Production Contracts and the Spot Market Price of Hogs

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Abstract. The increasing use of production contracts in the hog sector has reduced the number of spot market transactions, raised concerns about price manipulation and helped to spur legislation requiring price reporting by packers. Using data from the 2002 and 2007 Censuses of Agriculture, this study looks for evidence of market manipulation by examining whether the local prevalence of contracting affects the average price received by independent producers. The empirical approach uses a fixed-effects model to examine whether the change in the prevalence of contracting is correlated with the change in the spot market price received by individual farmers. This approach controls for unobservable time-invariant individual and county characteristics, such as product quality and location, that might be correlated with price and contracting prevalence. Findings indicate that a negative economically significant relationship between the share of local production delivered under production contracts and the price received by independent producers is unlikely.
Key words: production contracts, alternative marketing arrangements, market power, spot market price, hogs.

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Introduction

In recent decades, the share of hogs produced and marketed under a production contract has been increasing – from 5% in 1992, to 40% in 1998 and 67% in 2004 (Key and McBride, 2007). Contracts provide numerous benefits that might explain this shift, including reduced grower income risk and enhanced packer control over product quality and flow. However, the transition to production contracts has not been without controversy, in part, because it has resulted in a substantial reduction in spot market transactions. In general, independent producers sell their finished hogs on spot markets, while operators with production contracts transfer their finished hogs to integrators (who in turn have marketing agreements with packers) or directly to packers. The percent of U.S. hogs purchased by packers on spot markets has fallen from 62% in 1994 to 36% in 1999 to 11% in 2004 (Plain and Grimes, 2004). The increasing prevalence of production contracts and resulting "thinning" of spot markets have raised concerns about spot market price volatility, price transparency and manipulation, and increased market power by integrators and packers. These concerns have been heightened by growing concentration in the pork processing sector: the largest four firms controlled 36% of hog slaughter in 1982, 54% in 1997, and 63% in 2006 (GAO, 2009).

In the market for fed cattle, the increasing use of captive supplies by beef packers has raised similar concerns about thinning spot markets and market manipulation. Captive supplies are cattle acquired by packers at least two weeks before slaughter using alternative market arrangements (AMAs) – which include forward contracts, marketing agreements, market and production contracts, or direct ownership. Concerns have been expressed that packers who have a portion of their fed cattle needs met through captive supply arrangements are in a stronger position to negotiate a lower spot market price to the detriment of producers (Ward and Schroeder, 1997). There are also concerns that packers have an incentive to refrain from aggressive bidding in the spot market because prices for many AMAs are calculated from formulas derived from the spot price (Xia and Sexton, 2004). Livestock producers have also expressed concerns that a decreased reliance on spot markets increases the ability of packers to exercise market power (USDA, 2002).

Theoretical economic analyses have explored how packers could use AMAs to lower spot market prices. Azzam (1998) used a one-product, two-input model of a partially integrated

oligopsonistic industry to show that noncompetitive behavior by the firm could, under certain conditions, result in a negative relationship between the use of captive supplies and the cash price. Similarly, Love and Burton (1999) showed that a dominant firm with a competitive fringe using optimal backward integration could increase or decrease the input price, depending on how the integration affects the elasticity of input demand and its residual supply elasticity. Zhang and Sexton (2000) used a spatial model and a non-cooperative game approach to show that processors could use captive supplies to reduce the spot price and create a barrier to competition among processors. Wang and Jaenicke (2006) considered the effect of contracting on the spot market for hogs by embedding a principal-agent model within a market equilibrium model. Their approach, which allows for quality differentiation in the contract market, shows that an increased supply of hogs under formula-price contracts could increase or decrease the cash market price.

Another concern that has been raised is that thinning spot markets reduce public market information and inhibit the price discovery of livestock suppliers. A push for mandatory price reporting eventually resulted in the Livestock Mandatory Reporting Act of 1999. The Act required packers to report considerable information about their livestock purchases to the U.S. Department of Agriculture's Agricultural Marketing Service. More recently, concerns about thinning spot markets and the increasing use of alternative market arrangements by packers have spurred the inclusion of provisions in the 2008 farm bill that would have fundamentally changed the way hogs (and cattle) are marketed (Meyer, 2007). Although dropped from the 2008 Food, Conservation, and Energy Act, these provisions included a ban on packer ownership of livestock more than 14 days prior to slaughter, a requirement that packers purchase at least 25% of their daily supplies at each plant through the spot market, and a proposal to limit the number of hogs that can be priced under a single marketing contract to 30 head and to require that contracts contain an established base price. This last provision would have prohibited the use of any formula price that is not determined by a futures market price, required all contracts to be offered in a public market, and prohibited any premiums or discounts tied to packer-controlled measurements.

Most empirical analyses examining the relationship between AMA use and spot market prices have focused on the cattle sector. These studies have generally found that the increased use of alternative market arrangements by packers is associated with lower cash prices (Elam, 1992; Schroeder et al. 1993; Hayenga and O'Brien, 1992; Schroeter and Azzam, 2003), though

some have found ambiguous effects (Ward, Koontz, and Schroeder, 1996). In 2007, the Grain Inspection, Packers and Stockyards Administration (GIPSA) published the results of a congressionally mandated study of livestock and meat marketing that included an analysis of the hog market (GIPSA, 2007; Zheng and Vukina, 2009). As with most past research on cattle markets, the GIPSA study used plant-level data to examine the relationship between AMAs and spot market prices. The study found that plants that used AMAs paid lower prices for hogs than did plants using only cash/spot markets. After controlling for plant, product, and regional effects, they found that increases in the supply of contract and packer-owned hogs tend to decrease spot market prices. The authors also found a statistically significant presence of market power in live hog procurement, but could not conclusively identify AMAs as the source of this market power.

