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Evaluation of Market Thinness for Hogs and Pork

We investigate thinness of hog and pork markets in terms of quantity and representativeness of negotiated transactions. Transactional volume imparts marginally greater confidence in pricing precision for Iowa-Southern Minnesota negotiated hogs than for the national carcass cut-out, suggesting that contracts tying prices to the former rather than the latter may be more representative of industry conditions. Extending mandatory price reporting to pork may remedy this discrepancy. Despite declining volume, terminal hog markets may price accurately off of Iowa-Southern Minnesota prices. Hog quality differentials across procurement methods are documented, and quality of negotiated hogs is shown to decline with volume.

Keywords: Chebyschev's inequality, hogs, pork, thin markets

Introduction

The U.S. hog industry, like other livestock/poultry industries, has experienced substantial consolidation and growth in alternative marketing arrangements since the early 1990s when spot transactions dominated trade (Grimes and Plain 2005, 2007). With lower quantities (and perhaps quality) of livestock traded in spot markets, these negotiated transactions are increasingly scrutinized as being unreliable or unrepresentative of industry trade. Implications reach beyond spot transactions as many contracts are tied to spot prices. Concern for market price transparency relates to the quantity of trades from which the market price, or price range, is derived, and the term *thin market* is used to describe markets for which reliability of a supply and demand determined price is questioned due to low volume of transactions (Hayenga et al, 1979; Tomek, 1980; Nelson and Turner, 1995) or perhaps unrepresentative transactions (Anderson et al 2007).

The objective of this study is to examine thin market issues for U.S. spot markets for hogs and downstream negotiated prices for the wholesale pork carcass cutout. Empirical research on thin markets in agriculture generally considers market trade where concern that the quantity of reported market transactions is insufficient relative to the broader regional or national market to accurately reflect general market conditions (e.g., Tomek, 1980; Nelson and Turner, 1995). However, transactional volume is merely a proxy for pricing efficiency (Buschena and McNew 2008) and may not capture quality differentials in hogs transacted through spots and contracts (Anderson et al 2007). Here, we evaluate capacity for price discovery as it relates to volume in hog spot markets (i.e., a declining terminal market in St. Joseph, Missouri and mandatorily reported regional prices for Iowa-Southern Minnesota) and voluntarily reported carcass cutout prices. Additionally, using national data, we document hog quality differentials across procurement methods and show that quality of negotiated hogs declines with volume.

The paper is organized as follows. The next section presents a brief review of the relevant literature, informing the choice of empirical procedures, which are discussed subsequently and are followed by a description of the data. Then the results are presented, followed by a discussion of their implications in the concluding section of the paper.

Previous Research

Much of the relevant literature in agriculture investigates thin markets in terms of quantity issues. Not only do markets with few transactions (or few participants) hold potential for price manipulation[1] (Nelson and Turner 1995; Mueller et al. 1996), but more generally, some minimum number of transactions is needed to place confidence in average (equilibrium) prices (Tomek 1980). Relatively few transactions may be required, provided they are representative, i.e., occur at the margin (Smith 1982). Transaction representativeness has been recognized as a thin market issue only more recently with some spot markets, which often provide a base price for formula contracting, characterized as residual markets, i.e. markets for lower quality goods (Schroeder and Ward 2000; Anderson et al 2007). However, residual markets may serve an alternative role in facilitating inventory adjustment in addition to (or perhaps in place of) price discovery (Peterson 2005). Noting that the conventionally accepted definition of a thin market as "one with few negotiated transactions per unit of time" (c.f., Hayenga et al 1979) has directed this emphasis on transaction volume in empirical studies, Anderson et al (2007) suggest a more comprehensive taxonomy of thin markets considering both volume and representativeness (i.e., quality or type) issues. The literature is summarized in detail below.

Tomek (1980) uses a statistical sampling concept to show that a declining Denver market for fed cattle became a poor place for price discovery, relative to Omaha, prior to closing. Specifically, Chebyschev's inequality is applied to compute the number of transactions that yield a particular level of (confidence in) pricing precision given the variability of prices during the period observed. The large reductions in volume rendered pricing unreliable in the Denver market.

