Impacts of Alternative Marketing Agreement Cattle Procurement on Packer Costs, Gross Margins, and Profits: Evidence From Plant-Level Profit and Loss Data

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ABSTRACT

This work measures the impact of captive supplies, or cattle procured through alternative marketing agreements (AMAs), on meatpacker costs, gross margins, and profits. Confidential profit and loss data were examined from all the individual packing plants within the four largest packing firms for a 30-month period. Alternative marketing agreement use resulted in improved beef supply chain efficiency, product demand, and plant profitability. The slaughter and processing costs were lower for plants with higher volumes of AMA cattle relative to cash market cattle. Plants that slaughter cattle from AMA sources operated at higher volumes, had less variable volumes, and had lower average total costs per head because of the substantive economies of size. Plants that slaughter cattle from AMA sources also had higher gross margins and average profits per head. The general conclusion is clear: If policies are implemented that limit AMA use then packing industry efficiency would be negatively impacted. [EconLit Citation: Q130]. © 2010 Wiley Periodicals, Inc.

1. INTRODUCTION

Captive supplies, or alternative marketing arrangements (AMAs), are a contentious issue with some cattle industry members. Alternative marketing agreements are procurement alternatives that do not involve the use of cash markets. In the cattle industry, AMAs include forward contracts, marketing agreements, and packer-owned cattle. As a result, policy makers have introduced a number of Congressional bills to limit the use of AMAs. The most well-known bill was the Johnson Amendment to the 2002 Farm Bill. That amendment would have prohibited the use of AMAs, but was not included in the final Farm Bill that was signed into law.[1]

As a compromise to the proposed 2002 legislation, Congress mandated a study of AMAs. Prior research that has measured the impact of AMAs on fed cattle price includes Elam (1992); Schroeder, Jones, Mintert, and Barkley (1993); Azzam (1996); Ward, Koontz, and Schroeder (1998); Schroeter and Azzam (1999, 2003, 2004); and

[1]There was also a competition title within the U.S. Senate version of the 2007 Farm Bill that had similar intent. However, the U.S. House of Representatives version did not contain the competition title and it was not in the final bill. Regardless, this issue and question have persisted, and if passed sometime in the future, it remains to be seen if the strength of the language would prohibit commonly used AMAs.

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Zhang and Sexton (2000). Research that has examined the theoretical relationship between AMAs and market power include Azzam (1998) and Love and Burton (1999). A limitation of this prior work is that all of it focused on the costs associated with AMAs. The main objective of these studies was to measure the market power associated with AMA use. In contrast, the mandated study was to conduct a more comprehensive examination of benefits, as well as the costs. The resulting GIPSA Livestock and Meat Marketing Study (LMMS) was completed in early 2007. The research reported here was part of the LMMS and examines a specific benefit associated with the use of AMAs.

One economic justification for the use of AMAs is that these arrangements allow for more efficient use of packing plant facilities. Alternative marketing agreements may permit packing plants to be operated at lower costs because AMA volumes can be better anticipated and better matched with other inputs. Alternative marketing agreements may also permit the packing plant to be operated at optimal volumes. Finally, AMAs may permit the packing plant to operate at more consistent volumes. Variation in slaughter and processing volumes and U-shaped average cost functions result in higher costs than stable volumes. Although all of these arguments have economic logic and have long been recognized as possible (see Purcell, 1979, and Feuz et al., 2002), these arguments are hypotheses and have not been tested with data. There is no research that specifically looks at the impact of AMAs on packing costs. Our work does this and is a unique expansion on survey-based packing industry cost research by Ward (1990, 1993) and an expansion on census-based cost research by and summarized in MacDonald (2003).

Accompanying the cost logic, similar economic arguments can be made with respect to meat revenues and packer profitability. AMA cattle are of higher quality, are more likely to be the cattle that are in branded beef programs, and are more likely to be the cattle where something different is being done in the production process so that the additional service results in additional revenue to the packer. Analyses of private data collected through the LMMS (Muth et al., 2007, Section 4, pp. 1–31) and public data sources (Whitley, 2002) demonstrate that AMA cattle are of higher quality. Finally, if AMAs result in lower costs and higher revenue, then profitability of the plants should reflect both impacts.