Past empirical work on the relationship between AMAs and spot market prices has not explicitly considered the role of production contracts. This is partly because most empirical studies have focused on cattle markets where production contracts are rarely used to govern the transfer of fed cattle to packers (although they are frequently used to govern the relationship between feedlots and cattle owners). However, as discussed above, production contracts are very important in the hog sector and their use could impact spot prices. Production contracts could enhance the market power of meatpacking firms by discouraging the entry of competitors in local markets (MacDonald, 2006). Because there are substantial returns to scale in meatpacking, firms must assure a large and consistent supply of livestock in a local market to operate efficiently. If an incumbent packer can use contracts to tie up a substantial portion of local livestock, an entrant packer would have to pay substantially higher prices to attract sufficient additional livestock. Hence, by raising entrants' costs, contracts could deter entry. With entry restricted, the packer could force spot prices down by limiting spot market purchases. Hog production contracts often contain attributes that could help packers to restrict entry: requiring large specific capital investments by growers, prohibiting grower sales from contracted facilities to other packers, and specifying a contract term of five to ten years - effectively tying up local livestock supply for an extended period.

This study uses a new empirical approach to examine the relationship between marketing arrangements and the spot market price. Specifically, the study examines whether the local prevalence of production contracts (and by implication the use of AMAs by packers) is correlated with the spot market price received by independent producers. Rather than using

plant-level data on purchases, this study uses farm-level data on sales. This allows us to observe the effect on prices received by hog farmers, as opposed to prices received by hog integrators or packing firms (who may or may not pass price changes on to growers via contract terms). Since most hogs sold under production contracts are eventually acquired by packers using an AMA, the share of output under a production contract serves as an alternative measure of the share of production purchased using an AMA.

The study uses operator-level Census of Agriculture data from 2002 and 2007. In 2002, the Census began to collect information on the use of production contracts by livestock operations. Linking the two Censuses creates an individual-level panel dataset, which allows for comparisons of changes in the characteristics of contract or independent operations over time. Our empirical approach first examines whether the average spot price received by independent hog growers is correlated with the share of finished hogs sold locally under a production contract, controlling for grower and regional characteristics. Second, the study examines whether the change in the prevalence of contracting (defined as the share of all hogs removed in the county that were delivered under a production contract) is correlated with the change in the spot market price received by individual farmers. This empirical approach controls for unobservable time-invariant individual and county characteristics, such as product quality or location that might be correlated with price and contracting prevalence.

Empirical Approach

Let P_{ict} be the average sales price per head received by operator *i* in county *c* at time *t*, and assume the price can be explained by the linear model:

$$P_{ict} = \alpha + \alpha_t + X'_{ict}\beta + A'_{ic}\gamma + \delta C_{ct} + \varepsilon_{ict}, \quad (1)$$

where α_t is the year effect, X_{ict} is a vector of observed time varying covariates, A_{ic} is a vector of unobserved *time invariant* confounders, and C_{ct} is a county-level measure of the prevalence of contracting. Time invariant confounders A_{ic}, such as the quality of hogs sold by the operation or the location of the operation, might be correlated with the sales price and the prevalence of

contracting in the county. Since these variables are unobserved, regression estimates of the parameters in (1) (including the parameter of interest δ) will suffer from omitted-variable bias.

Differencing is used to obtain an unbiased estimate of δ:

$$\Delta P_{ict} = \Delta\alpha_t + \Delta X'_{ict}\beta + \delta\Delta C_{ct} + \Delta\varepsilon_{ict}, \quad (2)$$

where Δ denotes the change from one year to the next (e.g., $\Delta P_{ict} = P_{ict} - P_{ict-1}$). Note that in (2) the time invariant confounders drop out of the equation. Since there are only two periods, the notation in (2) can be simplified:

$$\Delta P_{ic} = \alpha + \Delta X'_{ic}\beta + \delta\Delta C_c + \varepsilon_{ic}. \quad (3)$$

To allow for the possibility that the initial levels of the covariates that do not vary substantially across time, such as operator's age and location, affect the change in price, the following model is also estimated:

$$\Delta P_{ic} = \alpha + \Delta X'_{ic}\beta + X'_{ic0}\beta_0 + \delta\Delta C_c + \varepsilon_{ic}, \quad (4)$$

where X_{ic0} is the vector of covariates in the initial period, including fixed effects for the State in which the operation is located.

Data

Data for the analysis are drawn from the 2002 and 2007 United States Census of Agriculture maintained by the USDA National Agricultural Statistics Service.[1] In contrast to earlier Censuses, starting in 2002 it is possible to distinguish the number of hogs removed under a production contract versus produced and sold independently. The Census questionnaires asked independent producers about the value of their hog sales, and asked contract producers about their total remuneration for delivering hogs under contract. No information was gathered about

[1] For more information see: http://www.agcensus.usda.gov/ .

the value of inputs provided by the contractor. Since there could be substantial variation in the value of inputs provided by contractors, gross revenue is likely a poor proxy for net revenue from contract production. For this reason this study does not examine how local contract prevalence is associated with average remuneration per head for production contract growers. Instead, the study considers only contract prevalence is associated with the average price per head for independent producers.

To compare producers of relatively similar types of output the study only considers operations that self-identified as "farrow-to-finish" or "finish-only", and who therefore marketed primarily finish (full-grown) hogs.[2] Farrow-to-finish operations are those on which pigs are farrowed (birthed) and raised to a slaughter weight of 240-270 pounds. Finish-only (sometimes called "feeder-to-finish") operations are those on which feeder pigs of 50-60 pounds are obtained (either purchased or placed via contract) from outside the operation and fed until they reach slaughter weight.

The Census of Agriculture reports 37,417 and 32,242 independent or production contract growers who had positive hog production and inventory and who described their operations as finish-only or farrow-to-finish in 2002 and 2007, respectively.[3] Of these, 24,281 and 17,650 produced at least 50 head in 2002 and 2007, respectively.[4] Independent operations are defined as those selling some output not under a production contract. There were 18,967 independent producers who responded to the 2002 Census and 12,529 in 2007.