In an experimental setting, Nelson and Turner (1995) find no evidence of systematic price bias in thin (i.e., eight traders) relative to thick (i.e., 22 traders) auction markets. Using a fed cattle market simulation, Ward and Choi (1998) find that even very large reductions in the number of reported cash transactions had little impact on price accuracy. Smith's (1982) work with double-oral auction markets demonstrates that the number of market participants or transactions required to generate perfectly competitive prices may be relatively small, providing each transaction takes place at the margin.

Other studies identify negative impacts of captive supplies (i.e., declining proportional spot transactions) on (expected) fed cattle spot prices, suggestive of potential price manipulation by buyers (Ward, Koontz, and Schroeder 1998; Schroeter and Azzam 2004).

Mueller et al. (1996) find that few participants and transactions on the National Cheese Exchange (NCE), a residual market for cheese, enabled price manipulation by key market participants. Moreover, most cheese is contracted based on NCE prices, though only block and barrel cheddar cheese trade on the exchange (Hamm and March 1995). In the egg industry, where contract prices are predominately tied to Urner-Barry price quotes, another residual market—Egg Clearinghouse, Inc.—serves primarily to facilitate inventory adjustments (Peterson 2005). Hence, residual markets may serve important roles beyond price discovery.

Empirical Methods and Procedures

Following Tomek (1980), the number of transactions n required to assure a *high* probability P that the deviation of intraday or daily mean prices X_n from the true mean (equilibrium) price μ lays within a particular range of accuracy +/-c is found using Chebychev's inequality

$$(1)\ P(-c \le X_n - \mu \le c) \ge 1 - \frac{\sigma^2}{nc^2}$$

where σ^2 is the variance of the distribution of the mean, and n is the number of observations. Rearranging to solve for the minimum n necessary to satisfy the inequality yields

$$(2)\ n = \frac{\sigma^2}{(1-P)c^2}\ .$$

Hence, greater numbers of transactions n are required as the level of pricing precision desired increases (i.e., higher P and lower c), and for any particular chosen level of pricing accuracy, n increases with market variation σ^2.

Up to this point, the discussion has emphasized intraday or daily prices under fixed economic conditions. Over time, economic conditions change as do equilibrium prices which may also vary with quality and across space. Following Tomek (1980), in such contexts, μ is interpreted as the true price difference across time periods (e.g., weeks), qualities (e.g., grades), or locations. Specifically, in the case of autocorrelated prices across space, μ may be estimated by year using a first-differenced equation

$$(3)\ S_t - S_{t-1} = \mu + \beta(I_t - I_{t-1}) + v_t,$$

where S_t and I_t are St. Joseph and IAMN prices and v_t is the error term in time period t. In this case, the variance of μ serves as the relevant measure of σ^2.

Data

Spot hog prices from 1992 through 2010 for the Iowa-Southern Minnesota interior market are obtained from the Livestock Market Information Center (LMIC) and for a terminal market in St. Joseph, Missouri are obtained from Plain (2011). With implementation of MPR in April 2001, Iowa-Southern Minnesota began reporting prices on a carcass basis along with volume of hogs sold. LMIC adjusted pre-MPR live hog prices for Iowa-Southern Minnesota to reflect lean value, and this adjustment was also applied to the St. Joseph price series.[2] Application of Chebychev's inequality to these price series yield estimates of the number transactions necessary to support various levels of pricing precision, which are compared to actual volumes of hogs sold. Weekly volume of hogs sold through negotiated transactions in Iowa-Southern Minnesota, available only from 2001 through 2010, is also obtained from LMIC. Monthly volume of hogs sold in St. Joseph from 1992 through June 2010 is obtained from the USDA Agricultural

Marketing Service. Similar analyses are conducted on negotiated wholesale pork carcass cutout prices and load counts from 2001 through July 2009, obtained from USDA Agricultural Marketing Service office personnel in Des Moines, Iowa (2010).