Here we report on one part of the LMMS that involved an analysis of confidential packer profit and loss (P&L) data. This type of data has never been available in a nonlitigation-based study and has never been available for a substantial portion of the packing industry for multiple years.[2] The objective of this research is to test the hypotheses above with data that packers generate for cost accounting and use for internal operations management. The data are a unique contribution of the research.

2. CONCEPTUAL MODEL

The underlying modeling framework involves measuring average total slaughter and processing costs. The margin between beef and byproduct prices received and cattle prices paid by a packer must cover average total economic costs of slaughter and processing in the long run. If costs are higher for cash market cattle than for AMA

[2]The USDA GIPSA collects and reports packer profits in that agency's annual report. However, those data are aggregated across firms and time.

cattle, then policies that limit or prohibit the use of AMAs will result in higher long-run costs. In a derived demand framework, increases in costs will result in decreases in fed cattle prices paid and a contraction in the size of the cattle-producing industry.

Plant-level packer total profits are total revenues less total costs. Total revenues are a linear combination of meat prices and quantities, byproduct prices and quantities, and other miscellaneous revenues. The main packer cost is fed cattle purchases. Remaining costs involve plant costs (labor, materials, energy, and physical facilities), corporate overhead (sales, administration, and management), and other miscellaneous costs. All packers allocated corporate overhead back to the plants. In summary,

$$\begin{aligned} &\textit{Total Profit} \\ &\quad = \textit{Total Revenue}\ (\textit{Meat}(\textit{Cash},\ \textit{AMA}),\ \textit{Byproduct}) \\ &\qquad + \textit{Miscellaneous Revenues} - \textit{Total Cattle Costs} \\ &\qquad - \textit{Total Costs}\ (\textit{Cash}, \textit{AMA}) - \textit{Miscellaneous Costs} \end{aligned} \tag{1}$$

where meat revenues and plant costs are influenced by the cattle source – cash versus AMA. The miscellaneous items can be combined and are ignored in terms of analysis. These items are small in number and magnitude, but required in the P&L statements. Total revenues and cattle costs are combined into a packer gross margin. The monthly dollar totals are divided by the number of head slaughtered, which results in an average profit per head, average gross margin, and average total costs. Or,

$$\begin{aligned} &\textit{Average Profit Per Head} \\ &\quad = \textit{Average Gross Margin Per Head}(\textit{Cash},\ \textit{AMA}) \\ &\qquad - \textit{Average Total Costs Per Head}(\textit{Cash},\ \textit{AMA}) \\ &\qquad + \textit{Miscellaneous Balance Per Head} \end{aligned} \tag{2}$$

and the analysis will focus on the first three terms—ATC (average total cost), AGM (average gross margin), and PPH (average profit per head)—of this equation.

The main economic argument used in this work is that Equation 2 describes an equilibrium relationship between meat and cattle prices and the provision of processing services. If AMAs result in lower costs and higher revenues, and if AMAs are limited or prohibited, then short-run profits will decrease. However, in the long run, the packing industry requires economic profits commensurate with investment and risk. It is the cattle prices paid that will likely do the adjusting. The purpose of this research is to measure whether AMA procured cattle are associated with lower costs and higher revenues.

Marketing margin research estimates or makes use of prior research findings of the supply and demand for the wholesale output and the supply and demand for the farm input (see Wohlgenant, 2001, and references therein). Equilibrium margins can then be inferred and changes in those margins can be simulated from these relationships. Our approach was more simplistic and was an input to such an equilibrium displacement model. We measured packer average total costs, average gross margins, and profit per head in P&L data and measured changes in those variables as AMA volumes changed. This information was then used in an equilibrium model (see Muth et al., 2007, Section 6, pp. 1–61). The work here reports only on the results of the P&L data analysis.

The P&L data are known to be problematic for the estimation of marginal relationships (see French, 1977). Accounting data simply do not well-represent marginal costs and marginal returns. Further, P&L data have limited detail. Packer P&L data contain dollar information on revenues and costs, information on the head slaughtered and pounds processed, but do not contain information on the quantity of inputs used nor input prices. Because of this the estimation of plant-level production or cost functions is not possible.[3] This issue is important because it prevents across-plant comparisons of cost and limits us to within-plant measurements. However, the first strength of P&L data is that it is real. It is what firms observe through plant operations and what firms use in the making of management decisions. Second, average cost relationships can be well-inferred from P&L data, and it is average costs that must be covered by margins in the long run.