Substantial changes in the characteristics of independent producers between 2002 and 2007 reflect ongoing structural changes in the hog sector (table 1). An average independent operation sold about 50% more hogs in 2007 than in 2002 (table 1). At the same time, the average price per head increased from $86.06 to $117.25, causing average value of sales to approximately double, in nominal dollars, between 2002 and 2007. During this period, the share of independent operations using a "farrow-to-finish" production system declined from 66.9% to 59.1%,

[2] Other Census hog farm types include farrow-to-wean, farrow-to-feeder, and nursery.
[3] Operators who described themselves as a "contractor or integrator" were not included in this analysis.
[4] Operations with sales of fewer than 50 head were removed to increase sample homogeneity and because these operations are more likely to be sold in organic, free-range, or other specialty meat markets, and would be less likely to be in direct competition with larger commercial contract operations.

reflecting the shift to more specialized operations. The average age and farming experience of operators both increased by about two years.

The prevalence of production contracts in the local region is measured as the share of county-level market hog production removed under a production contract. The independent hog producers in the sample were located in 1965 counties in 2002 and 1724 counties in 2007. On average (table 1), the number of hog producers per county declined from 50.0 and 41.4 between 2002 and 2007, while share of total county output delivered under a production contract increased from 25.8% and 29.7%. Figure 1 illustrates the distribution across independent producers of the share of county-level hog production delivered under a production contract in the Census years. About 22% of producers were located in counties where no output was delivered under a production contract.

Results

Table 2 illustrates correlations between the average sales price per head for independent producers and three covariates in 2002 and 2007. The second column in the table compares the average price for the row with the price for the first row in each category. The table shows that, on average, farrow-to-finish operations earned $2.78 and $3.98 per head less than finish-only operations in 2002 and 2007, respectively. The table also shows that the average price received per head generally increases with farm size. Farms selling at least 5000 head received $5.68 and $4.08 more per head than did farms selling fewer than 250 head. About 2% of independent operations also removed some output under a production contract.[5] Independent operations with contracts received substantially higher prices ($12.29 and $14.16 in 2002 and 2007)) than independent operations without contracts. These differences in average sales price could reflect differences in animal quality or differences in local market conditions.

[5] It is possible that hogs produced under contract and independently were raised at different times during the year, reflecting a shift from one form of organization to another.

Tables 3 compares the average sales price per head for independent growers having different shares of county output delivered under a production contract in 2002. The third column displays the price difference with the "contract share=0" group. For the full sample, producers in counties with some production contracts received a statistically significantly higher price than producers in counties where no production contracts were used. The price premium for being in a county where growers used production contracts ranged between $1.22 and $2.00 per head, or 1.4 - 2.3% of the average sales price, and was not clearly associated with the share of production under a contract.

To examine whether price outliers were driving these results, the second set of comparisons removes observations with an average sales price in the top or bottom 1 percentile. Results indicate a smaller, but still statistically significant increase in price for the farms in counties with between 0 and 50% of production under contract, but no statistically significant difference in price for farms in counties with more than 50% of production under contract compared to farms in counties with no production under contract.

We saw in table 2 that operations with some output under a production contract received a significantly higher average price than operations with no output under a production contract. To examine whether the positive association between contract prevalence and price is being driven by these operations, the third set of comparisons in table 3 considers only farms without production contracts. The results are similar, with a small statistically significant increase in price for farms in counties with between 0 and 50% contract prevalence, and no significant difference for farms in counties with higher contract prevalence.

Table 2 also showed that finish-only operations received a significantly higher price than farrow-to-finish operations. If independent operations are more likely to be finish-only in counties with greater contract prevalence, then this could explain the correlation between contract share and price. To test this hypothesis, the fourth set of comparisons considers only farrow-to-finish operations (table 3). Again the results are generally consistent with the earlier results.

Table 2 also revealed a positive relationship between scale and price. To control for farm size, only large-scale operations (that sold more than 2500 head) are included in the fifth set of comparisons in table 3. Again contract prevalence is associated with a positive price premium, however, for the large-scale operations sample, it is not possible to reject the null hypothesis of no difference at the 10% confidence level.

The fourth column in table 3 compares the average sales price for the row with the average sales price of producers located in counties where between 0 and 25% of total output is delivered under a production contract. It is possible that counties with no contracting differ in unobservable ways from counties with production contracts, and that these differences also influence the price. By making the comparison only among counties having some producers that used production contracts, this potential source of bias is eliminated. Results indicate no statistically significant difference in price for farmers in counties with a small non-zero share of contracting to those with a larger share in 2002 for all the samples in table 3.

Table 4 repeats the analysis in table 3 using data from the 2007 Census. As in 2002, being located in a county with between 0 and 50% of output being delivered under contract is associated with a statistically significant increase in price, compared to being in a county with no production contract use. However, unlike in 2002, there is evidence that being in a high contract share county (greater than 75% of output under contract) is associated with a lower price than the no production contract county. This negative price effect holds for the full sample, operations without production contracts, and for farrow-to-finish operations, but does not hold when price outliers are removed or for large-scale operations.

Results (column 4) indicate that farms in counties with more than 75% of output under contract receive $5-8 dollars *less* than those with a low contract share (between 0 and 25% of output). This negative relationship holds for all samples considered except the sample of large-scale operations. However, because there are relatively few (84) large-scale independent operations in the high contract share counties, the statistical test lacks sufficient precision to identify a small difference from the low contract share group.