Summary statistics are reported for Iowa-Southern Minnesota (IAMN) and St. Joseph hog prices on a carcass basis and national carcass cut-out prices in Table 1. Correlations among hog and carcass cut-out prices exceed 0.90. A small but positive correlation (0.14) indicates that St. Joseph price has decreased with lower volume, but this relationship is not apparent in IAMN or the national carcass cut-out based on correlations between prices and volume (-0.34 and -0.46).

Daily national data on base prices and average prices (accounting for quality premiums and discounts), backfat, loin depth, loineye area, and percent lean by procurement method (i.e., negotiated, swine market formula, other market formula, and other procurement arrangement) for producer sold hogs are obtained from LMIC spreadsheets on prior day national hog slaughter. Pair-wise t-tests of mean differences permit detection of statistical differences in carcass performance and associated quality premiums paid across procurement method. Table 2 provides summary statistics for these data. Figure 1 illustrates the decline in the proportion of hogs procured through negotiated transactions.

Mean weekly volumes of IAMN negotiated hogs are divided by 70 hogs per lot to infer an implied number of transactions. Vukina and Zeng's (2010) analysis of major packers' records of 76,850 negotiated transactions involving 4,822,634 hogs sourced from Iowa between October 8, 2002 and March 31, 2005, implies an average transaction size of 63 hogs per lot. After data cleaning, including elimination of very small lots of five or fewer hogs that may not be arms-length transactions, the remaining 51,798 transactions involving 3,548,609 hogs implies about 70 hogs per lot. The larger lot size is assumed here to invoke more stringent volume (i.e., head of hogs) requirements. Transactions are by load counts for the carcass cut-out. Lot sizes average about 35 head at St. Joseph according to University of Missouri Extension Economist, Ron Plain (2011). Hence, this value is used to convert St. Joseph receipts to estimated transactions.

Results

Sufficient Transactions for Precise Pricing

Table 3 compares the actual volume of hogs procured through negotiated transactions in the IAMN market to transaction requirements per week for three scenarios of pricing accuracy, as estimated by Chebychev's inequality. Corresponding results for national carcass cut-out data and data on the St. Joseph terminal market are presented in Tables 4 and 5.[3] The variance σ^2 used to establish the required number of transactions is estimated from first differences in weekly average negotiated prices for each market. In each case $P = 90\%$, but the value of c, which is in the context of standard deviations of the first differenced prices, varies at +/-$0.25, +/-$0.35, and +/-$0.45 per hundredweight (cwt).

Several interesting observations are apparent from the results. First, growing price variance is placing increasing volume requirements to maintain confidence in pricing precision in each

market. For IAMN in particular, price variance appears to have increased substantially in the period following enactment of mandatory price reporting (Table 3). The increased price variance may reflect greater variation in hog quality observed under mandatory reporting if transactions were reported selectively under the voluntary system. However, much of the increase in price variance may reflect increasing variance in the cost of feed inputs, and distinguishing the relative contribution of these factors to price variance is beyond the scope of this research.

Notably, the volume of hogs procured through negotiated transactions in IAMN is sufficient for +/-$0.35/cwt but not for more precise pricing (Table 3). This level of precision is not supported by the volume of transactions for the national carcass cut-out or for hogs in the terminal market at St. Joseph. Specifically, load counts for the national carcass cut-out support pricing precision of +/-$0.40/cwt (Table 4). Though ranging within a dollar (+/-$0.50/cwt) of the *true* price 90% of the time is a fairly reliable level of accuracy, these results indicate that hog contracts that formula price based off of the mandatorily reported IAMN negotiated hog price are likely more representative of market conditions than those tied to voluntarily reported national carcass cut-out prices. Mandating wholesale pork price reporting may hold potential to increase confidence in the precision of these prices if additional transactions are reported without substantially increasing the price variance. Currently, it is estimated that less than a quarter of pork buyers' purchases meet USDA qualifications for negotiated transactions, and only 80% of qualifying transactions are reported (Value Ag, LLC 2009).

