tobacco and hogs moved rapidly toward more contracting over the last decade. Contracts now dominate the exchange of several commodities such as tobacco, cotton, rice, broilers, and hogs. Other commodities such as corn, wheat, and soybeans continue to be sold predominantly on the spot markets. This study provides evidence that the absence of local spot markets does not lead to lower contract prices for the commodities considered in this study, except for corn which has prevalent spot markets.

From a government policy perspective, the shift away from spot markets toward contracting facilitates the traceability of food and food ingredients in the agri-food chain. The increased vertical coordination in the production and marketing of agricultural commodities is typically associated with ensuring food safety and delivering quality assurances to consumers, especially when commodity attributes are not easily observable.

The shift from spot markets to contracting also raises concerns about whether spot markets will be a viable option in the future. As more quantities are marketed with contracts, the lower traded volume on the spot markets may induce a tipping point where the thinness and uncertainty of spot markets may force independent producers to accept contracts (MacDonald et al., 2004). This study shows that the absence of spot markets does not lead to lower commodity prices offered by the processing industry, which means that additional regulations regarding the increasing concentration of processors may not be needed at this time. Even so, government intervention is still necessary to ensure that there is no loss in price information because of contracting. The Congress and the United States Department of Agriculture have recently proposed to reauthorize the Livestock Mandatory Reporting Act of 1999 to ensure transparency of commodity prices when the sector undergoes structural changes toward more contracting. Price transparency is of crucial importance for farmers since the consolidation in the processing industry may lead to a decreasing bargaining power for producers.

Previous studies have examined market power using the new empirical industrial organization structural models and aggregate industry-level data and have concluded that the processing industry is exercising market power but it is small in magnitude (for overview see Sexton, 2000). In contrast, this study used farm-level contract data to examine imperfect competition among local processors uniquely from a farmers' perspective by taking into consideration the spatial nature of agricultural production and marketing. Using different approach, models, and data, the findings here are also consistent with the limited evidence for market power in the processing industry found in other studies. While the absence of local competition from other buyers currently does not lead to lower prices, the bargaining power of farmers will likely continue to weaken as more production shifts to contracting with larger processors. Therefore, policy makers need to monitor these structural changes in agricultural contracting as more government intervention may be needed in the future.

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