Next, a regression analysis is used to control for factors that might be correlated with price (table 5). In the model with no controls (column 1), contract prevalence was positively and statistically significantly correlated with the price in 2002, but not in 2007. Adding controls for county, operator, and operation characteristics (column 2) changes the results dramatically. In 2002, the contracting share loses its statistically significant correlation with price, but, in 2007 the negative correlation gains statistical significance. In addition, for both years the number of hog operations in county is positively associated with price, and being a farrow-to-finish operation is negatively associated with price. The scale of the operation has a positive correlation with price, but this is only statistically significant in 2002.

When State fixed effects are included (column 3), the contracting prevalence variable is not statistically significantly different from zero in either year. In addition, the "number of hog farms in a county" variable is no longer statistically significantly different from zero. It is possible that because hog production is concentrated in certain States, "the number of hog farms in a county" variable was capturing State-level variation in prices.

Column 4 introduces an indicator for whether the operation is located in a county with no production contracts. This variable is negative and significant in 2002 but not significant in 2007. In column 4, the contracting share parameter can be interpreted as the price effect of an increase in contract share, given that some producers in the county use production contracts. The sign of this parameter is negative but is not statistically significantly different from zero.

The regression analyses have sufficient statistical precisions to "rule out" an economically important price effects. Using the model in column 3, the results predict that moving from a county with no contracting to a county with 100% contracting would result in a $0.59 per head increase in price in 2002 and $0.58 per head decrease in price in 2007. In terms of statistical precision, the 95% confidence intervals for these estimates are [-$1.14, $2.32] and [-$3.14, $1.98] for 2002 and 2007. Hence, it would be statistically unlikely that switching from a county with no contracting to one with 100% contracting would result in a decline in price greater than about 2%. As discussed in the methodology section, the estimated coefficients in table 5 could suffer from omitted variable bias, which is addressed next.

Controlling for time invariant fixed effects

Evaluating how a change in the county-level prevalence of production contracts affects an individual operator's average sales price requires restricting the sample to continuing operations. Of the 18,967 independent producers in 2002, only 7,108 continued to produce hogs independently, had sales of at least 50 head, and responded to the Census in 2007. To eliminate variations in price caused by changes in the operator, the sample includes only those observations where the operator's age in 2007 was 4 to 6 years greater than the operator's age in 2002. Matching by operator age results in a final sample of 6,331 continuing independent operations.

Figure 2 illustrates the distribution across continuing operations of the change in the share of county-level hog production that is delivered under a production contract. About 15% of producers were located in counties that experienced no change in the share of output under contract.[6] Most (85%) producers were located in counties where the contract share changed less than 25 percentage points (including no change).

Table 6 compares the average change in price of hogs for continuing operations with varying changes in the share of county output under a production contract. For the full sample and for the sample with the price change outliers removed, there was no statistically significant difference between groups. Operators in counties that experienced a large (greater than 25 percentage points) increase in contract share experienced a smaller increase in price than those in counties with a large contract share decline. In contrast, those in counties experiencing a large increase in contract share had a slightly greater increase in price than those experiencing no change in contract share. There was very little difference in the average price change for producers in counties with a small (between 0 and 25 points) increase in contract prevalence compared to those in counties with a small decrease.

[6] This is a much smaller percentage than displayed in the bin centered at zero in figure 2 because this zero bin includes all producers in counties where the contract share changed between -0.25 and 0.25 percentage points.

Table 7 presents the results of the fixed effects regression model (equations (3) and (4)). Column 1 has no controls, column 2 introduces the time-varying covariates, column 3 adds controls for initial operator and operation characteristics, and column 4 includes state fixed effects.[7] For all models, an increase in farm size is associated with a decrease in price – with an additional 1000 head lowering the average sales price by about $0.60. This contrasts with the positive association between scale and price reflected in tables 2 and 5. It is possible that some time invariant factors are correlated with farm size and price, causing the positive relationship in the cross-sectional analysis. For example, if hog quality were correlated with price and size, one would observe a spurious positive correlation between size and price. The fixed-effects model controls for these time invariant confounders.

For all models, the coefficients associated with the change in contract share variable are negative, but not statistically significantly different from zero. The data provide sufficient precision to rule out a large price effect from contracting prevalence. The estimate of a $1.71 decrease in price resulting from a 100 percentage point increase in the share of county production under contract (column 4) has a 95% confidence interval of [-$6.41, $2.99]. In other words, results indicate that it would be statistically unlikely that shifting all county production from independent to contract production would results in a price decline of more than about 5.5% of the 2007 price.

Conclusion

The increasing use of production contracts in the hog sector has caused the number of spot market transactions to decline. Thinning spot markets have raised concerns about price manipulation, which has helped spur legislation to require price reporting by packers. Recently, Congress debated proposed Farm Bill provisions that would have substantially limited the ability of packers to use alternative marketing arrangements commonly used to purchase hogs from contractors (integrators). Contracts that bind growers to a particular firm can tie up local production, which would raise costs for packers who enter the market. Hence, in the hog sector,

[7] The coefficient on a dummy variable indicating whether the county had no change in the contracting share was not significantly different from zero. Including this dummy variable had little effect on the other model coefficients.

production contracts could enhance the local market power of packers by helping to restrict the entry of competitors.

Using data from the 2002 and 2007 Census of Agriculture, this paper looks for evidence of market manipulation by examining whether the local prevalence of contracting affects the average price received by independent producers. The study first compares the average price per head received by growers in counties with different levels of contracting. The simple price comparisons reveal no evidence that growers in counties with a low prevalence of contracting receive a low price. In fact, average prices in counties having between 0-50% of output produced under contract were generally higher than prices in counties with no contracting. However, being located in a high contract prevalence county (more than 75% of output under contract) was associated with a lower price in 2007, though there was no correlation to price in 2002.