For St. Joseph, volume has been insufficient for independent price discovery since the mid 1990s (Table 5). Following Tomek's (1980) comparison of a declining Denver market to a more vibrant Omaha market for fed cattle, the St. Joseph terminal hog market need not rely solely on its own volume to arrive at accurate prices if it can anchor to a viable IAMN market. Franken, Parcell, and Tonsor's (2011) finding that IAMN prices granger cause St. Joseph terminal prices supports this possibility. Table 6 compares St. Joseph mean weekly transactions with the number required for three levels of pricing accuracy. Here, the variance of $\hat{\mu}$ obtained from least squares estimates of equation (3) by year is used to establish the required number of transactions. Hence, *c* is in the context of the precision of changes in price differentials between IAMN and St. Joseph. Until recently (2008 and 2009), St. Joseph has been able to peg weekly price changes to IAMN weekly price changes within +/-$0.35/cwt of the true difference between price changes in these locations.

Quality Aspects of Thin Markets

In addition to lower volumes in thinning spot markets for hogs and pork, another criticism is that transactions in those markets may not reflect the quality of product generally available. Table 7 reports procurement mode's market share of hogs sold, and pair-wise t-tests of mean differences in hog quality between negotiated transactions and other procurement methods for the entire sample, as well as three consecutive three year subsamples. This design aids in assessing whether differences in hog quality across procurement mode have become more prominent over time. Moreover, subsample periods correspond to typical marketing contract duration of three to five years (Kliebenstein and Lawrence, 1995), facilitating insight into possible adjustments that could be made at contract renewal/renegotiation to make formula pricing representative of the industry conditions.

In each period, mean quality measures for negotiated transactions are presented, followed by mean differences with other procurement in ensuing rows (Table 7). Full sample results reveal statistically lower quality premiums (average price minus base price) for negotiated transactions, corresponding to statistically lower quality hogs in terms of smaller loins and lower percent lean, relative to other procurement methods. Findings for backfat differentials across procurement modes are mixed, as some alternative procurement methods have higher while others have lower values for these quality attributes than negotiated transactions. Statistically significant mean differences for loin depth and loin eye area growing ever more negative across consecutive sub-periods corroborate assertions of decreasing relative quality of spot market hogs, particularly in comparison to the most common procurement mode—market formula contracts. Notably, the proportion of hogs sold on average through these contracts increased six percent from the first to the last sub-period of the sample studied, accounting for most of the seven percent decrease in negotiated hog sales.[4] However, evidence of the declining relative quality of spot market hogs in terms of backfat and percentage lean, and consequently quality premiums, is mixed. Backfat and percentage lean are clearly related, and in relation to market formula contract hogs in particular, spot market hogs are closing the gap in terms of leanness. These findings may reflect general industry wide improvements in hog genetics and management over time, as evidenced by the regression analysis results discussed next.

Simple ordinary least squares (OLS) regressions of these measures of negotiated hog quality on the share of hogs marketed through negotiated transactions, denoted *%SPOT*, and a trend variable *t* yield intuitive results (Table 8).[5] The trend variable *t* indicates improvements in quality (i.e., lower backfat and greater loin size and percentage lean) occur over time, perhaps due to advancements in genetics and/or management. Meanwhile, the quality of spot market hogs tends to decrease with the declining share of hogs procured through negotiated transactions. Specifically, with a 10% decrease in *%SPOT*, backfat increases about one hundredth of an inch, loin depth decreases about four hundredths of an inch, loin eye area increases thirteen hundredths of an inch squared, and percentage lean decreases nearly half a percent.[6] While these estimates are statistically significant, they are not very large in magnitude. Similar results are found using two-limit Tobit regressions not reported here.