3. DESCRIPTION OF PROFIT AND LOSS STATEMENT DATA

The data used for the analysis are from monthly P&L statements for 21 beef packing plants in the United States from October 2002 through March 2005. These 21 plants are owned by the four largest companies, with all companies owning multiple plants. The data were collected by RTI International (Research Triangle Park, NC) under contract with U.S. Department of Agriculture Grain Inspection, Packers, and Stockyards Administration (USDA GIPSA) in spring 2006. GIPSA has subpoena power, but all packers cooperated with the data request. The highly confidential nature of the data required it to be collected and maintained under the provisions of the Confidential Information Protection and Statistical Efficiency Act (CIPSEA) of 2002.[4] Data collected under CIPSEA can be used only for statistical analysis purposes and cannot be used for investigations. Furthermore, results of analyses cannot reveal plant-specific or firm-specific information. P&L data were obtained for each of the 21 plants and all analysis was conducted at the plant level. However, all presented results must be aggregated across plants so that no individual plant or firm is identified. A weighted average set of results was constructed where the weights were plant volume.

The volume of head slaughtered and processed by the four largest firms for the October 2002 through March 2005 period was approximately 82% of USDA Federally Inspected (FI) Fed Steer and Heifer slaughter. All firms provided P&L information for each of their domestic plants. Smaller beef packers were not used for a variety of reasons, which include data not being provided in electronic format, incomplete data, changes in accounting systems during the sample period, and small volumes relative to the industry as a whole. Small packers with usable P&L data

[3]Morrison-Paul (2001) provided information on a plant-level cost function for the beef packing industry using data collected by GIPSA through a survey of packers. The work found substantive scale economics and little evidence of market power. However, the scale economies information was a single elasticity and the impact of AMA volumes on costs was not examined. AMA volumes only impact the market power measures. Driscoll, Kambhampaty, and Purcell (1997), use the same data and suggest that there were difficulties in extracting proof of, for example, profit maximizing behavior, and they questioned the quality of the survey data.

[4]Text of the public law can be found at http://www.eia.doe.gov/oss/CIPSEA.pdf.

accounted for less than 4% of the USDA FI Fed Steer and Heifer slaughter so including these plants would not change the results.

The P&L data are interesting. It is maintained differently across the major packers. The structure of the P&L statements is different across firms, and there are large variations in the categories of information that are detailed. For example, some firms reported very detailed byproduct revenue information, whereas other firms reported very few lines associated with revenue categories. The placement of specific types of information within P&L statements also varies across packers. Some firms reported labor as a variable cost; others reported labor with other costs that were most likely fixed costs. Likewise, some firms reported plant costs as a fixed cost, and some reported plant costs with other costs that were most likely variable costs. Some of the firms reported slaughter and processing on separate P&L statements, even when the slaughter and processing operations were at the same facility site, whereas other firms combined slaughter and processing into a single P&L statement.

Because of the differences in P&L statements across firms, only the comparison of basic information can be reported. Results reported are average total costs per head (ATC), average gross margin per head (AGM), and average profit per head (PPH). Total costs, total gross margin, and total profits were available for each plant from each monthly P&L statement. We divided each total by the number of head slaughtered and processed each month to create an average per head per month figure. We conducted more detailed analysis of the firms that provided more detailed data, the results were consistent with those reported here, and will be discussed later.

4. METHODOLOGY FOR ANALYZING PROFIT AND LOSS DATA

Below, we describe the models for ATC, AGM, and PPH. Models are estimated for each plant, but the reported results are aggregated over all plants. The aggregate result is referred to as a "representative" plant for the industry. These plant-level models describe how ATC, AGM, and PPH vary with plant volume and plant AMA use.