Single-period regression analyses are used to control for observable operator and operation characteristics that might cause the correlation between contract prevalence and prices. The regressions provide no evidence of price manipulation related to contract use. Results indicate that having some contracting in a county is generally associated with a higher price. Given that there is some contracting in a county, there no statistically significant relationship between the share of production under contract and prices. The large dataset provides sufficient statistical precision to rule out negative price effect greater than about 2%.

To control for time invariant factors that might be correlated with price and contract share, such as product quality or location, the study first compared the change in the price received by operators experiencing different changes in the local prevalence of contracting. Results indicate no statistically significant difference in price between operators experiencing an increase or decrease in the local contracting share. Results of a regression analysis that controlled for operation and operator characteristics indicate that a change in the share of contracting at the county level has no statistically significant price effect. For the fixed-effects model, the data rules out as statistically unlikely a negative price effect greater than about 5.5%.

In sum, the study finds that in 2002 and 2007, a negative economically significant relationship between the share of local production delivered under production contracts and the price received by independent producers is unlikely. However, while an increase in the use of production contracts does not appear to substantially lower spot prices for independent growers, it could increase transaction costs. Lower spot market volume is likely to be associated with higher transportation costs (which are correlated with animal weight loss and risk of injury), greater risk of no sale (due to an insufficient number of buyers), and higher commission costs (Hobbs, 1997). Higher spot market transaction costs can provide an incentive for farmers to begin to contract, which can further thin the spot market, leading to a greater prevalence of contracting and perhaps eventually to the elimination of independent production as a viable option (Roberts and Key, 2005).

Operations that use production contracts represent an increasing share of hog farms and output. A substantial number of these contract operations are located in counties with thin or no spot markets, which could limit non-contract production opportunities for growers and thereby lower their bargaining power vis-à-vis contractors. Because of data limitations, the study was not able to address whether the remuneration received by production contract growers was related to the local prevalence of contracts. This remains an important area for future research.

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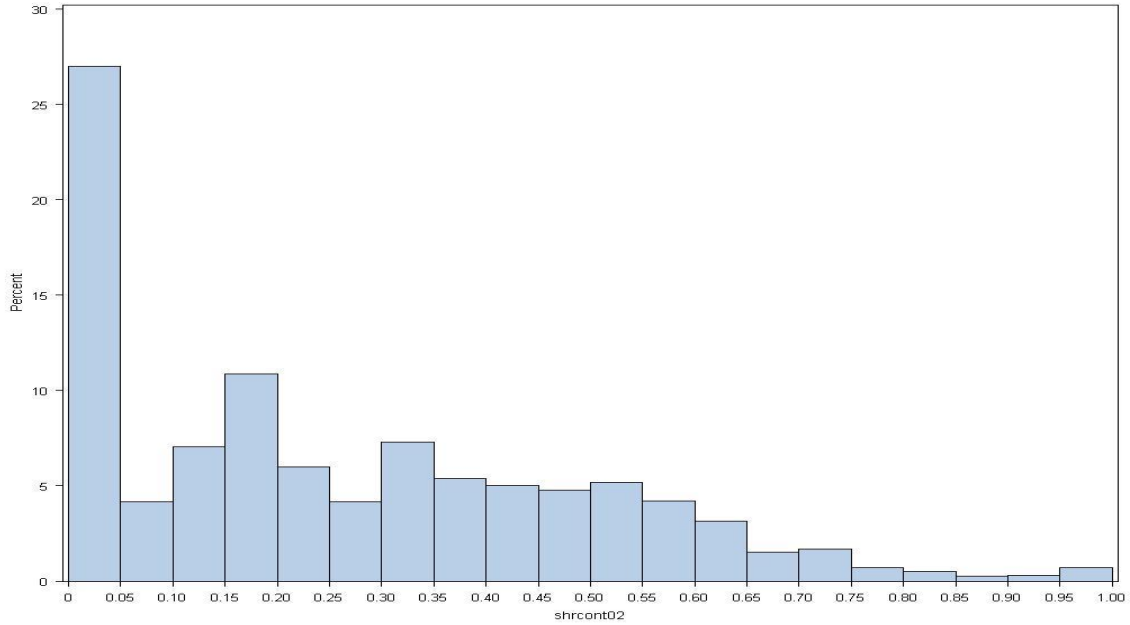
Table 1. Summary Statistics, Independent Finish Hog Producers, 2002 and 2007.

Variable	Mean	Std. Dev.	Median
2002			
Head removed	2224	14644	592
Head removed, not under contract	2157	14599	560
Head removed, under production contract	67.09	973.5	0
Value of sales, not under contract (dollars)	190845	1431332	47680
Average price per head, not under contract (dollars)	86.06	27.11	85
Share of county hog output under contract	0.258	0.260	0.204
Number of hog farms in county	49.98	60.82	33
Operator's age (years)	50.88	13.70	50
Operator's farming experience (years)	24.11	14.32	24
Farrow-to-finish operation (yes=1, no=0)	0.669	0.523	1
N	18967		
2007			
Head removed	3404	20636	650
Head removed, not under contract	3323	20597	606
Head removed, under production contract	81.15	1095	0
Value of sales, not under contract (dollars)	390277	2367972	72000
Average price per head, not under contract (dollars)	117.25	34.57	120
Share of county hog output under contract	0.297	0.281	0.286
Number of hog farms in county	41.43	53.83	25
Operator's age (years)	52.82	13.63	52
Operator's farming experience (years)	26.46	14.86	27
Farrow-to-finish operation (yes=1, no=0)	0.591	0.542	1
N	12529		