Conclusions

This study investigates the thinness of hog and pork markets, as measured by quantity- and quality-based indicators. Statistical sampling procedures indicate that transactional volume for negotiated hogs in the Iowa-Southern Minnesota market and for the national carcass cut-out is sufficient to impart confidence in the reliability of pricing precision. Although, the results suggest that formula contract prices based off of mandatorily reported Iowa-Southern Minnesota negotiated hog prices may be more representative of industry conditions than contracts tying to voluntarily reported national carcass cut-out prices. Mandatory reporting of underlying pork primals may increase the reliability of carcass cut-out pricing precision. Similar analyses indicate that a terminal hog market in St. Joseph, Missouri is no longer viable for independent price discovery, but can price fairly reliably based off of Iowa-Southern Minnesota prices. Statistically significant, though economically minor deficiencies in negotiated hog quality relative to hogs procured via alternative marketing arrangements are documented, and negotiated

hog quality is shown to decrease significantly with the declining share of hogs procured through negotiated transactions.

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Endnotes

[1] While transactional volume and market structure (i.e., number of participants) are distinct issues, they are inextricably linked. Clearly, consolidation on both sides of a market contributes to declining transactions. Furthermore, the potential for price manipulation under low transactional volume may be exacerbated in a market structure with few participants.

[2] Due to a typical slaughter yield of about 74%, the lean price is generally computed as the live price divided by 0.74 (Wellman 1996).

[3] See Value Ag, LLC (2009) for a similar analysis of primals underlying the carcass cut-out.

[4] Several studies suggest that contracting is significantly more likely among larger farms (Key and McBride 2003; Franken, Pennings, and Garcia 2009). The number of farms with 2,000 or more hogs increased during the period of study, with 7,155, 7,868, and 8,313 farms on average in the three consecutive sub-periods, according to USDA National Agricultural Statistics Service (2011).

[5] The large inverse correlation (-0.855) between *%SPOT* and the trend variable *t* could pose multicollinearity problems, but the potential for such problems is low with the large sample size.

[6] These results imply that the negative relationship between captive supplies (i.e., declining proportional spot transactions) and spot prices, interpreted by Ward, Koontz, and Schroeder (1998) and Schroeter and Azzam (2004) as evidence potential price manipulation by buyers, may also reflect a simultaneous decrease in the quality of animals traded in spot markets.

Table 1. Summary Statistics for Weekly Spot Market Hog and Pork Prices and Volumes

	Max	Min	Mean	S.D.
St. Joseph				
Prices [a]	83.92	13.38	55.99	11.16
Receipts [b]	37,541	308	10,194	10,932
Receipts [c]	9,385	77	2,549	2,733
IAMN [d]				
Prices [e]	90.95	14.19	61.21	11.94
Receipts [f]	138,520	17,786	72,159	23,449
Carcass Cut-Out [g]				
Prices	93.75	43.89	65.31	8.93
Loads	620	196	359	74

[a] Weekly average prices, N = 962 observations (1992-6/5/2010).
[b] Monthly Receipts, N = 222 observations (1992-6/15/2010).
[c] Inferred Weekly Receipts
[d] IAMN denotes Iowa-Southern Minnesota market.
[e] Weekly average prices, N = 991 observations (1992-2010).
[f] Weekly Receipts, N = 505 observations (5/4/2001-2010).
[g] Data are N = 448 weekly observations (2001-7/31/2009).

Table 2. Summary Statistics for Hog Quality Measures and Spot's Market Share, National Data