4.1. Total Costs per Head Model

The primary modeling effort using P&L data involves regressing ATC for each plant as a function of the volume slaughtered and processed at the plant and the percentages of volumes that are procured through AMAs at the plant. The basic ATC model is as follows:

$$\begin{aligned} &\mathit{Average\ Total\ Cost\ Per\ Head}_t \\ &\quad = \beta_0 + \beta_1 \ln(\mathit{Volume}_t) + \beta_2(\%FC_t) + \beta_3(\%MA_t) \\ &\qquad + \beta_4(\%PO_t) + \Sigma_j(\alpha_{jt} x_{jt}) + \varepsilon_t \end{aligned} \tag{3}$$

where t denotes month and the variables $\%FC$, $\%MA$, and $\%PO$ denote forward contract, marketing agreement, and packer-owned fed cattle expressed as a percentage of total monthly volumes. The vector x_j represents other variables, which for this model, are a trend variable, and labor, energy, and capital input price indices were obtained from the U.S. Bureau of Labor Statistics sources. The semilogarithm functional form was found to be appropriate. Quadratic ATC functions were not because the data showed no regions where ATC increased with higher volumes. ATC functions were not U-shaped, or at least plants never operate on the increasing cost portion, nor was there a flat spot reflecting a minimum.

Coefficients on the AMA variables measure whether higher volumes of fed cattle purchased through AMAs were associated with lower ATCs. We refer to the coefficients as the direct effect of the cost differences attributed to AMA use. These measurements are cost differences that firms can recognize at plants through P&L accounting. These cost differences are specific to each plant. This approach should underestimate cost differences as AMA use may provide relative plant advantages. However, there is insufficient information in the P&L data about the different plant technologies to be able to model these technological differences through production or cost functions and then attribute what is not explained to variations in AMAs. The result is that the reported approach is conservative in the measurement of cost differences, but alternative approaches would require data we do not have.

Results from Equation 3 can be used to simulate changes in ATCs when AMA volumes are limited because of policy intervention. For example, if a policy required that no cattle be procured through AMAs, then substituting zero for the AMA variables enables a calculation of the change in ATCs due to the restriction while holding all else constant, in particular, the plant volume.

4.2. Model of Plant-Level Volumes

When conducting policy simulations, in addition to the direct effects on costs, there are two important indirect effects. First, if a policy change results in reduced volumes of cattle slaughtered and processed at a packing plant, then the effect of those changes can be measured through the volume coefficient in the ATC model. Thus, volume changes need to be measured. Second, if a policy change results in changes in the variability of cattle volumes at a packing plant, then those changes also need to be measured.

Plant volumes are modeled as follows:

$$\begin{aligned} Volume_t =& \beta_0+\beta_1(USDAFI_t)+\beta_2(FC_t)+\beta_3(MA_t) \\ &+\beta_4(PO_t)+\textstyle\sum_j(\alpha_{jt}x_{jt})+\varepsilon_t \end{aligned} \tag{4}$$

where the total monthly volume of head slaughtered and processed at a plant (*Volume*) is modeled as a function of AMA volumes (*FC*, *MA*, and PO) that are measured in number of head and the monthly USDA FI Fed Steer and Heifer slaughter (*USDAFI*) that are measured in thousands of head. The vector x_j represents other variables. Models are estimated for each plant so that plant-specific associations are measured. The *USDAFI* variable captures general changes in supply numbers. During the study period, cattle numbers were initially large because the market was in the liquidation phase of the cattle cycle. Cattle numbers were smaller toward the end of the sample as the cycle changed to herd rebuilding. This specification is similar to stock market beta models where the underlying stock market index is included to explain an individual stock price. The other variables were a trend, seasonal, and market disruption variables. An individual plant may have variation in volumes which are different from the national aggregate because of unique seasonal variation, changes in local feeding capacity, changes in regional trade flows, and other market shocks.

The model measures how changes in the total volume of cattle slaughtered and processed at a plant vary with changes in AMA volumes, while holding constant the total number of cattle in the marketplace and accounting for unique characteristics of the region and market events. Some plants readily substitute cash market cattle for AMA cattle. For example, if volume of marketing agreement cattle decreases by 1,000 head, then those cattle might be offset by an increase of 900 cash market cattle, and the total cattle purchase volume will decrease by 100 head. On the other hand, some plants substitute fewer cash market cattle to make up for variations in volumes procured through AMAs. Substantial differences occur across plants, and some plants readily substitute cash for AMA cattle; other plants do not. However, this measurement holds constant the variations in total U.S. fed cattle slaughter.