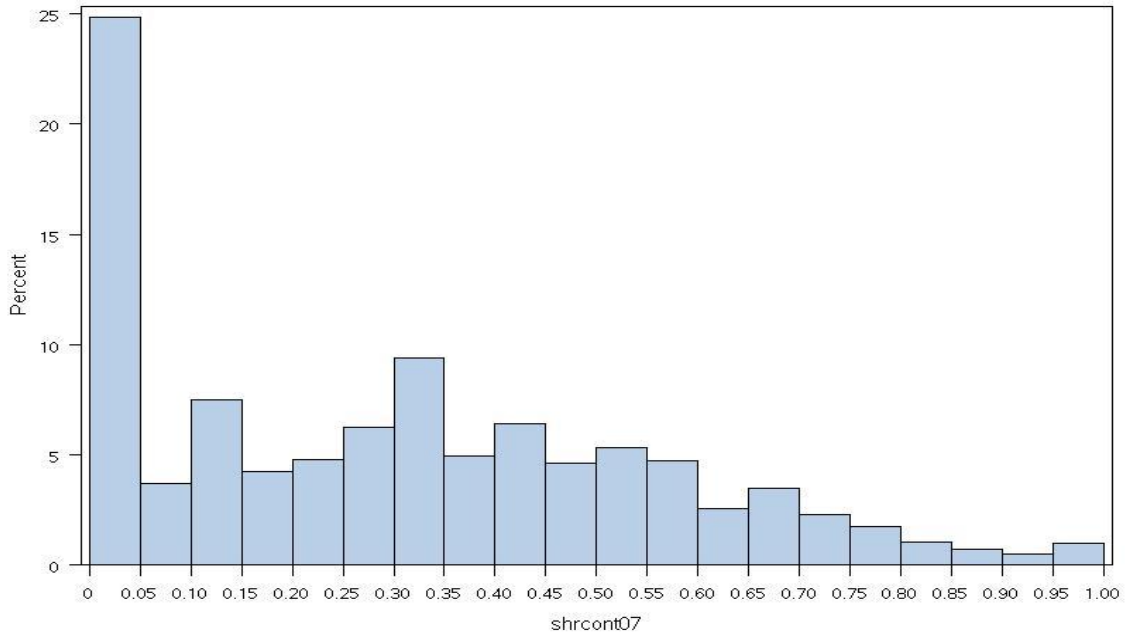
Source: Census of Agriculture, 2002, 2007.

Figure 1. Distribution of the Share of County-level Hog Production Delivered under a Production Contract

2002



2007



Source: Census of Agriculture, 2002, 2007.

Table 2. Average Price per Head, Independent Finish Hog Producers by Type

Farm Category	Mean	Std. Err.	Difference[1]	N
2002				
Production system				
Finish only	87.92	0.234		6380
Farrow to finish	85.14	0.237	-2.78***	12587
Head removed				
50-249	84.26	0.314		5511
250-999	85.74	0.243	1.48***	5853
1000-2499	86.56	0.287	2.30***	3839
2500-4999	88.76	0.555	4.50***	1749
5000+	89.94	1.072	5.68***	2015
Some output under prod. contract				
No	85.80	0.161		18528
Yes	98.09	3.509	12.29***	439
2007				
Production system				
Finish only	119.60	0.405		5285
Farrow to finish	115.62	0.381	-3.98***	7244
Head removed				
50-249	114.99	0.646		3571
250-999	117.11	0.495	2.12***	3277
1000-2499	117.92	0.541	2.93***	2217
2500-4999	120.82	0.894	5.83***	1418
5000+	119.07	0.479	4.08***	2046
Some output under prod. contract				
No	116.95	0.274		12246
Yes	131.11	3.524	14.16***	283

Note: [1] Difference between row and first row in category. The asterisks indicate statistical significance of the test of the null hypothesis that the mean for the row is equal to the mean of the first row at the (*) 10%; (**) 5%; and (***) 1% levels.
Source: Census of Agriculture, 2002, 2007.

Table 3. Average Price per Head by Share of County Output under Production Contract, Independent Finish Hog Producers, 2002

Farm Category	Mean	Std. Err.	Diff. with Share=0[1]	Diff. with 0 < shr. ≤ 0.25[1]	N
2002					
Full sample					
Contract share = 0	84.96	0.380			4153
0 < Contract share ≤ 0.25	86.18	0.243	1.22***		6289
0.25 < Contract share ≤ 0.5	86.80	0.368	1.84***	0.62	5057
0.5 < Contract share ≤ 0.75	86.06	0.540	1.10*	-0.12	2992
0.75 < Contract share	86.96	1.060	2.00*	0.78	476
Price outliers removed[2]					
Contract share = 0	85.14	0.270			3967
0 < Contract share ≤ 0.25	85.81	0.180	0.67**		6172
0.25 < Contract share ≤ 0.5	86.18	0.195	1.04***	0.37	4949
0.5 < Contract share ≤ 0.75	85.53	0.245	0.39	-0.28	2941
0.75 < Contract share	85.26	0.671	0.12	-0.55	462
Operations without prod. contracts					
Contract share = 0	84.96	0.380			4153
0 < Contract share ≤ 0.25	85.98	0.235	1.02***		6179
0.25 < Contract share ≤ 0.5	86.41	0.369	1.45***	0.43	4875
0.5 < Contract share ≤ 0.75	85.46	0.316	0.50	-0.52	2855
0.75 < Contract share	87.08	1.074	2.12	1.1	466
Farrow-to-finish operations					
Contract share = 0	83.93	0.443			3200
0 < Contract share ≤ 0.25	85.40	0.311	1.47***		4228
0.25 < Contract share ≤ 0.5	86.00	0.536	2.07***	0.6	3088
0.5 < Contract share ≤ 0.75	85.31	0.856	1.38	-0.09	1743
0.75 < Contract share	85.40	1.314	1.47	0	328
Large scale (head removed ≥ 2500)					
Contract share = 0	86.84	1.095			391
0 < Contract share ≤ 0.25	88.72	0.565	1.88		1279
0.25 < Contract share ≤ 0.5	89.99	1.187	3.15	1.27	1321
0.5 < Contract share ≤ 0.75	90.72	2.047	3.88	2	723
0.75 < Contract share	87.91	2.530	1.07	-0.81	50

Notes: [1] The asterisks indicate statistical significance of the test of the null hypothesis that the mean for the row is equal to the mean of the base comparison row at the (*) 10%; (**) 5%; and (***) 1% levels.
[2] Top and bottom 1% outliers for average price per head are removed from sample.
Source: Census of Agriculture, 2002, 2007.