Variable	Max	Min	Mean	Std. Dev.
Negotiated				
Premium ($/cwt)	4.68	-0.48	1.65	0.63
Yield (carcass wt / live wt)	0.80	0.73	0.76	0.01
Backfat (inches)	0.84	0.66	0.74	0.03
Loin depth (inches)	2.48	2.02	2.28	0.05
Loineye area (square inches)	7.44	6.05	6.85	0.16
Lean (%)	55.45%	51.53%	53.74%	0.46%
Market Share (%)	26.82%	2.36%	13.29%	4.00%
Market Formula				
Premium ($/cwt)	4.29	-0.23	2.50	0.42
Yield (carcass wt / live wt)	0.76	0.72	0.76	0.00
Backfat (inches)	1.08	0.68	0.74	0.02
Loin depth (inches)	2.90	2.31	2.49	0.06
Loineye area (square inches)	8.72	6.92	7.47	0.19
Lean (%)	55.36%	53.27%	54.59%	0.33%
Market Share (%)	70.74%	40.79%	54.49%	4.54%
Other Market Formula (based on CME)				
Premium ($/cwt)	7.41	-3.02	2.99	0.62
Yield (carcass wt / live wt)	0.79	0.72	0.76	0.01
Backfat (inches)	0.87	0.66	0.75	0.03
Loin depth (inches)	2.85	2.15	2.50	0.08
Loineye area (square inches)	8.58	6.43	7.50	0.23
Lean (%)	55.60%	52.56%	54.43%	0.55%
Market Share (%)	26.66%	3.71%	12.32%	3.62%
Other Procurement Arrangement (window, cost-plus)				
Premium ($/cwt)	4.34	-8.84	1.70	1.23
Yield (carcass wt / live wt)	0.80	0.74	0.77	0.01
Backfat (inches)	0.99	0.66	0.73	0.02
Loin depth (inches)	3.31	2.12	2.30	0.07
Loineye area (square inches)	9.98	6.20	6.90	0.22
Lean (%)	57.85%	53.00%	54.26%	0.31%
Market Share (%)	35.20%	4.54%	19.90%	4.43%

Note: N = 2452 observations. Premium =average price - base price.

Table 3. IAMN Negotiated Volume and Transactions Needed for Reliable Price Discovery

Year	Mean Weekly Volume (head)	Estimated Transactions/Week (head ÷ 70 head/lot)	Variance in IAMN 1st Differences	Transactions/Week for Accurate Price Discovery (P = 90%, c = stated value)		
				+/- $0.25/cwt	+/- $0.35/cwt	+/- $0.40/cwt
1992	n.a.	n.a.	2.04	327	167	128
1993	n.a.	n.a.	1.62	260	133	101
1994	n.a.	n.a.	2.94	470	240	184
1995	n.a.	n.a.	3.46	554	282	216
1996	n.a.	n.a.	5.81	930	474	363
1997	n.a.	n.a.	4.26	681	347	266
1998	n.a.	n.a.	6.73	1,076	549	420
1999	n.a.	n.a.	8.86	1,418	723	554
2000	n.a.	n.a.	4.06	649	331	253
2001	58,349	834	5.09	814	415	318
2002	86,240	1,232	11.12	1,779	908	695
2003	97,242	1,389	6.54	1,046	534	409
2004	82,848	1,184	12.66	2,025	1,033	791
2005	86,777	1,240	10.05	1,607	820	628
2006	68,271	975	11.88	1,901	970	742
2007	60,422	863	7.18	1,149	586	449
2008	74,020	1,057	10.78	1,726	880	674
2009	53,872	770	9.54	1,526	779	596

Note: N = 991 observations (1992-2010) for weekly average prices, and N = 505 observations (5/4/2001-2010) for weekly Receipts.

Table 4. Carcass Cut-Out Negotiated Volume and Transactions Needed for Reliable Price Discovery

Year	Mean Weekly Load Count	Variance in IAMN 1st Differences	Transactions/Week for Accurate Price Discovery (P = 90%, c = stated value)		
			+/- $0.25/cwt	+/- $0.35/cwt	+/- $0.40/cwt
2001	410	3.72	595	304	232
2002	408	3.72	595	303	232
2003	366	4.27	683	349	267
2004	343	5.41	866	442	338
2005	306	4.15	665	339	260
2006	301	4.79	766	391	299
2007	344	3.80	609	311	238
2008	362	7.96	1273	650	497
2009	422	6.80	1088	555	425

Note: N = 448 weekly observations (2001-7/31/2009). See Value Ag, LLC (2009) for comparable calculations for underlying pork primals.