We recognize that this is a reduced form model and it may be problematic for policy simulation. A structural model of procurement method choice may be better, but there is not one in the literature and it is not possible to estimate one with the data obtained by the LMMS.[5] The model that we use does show how cash procurement volumes have changed with variation in AMA procurement volumes for the sample period, and there has been considerable variation in AMA volumes.

4.3. Plant Volume Variability

The second volume modeling effort measures the variability of plant volumes by measuring the variation associated with the different procurement methods. By definition, the variance of plant volume is the variance of the sum of the volume of the different procurement methods:

$$\begin{aligned}&\mathrm{Var}(\mathit{Volume})\\&\quad=\mathrm{Var}(\mathit{Cash}+\mathit{FC}+\mathit{MA}+\mathit{PO})\\&\quad=\mathrm{Var}(X_1+X_2+X_3+X_4)\end{aligned}\tag{5}$$

A constant can be multiplied by each procurement method so that the mean total volume is preserved and then the total volume variance is by definition the weighted sum of variances and covariances:

$$\begin{aligned}&\mathrm{Var}(\mathit{Volume})\\&\quad=\mathrm{Var}(k_1X_1+k_2X_2+k_3X_3+k_4X_4)\\&\quad=\textstyle\sum_i k_i^2\mathrm{Var}(X_i)+\sum_i\sum_j k_ik_j\,Cov(X_i,X_j).\end{aligned}\tag{6}$$

Similarly, the expected value of plant volume is

$$\begin{aligned}E(\mathit{Volume})=&k_1E(X_1)+k_2E(X_2)\\&+k_3E(X_3)+k_4E(X_4).\end{aligned}\tag{7}$$

So, if AMAs are limited or prohibited then $E(X_2)$, $E(X_3)$, and $E(X_4)$ can be reduced through changing k_2, k_3, and k_4, but k_1 will need to be increased so the mean is

[5]There was a model of marketing method choice that was estimated in the 1996 GIPSA study but it was not a strong model (see Texas Agricultural Market Research Center, Slaughter Cattle Procurement and Pricing Study Team, 1996). There was relatively little switching between marketing methods observed in transactions data. Marketing method choices are infrequent and are not made on a transaction by transaction basis. Rather, these choices are management decisions made through negotiation between cattle feeders and beef packers and involve a long-term commitment.

preserved. Here $k_1 = 1$ and k_2, k_3, and k_4 are the percent of total volume procured through AMA methods. Any reduction in k_2, k_3, and k_4 are added to k_1. Equation 5 is then used to construct the volume variance for each plant from the variance of procurement sources with proper changed weights. This assumes the variability of plant total volume is the same as the relative proportion of the variability of individual procurement methods. For example, if half of the volume for a plant is procured from AMAs, and if AMAs are prohibited, then to maintain the mean total volume the plant will have to procure twice the amount from the cash market. And if cash procurement volume is more variable than AMA procurement volumes then the plant total volume variance will reflect this. This process allows for measurement of a variability effect caused by changing AMA use, but changes in variability were not confounded with changes in the mean plant volume.

Similar to the volume level model, we recognize that this variance calculation is a reduced form result and it may be problematic for policy simulation. It is possible that if AMAs are limited or prohibited, then packer behavior would change and the structure of the cash procurement variability would change. We discuss this, and volume levels, more in the results section.

4.4. Average Gross Margin Per Head Model

The second primary modeling effort using P&L data involves modeling AGM as a function of the volume and the percentage of volumes procured through AMAs. The AGM model is:

$$\begin{aligned} &\textit{Average Gross Margin Per Head}_t \\ &\quad = \beta_0 + \beta_1 \ln(\textit{Volume}_t) + \beta_2(\%FC_t) + \beta_3(\%MA_t) \\ &\quad + \beta_4(\%PO_t) + \textstyle\sum_j(\alpha_{jt}x_{jt}) + \varepsilon_t \end{aligned} \tag{8}$$

where t denotes month and $\%FC$, $\%MA$, and $\%PO$ denote forward contract, marketing agreement, and packer-owned procurement of cattle expressed as a percentage of the total monthly volume. Other variables, x_j, found to be important for this model include a trend variable and the USDA Economic Research Service (ERS) farm-to-wholesale beef price spread, which captures market conditions that all packers face. The plant specific variables in the model measure the performance of the plant relative to those general market conditions.