Table 4. Average Price per Head by Share of County Output under Production Contract, Independent Finish Hog Producers, 2007

Farm Category	Mean	Std. Err.	Diff. with Shr.=0[1]	Diff. with 0 < Shr. ≤ 0.25[1]	N
2007					
Full sample					
Contract share = 0	115.37	0.756			2831
0 < Contract share ≤ 0.25	118.06	0.535	2.69***		2816
0.25 < Contract share ≤ 0.5	119.15	0.415	3.78***	1.09	3960
0.5 < Contract share ≤ 0.75	116.94	0.633	1.57	-1.12	2295
0.75 < Contract share	111.96	1.112	-3.41**	-6.1***	627
Price outliers removed[2]					
Contract share = 0	109.72	0.425			2637
0 < Contract share ≤ 0.25	114.95	0.383	5.23***		2700
0.25 < Contract share ≤ 0.5	116.62	0.301	6.90***	1.67***	3795
0.5 < Contract share ≤ 0.75	114.06	0.402	4.34***	-0.89	2197
0.75 < Contract share	109.79	0.860	0.07	-5.16***	602
Operations without prod. contracts					
Contract share = 0	115.37	0.756			2831
0 < Contract share ≤ 0.25	117.89	0.538	2.52***		2770
0.25 < Contract share ≤ 0.5	118.77	0.413	3.4***	0.88	3837
0.5 < Contract share ≤ 0.75	116.37	0.536	1.00	-1.52*	2194
0.75 < Contract share	111.49	1.089	-3.88**	-6.4***	616
Farrow-to-finish operations					
Contract share = 0	115.05	0.896			2088
0 < Contract share ≤ 0.25	116.72	0.736	1.67		1664
0.25 < Contract share ≤ 0.5	117.41	0.620	2.36**	0.69	1979
0.5 < Contract share ≤ 0.75	114.40	0.779	-0.65	-2.32**	1130
0.75 < Contract share	109.00	1.376	-6.05***	-7.72***	383
Large scale (head removed ≥ 2500)					
Contract share = 0	116.79	1.513			345
0 < Contract share ≤ 0.25	118.03	0.822	1.24		880
0.25 < Contract share ≤ 0.5	120.91	0.589	4.12***	2.88***	1385
0.5 < Contract share ≤ 0.75	121.24	1.343	4.45**	3.21**	770
0.75 < Contract share	119.83	3.41	3.04	1.8	84

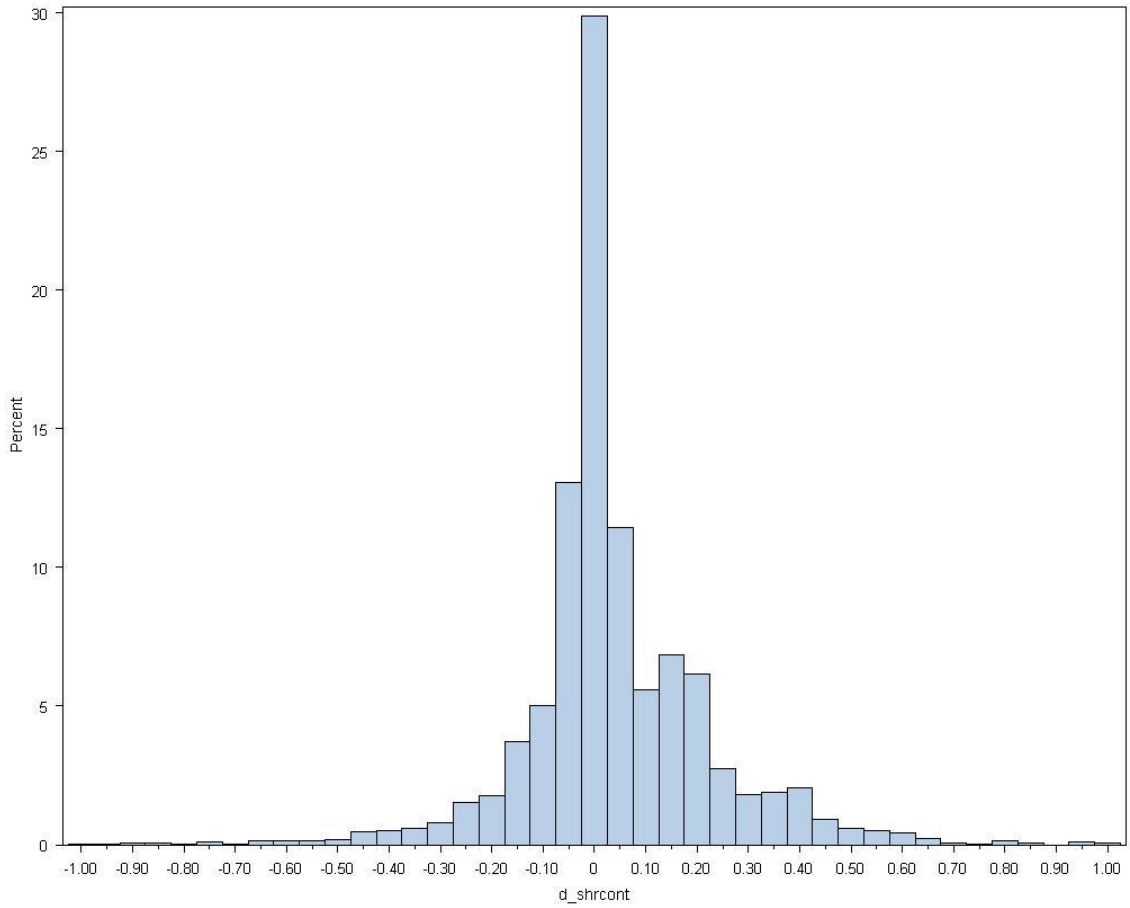
Notes: [1] The asterisks indicate statistical significance of the test of the null hypothesis that the mean for the row is equal to the mean of the base comparison row at the (*) 10%; (**) 5%; and (***) 1% levels.
[2] Top and bottom 1% outliers for average price per head are removed from sample.
Source: Census of Agriculture, 2002, 2007.