Table 5. St. Joseph, MO Negotiated Volume and Transactions Needed to for Reliable Price Discovery

Year	Mean Weekly Volume (head)	Estimated Transactions/Week (head ÷ 35 head/lot)	Variance in St. Joseph 1st-Differences	Transactions/Week for Accurate Price Discovery (P = 90%, c = stated value)		
				+/- $0.25/cwt	+/- $0.35/cwt	+/- $0.40/cwt
1992	6,753	193	2.28	365	186	143
1993	6,441	184	2.21	354	181	138
1994	7,285	208	3.27	524	267	205
1995	6,170	176	4.14	663	338	259
1996	4,104	117	6.41	1,026	523	401
1997	2,954	84	5.19	830	423	324
1998	2,293	66	7.43	1,190	607	465
1999	1,614	46	10.30	1,648	841	644
2000	1,043	30	5.05	808	412	316
2001	916	26	6.51	1,041	531	407
2002	815	23	12.15	1,944	992	759
2003	688	20	7.89	1,262	644	493
2004	553	16	15.77	2,524	1,288	986
2005	459	13	14.92	2,387	1,218	933
2006	539	15	14.05	2,247	1,147	878
2007	393	11	6.56	1,049	535	410
2008	281	8	11.85	1,896	967	741
2009	157	4	7.00	1,120	571	437

Note: N = 962 observations (1992-6/5/2010) for weekly average prices, and N = 222 observations (1992-6/15/2010) for monthly Receipts.

Table 6. St. Joseph, MO Negotiated Volume and Transactions Needed to Reliably Price off of IAMN Prices

Year	Mean Weekly Volume (head)	Estimated Transactions/Week (head ÷ 35 head/lot)	Mean Var of Week-to-Week Relation between 1st-Differenced St. Joseph and IAMN Prices	Transactions/Week for Accurate Price Discovery (P = 90%, c = stated value)		
				+/- $0.10/cwt	+/- $0.25/cwt	+/- $0.35/cwt
1992	6,753	193	0.0087	9	1	1
1993	6,441	184	0.0074	7	1	1
1994	7,285	208	0.0043	4	1	0
1995	6,170	176	0.0139	14	2	1
1996	4,104	117	0.0154	15	2	1
1997	2,954	84	0.0103	10	2	1
1998	2,293	66	0.0232	23	4	2
1999	1,614	46	0.0349	35	6	3
2000	1,043	30	0.0166	17	3	1
2001	916	26	0.0332	33	5	3
2002	815	23	0.0391	39	6	3
2003	688	20	0.0346	35	6	3
2004	553	16	0.0357	36	6	3
2005	459	13	0.0386	39	6	3
2006	539	15	0.0726	73	12	6
2007	393	11	0.0589	59	9	5
2008	281	8	0.0866	87	14	7
2009	157	4	0.1442	144	23	12

Note: N = 962 observations (1992-6/5/2010) for weekly average prices, and N = 222 observations (1992-6/15/2010) for monthly Receipts.

Table 7. Pair-wise t-tests of Mean Quality Differentials between Negotiated and Other Procurement Methods