Gross margins were calculated as meat and byproduct revenues net of fed cattle purchase costs. The model was used to examine whether margins were larger than for plants when AMA volumes were larger versus cash market volumes. The model determines whether AMA cattle generate more revenue for the plant because of factors such as better quality, better quality control, or participation in branded beef programs. However, the source of the improved margins is not specifically identified.

4.5. Average Profit per Head Model

The third main modeling effort using P&L data involves modeling PPH as a function of slaughter volume and the percentage of volumes that are procured through

AMAs. The PPH model is as follows:

$$\begin{aligned} &\textit{Average Profit Per Head}_t \\ &\quad = \beta_0 + \beta_1 \ln(\textit{Volume}_t) + \beta_2(\%FC_t) \\ &\qquad + \beta_3(\%MA_t) + \beta_4(\%PO_t) + \sum_j (\alpha_{jt} x_{jt}) + \varepsilon_t \end{aligned} \tag{9}$$

where the variables are as defined earlier. Again, other variables, x_j, were found to be important and include a trend and the USDA ERS farm-to-wholesale beef price spread.

Profits can be defined as gross margins minus total costs. But all firms include other special revenues (e.g., facility equipment sales) and other nonrecurring costs (e.g., management bonuses) in P&L statements. Equation 9 is used to examine whether profits associated with procuring fed cattle through AMAs are greater for a plant than profits associated with cash market cattle. The model determines whether AMA cattle generate more profits for the packer. Changes in PPH due to changes in AMA volumes should confirm results from the ATC and AGM models. Specifically, changes in costs and changes in revenue should approximately total changes in profits.

5. MODEL ESTIMATION DETAILS

The ATC, AGM, and PPH equations were pooled and estimated jointly for all plants within each firm using seemingly unrelated regression (SUR). The block of equations also contained other relationships specific to each packer. For example, labor costs, plant costs, boxed beef revenue, cattle costs, and other costs and revenues were available from P&L statements for some firms. Models explaining the relationships among these variables were estimated along with the ATC, AGM, and PPH models. Cost-related items were estimated with the same specification as the ATC model, and revenue-related items were estimated with the same specification as the AGM and PPH models. SUR cannot be estimated for cases in which a linear combination of some of the dependent variables equals another dependent variable. In these cases, equations were dropped from the system. The errors for all of the ATC, AGM, and PPH models were highly correlated. There were strong negative correlations between the errors for the ATC models and the errors for the AGM and PPH models, and there were also strong positive correlations between the errors for the AGM and the PPH models. Specifically, when costs were "too high" when compared to the expected value of the cost model then gross margins and profits were "too low." It is the close relationship between costs, gross margins, and profits that greatly improved the efficiency of the estimates. This is what pooling does: information from all other models is useful for estimation of a specific model. SUR substantively improved efficiency with the 30-month sample.

6. RESULTS OF PROFIT AND LOSS DATA ANALYSIS

In this section, we begin with a description of the summary statistics of the data used in the modeling and then present results of the volume and P&L data models.

6.1. Descriptive Statistics From the P&L Data

Summary statistics for ATC, AGM, and PPH are reported in Table 1. Values shown are weighted averages across plants, using the plant volume as the weights.

TABLE 1. Weighted Average Summary Statistics for Variables Used in the Average Total Cost per Head, Average Gross Margin per Head, Average Profit per Head, and Volume Equations

Variable	*M*	*SD*	Minimum	Maximum
Average total cost per head (ATC)	$138.61	10.7476	120.3196	164.2098
Average gross margin per head (AGM)	$140.72	38.8241	22.6245	211.9827
Average profit per head (PPH)	–$2.40	43.8242	–137.3646	73.3409
AMA Volumes (%)				
Forward contract	0.0424	0.0414	0.0020	0.1661
Marketing agreement	0.2951	0.0742	0.1716	0.4594
Packer owned	D[a]	D	D	D
Other	0.0016	0.0024	0.0000	0.0092
Volumes (No. of head)				
Forward contract	18,216	4,086	196	16,884
Marketing agreement	145,227	9,398	14,121	52,121
Packer owned	D	D	D	D
Other	1,340	250	0	1,004
Total fed cattle volume	426,759	14,341	68,102	127,845

Note. AMA = Alternative marketing agreements; D = results suppressed due to confidentiality requirements.
[a]This value has an upper bound of 0.05.