Table 5. Least Squares Estimates, Dependent Variable: Average Price per Head

	1	2	3	4
2002				
Intercept	85.59***	86.78***	84.63***	86.10***
	(0.26)	(0.91)	(4.17)	(4.21)
Shr. of co. output under cont.	1.81**	0.50	0.59	-0.74
	(0.75)	(0.81)	(0.88)	(0.70)
Number of hog farms in county	-	0.0093***	0.0062	0.0053
		(0.0035)	(0.0041)	(0.0041)
Head removed (1000)	-	0.032**	0.031**	0.030**
		(0.013)	(0.013)	(0.013)
Operator's age	-	0.0099	-0.0107	-0.0089
		(0.021)	(0.021)	(0.021)
Operator's farming experience	-	-0.0078	0.0095	0.0080
		(0.020)	(0.020)	(0.020)
Farrow-to-finish operation (1/0)	-	-2.55***	-2.69***	-2.70***
		(0.38)	(0.38)	(0.38)
No prod. contracts in co. (1/0)	-	-	-	-1.52**
				(0.66)
State fixed effects	-	-	Yes	Yes
R-squared	0.0003	0.0037	0.0341	0.0343
N	18967	18967	18967	18967
2007				
Intercept	117.39***	120.71***	122.13***	123.45***
	(0.43)	(1.45)	(6.36)	(6.44)
Shr. of co. output under cont.	-0.46	-3.37***	-0.58	-1.78
	(1.09)	(0.81)	(1.30)	(1.59)
Number of hog farms in county	-	0.0301***	0.0078	0.0070
		(0.0062)	(0.0071)	(0.0072)
Head removed (1000)	-	0.0010	0.0003	0.0013
		(0.014)	(0.014)	(0.014)
Operator's age	-	-0.0072	-0.0044	-0.0028
		(0.034)	(0.034)	(0.034)
Operator's farming experience	-	-0.0488	-0.0510	-0.0518
		(0.031)	(0.031)	(0.031)
Farrow-to-finish operation (1/0)	-	-3.43***	-3.31***	-3.30***
		(0.58)	(0.58)	(0.58)
No prod. contracts in co. (1/0)	-	-	-	-1.38
				(1.05)
State fixed effects	-	-	Yes	Yes
R-squared	<0.0000	0.0064	0.0390	0.0391
N	12529	12529	12529	12529

Note: Asterisks denote statistical significance at the (*) 10%; (**) 5%; and (***) 1% levels.

Figure 2. Distribution of the Change in County-level Hog Production Delivered under a Production Contract



Source: Census of Agriculture, 2002, 2007.

Table 6. Change in the Average Price per Head by 2002-07 Change in Share of County Output under Production Contract, Independent Continuing Finish Hog Producers

Farm Category	Mean	Std. Err.	Difference[1]	N
Full sample				
Cont. shr. chg. ≤ -0.25	31.81	2.299		264
-0.25 < Cont. shr. chg. < 0	31.51	0.823	-0.30	2057
Cont. shr. chg. = 0	28.83	1.305	-2.98	966
0 < Cont. shr. chg. < 0.25	31.38	0.614	-0.43	2378
0.25 ≤ Cont. shr. chg.	29.30	1.171	-2.51	666
Price change outliers removed				
Cont. shr. chg. ≤ -0.25	30.41	1.848		260
-0.25 < Cont. shr. chg. < 0	31.32	0.569	0.91	2013
Cont. shr. chg. = 0	27.62	0.929	-2.79	929
0 < Cont. shr. chg. < 0.25	31.38	0.512	0.97	2344
0.25 ≤ Cont. shr. chg.	28.81	0.968	-1.60	657

Notes: [1] Difference between row and first row in category. The asterisks indicate statistical significance of the test of the null hypothesis that the mean for the row is equal to the mean of the "Contract share =0" row at the (*) 10%; (**) 5%; and (***) 1% levels.
Source: Census of Agriculture, 2002, 2007.

Table 7. Least Squares Estimates, Dependent Variable: 2002-07 Change in Average Price per Head

Variable	1	2	3	4
Intercept	30.86***	29.65***	30.22***	25.84***
	(0.44)	(0.58)	(2.37)	(8.87)
Change in county contract share	-1.08	-2.17	-2.07	-1.71
	(2.36)	(2.37)	(2.43)	(2.39)
Change in no. of hog farms in county (1000)	-	-0.110***	-0.106***	-0.040
		(0.031)	(0.032)	(0.036)
Change in no. of head removed (1000)	-	-0.583***	-0.589***	-0.600***
		(0.131)	(0.132)	(0.131)
Operator's age 2002	-	-	0.024	0.062
			(0.061)	(0.062)
Operator's farming experience 2002	-	-	-0.024	-0.065
			(0.058)	(0.059)
Farrow-to-finish operation 2002 (1/0)	-	-	-1.59	-1.50
			(0.96)	(0.97)
State fixed effects	-	-	-	Yes
R-squared	<0.0000	0.0050	0.0054	0.0354
N	6331	6331	6331	6331

Note: Asterisks denote statistical significance at the (*) 10%; (**) 5%; and (***) 1% levels.