Mean or Mean Difference	Procurement Market Share	Premium[a]	Backfat	Loin Depth	Loineye Area	Lean (%)
Full Sample (n = 2452)						
Negotiated Mean	13%	1.65	0.742	2.28	6.85	53.74
- Market Formula Mean	54%	-0.85***	4.853×10^{-4}	-0.20***	-0.62***	-0.84***
- Other Market Formula Mean	12%	-1.34***	-0.003***	-0.21***	-0.65***	-0.68***
- Other Procurement Arrangement Mean	20%	-0.05**	0.008***	-0.01***	-0.04***	-0.52***
8/3/2001 - 8/3/2004 (n = 764)						
Negotiated Mean	17%	1.51	0.77	2.24	6.72	53.28
- Market Formula Mean	52%	-1.39***	0.03***	-0.19***	-0.57***	-0.96***
- Other Market Formula Mean	12%	-1.36***	0.01***	-0.19***	-0.57***	-0.58***
- Other Procurement Arrangement Mean	19%	0.04	0.03***	-2.36×10-3*	-0.01	-0.86***
8/4/2004 - 8/3/2007 (n = 765)						
Negotiated Mean	13%	1.50	0.74	2.29	6.88	53.76
- Market Formula Mean	53%	-0.94***	-3.91×10-3***	-0.20***	-0.60***	-0.86***
- Other Market Formula Mean	12%	-1.51***	-0.02***	-0.24***	-0.73***	-0.65***
- Other Procurement Arrangement Mean	22%	-2.85×10^{-3}	4.92×10^{-3}***	-0.03***	-0.10***	-0.39***
8/4/2007 - 3/18/2011 (n = 923)						
Negotiated Mean	10%	1.89	0.72	2.31	6.95	54.12
- Market Formula Mean	58%	-0.33***	-0.02***	-0.22***	-0.67***	-0.74***
- Other Market Formula Mean	13%	-1.20***	-2.36×10-3***	-0.21***	-0.64***	-0.79***
- Other Procurement Arrangement Mean	19%	-0.17***	-4.02×10^{-3}***	-0.01***	-0.03***	-0.34***

Note: *, **, *** denote statistical significance at 10%, 5%, 1% level.

[a] Premium =average price - base price.

Table 8. Quality Attributes for *Spot* Hogs Regressed on Proportion of Daily National Hog Slaughter Procured via Negotiated Transactions and Time

	Backfat	Loin Depth	Loineye Area	Lean
%Negotiated	-0.001***	0.004***	0.013***	0.0465***
	(1.757×10^{-4})	(3.958×10^{-4})	(0.001)	(0.003)
t	-3.800×10^{-5}***	6.810×10^{-5}***	2.079×10^{-4}***	6.822×10^{-4}***
	(-9.930×10^{-7})	(2.240×10^{-6})	(6.810×10^{-6})	(1.740×10^{-5})
Constant	0.799***	2.143***	6.420***	52.290***
	(0.003)	(0.008)	(0.024)	(0.060)
Adjusted R^2	0.641	0.417	0.418	0.534

Note: n = 2452 observations. Yield equals average carcass weight divided by average live weight of hogs.
*** denotes statistical significance at 1% level.

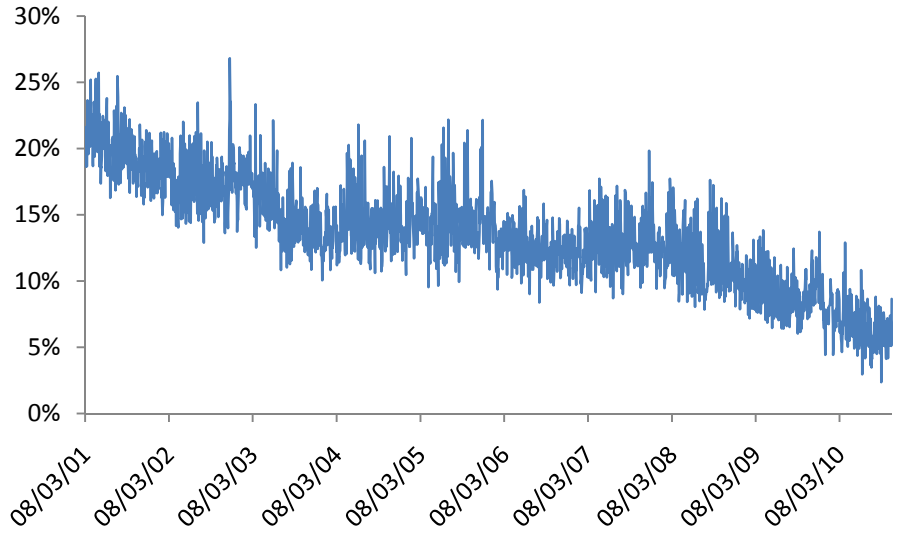

Figure 1. Proportion of Daily National Hog Slaughter Procured via Negotiated Transactions, 2001 -2010