The values for the sample period were as follows: ATC was $138.61 per head, AGM was $140.72 per head, PPH was a loss of $2.40 per head. All of the dollar-denominated variables were deflated to 2004 dollars. ATC and AGM were typical values for costs and revenues. ATC did not include cattle costs, and AGM was revenue from beef and byproduct sales net of cattle costs. The average PPH value was negative because of miscellaneous costs and revenues in P&L statements. It was an unprofitable time for beef packers.

A unique characteristic of the sample period was the border closing to imports of cattle and beef from Canada after the discovery of bovine spongiform encephalopathy (BSE) in May 2003. Then, in January 2004, many countries stopped allowing exports of beef from the United States because of the discovery of BSE at the end of December 2003. This was a time period of disrupted cattle and beef flows. However, packer profitability problems were not related only to these disruptions. All packers were initially profitable, became unprofitable between the Canadian border closing and the U.S. border closing, returned to profitability, but then costs became substantively higher late in the sample and profits decreased. The industry profitability problem is related primarily to variation in cattle numbers due to the cattle cycle.

Many individual plants and firms were profitable during most of the sample period, and some firms were more profitable than were others. No one firm had all plants operating at an average positive profit for the entire period. Further, the cost and profit variation within each firm was generally larger than across firms. High-cost firms were also high-gross margin firms, indicating that additional processing creates value. The most profitable firm was a low-cost and relatively low gross margin firm.

The variables for the percentage of fed cattle purchased through AMAs were created for each plant using fed cattle transactions data sets from each packer that were secured through the LMMS. The P&L data are monthly. The different sources of cattle procured by cash and AMA methods were totaled for each month for each plant, using these transactions data bases. The total numbers of cattle procured by each type of marketing arrangement were very close to the total numbers of cattle slaughtered and processed as reported on P&L statements. The average discrepancy was less than 1%, and the largest discrepancy was less than 2%.

Summary statistics of the AMA percentage variables are also reported in Table 1. The weighted average percentages of plant-level AMA use were the following: marketing agreements were 29.5% of the fed cattle volume, forward contracts were 4.2% of the volume, packer owned was less than 5% (results cannot be reported because only two firms used this procurement method), other methods were 0.2%, and transactions with missing information were less than 1%. The remainder of the volume was through direct trade or auction barns (approximately 60%). Large variation in procurement methods occurs across firms, across different plants within firms, and across time for given plants.

6.2. Results of the Volume-Level Models and Volume Variability

Results of the volume models are reported in Table 2. The coefficients, standard errors, and model statistics are weighted averages across all 21 plants. These equations were estimated in levels and first differences. Tests indicate that some plant volumes were nonstationary, which was due to the shrinking supplies during the sample period, but it is not reasonable to extrapolate that trend. There were no substantive differences in conclusions drawn across the two, so we discuss the results from levels. For the simulations specific to each plant, we were conservative and used the model that implied the smallest changes in plant volume.

TABLE 2. Weighted Average Results of the Models of Total Plant Volumes as a Function of AMA Volumes

	Plant volume levels		Plant volume changes
	Coefficient (*SE*)	Implied Elasticities[a]	Coefficient (*SE*)
Mean dependent variable	103733	–	–574.1694
Standard deviation of model error	8558.2429	–	9186.7250
Intercept	90261.7364	–	–339.5124
	(6950.7315)[b]		(1718.4385)
Quantity of forward contract cattle	0.2289		
	(0.5226)	+0.0098	0.1140
			(0.4742)
Quantity of marketing agreement cattle	0.5125	+0.1744	0.3827
	(0.3154)		(0.3434)
Quantity of packer-owned cattle	0.0394	+0.0012	0.0507
	(0.0957)		(0.1006)
R^2	0.6561	–	0.5527

Note. AMA = Alternative marketing agreements.
[a]Implied elasticities are calculated from the weighted average results and are not weighted averages of individual elasticities.
[b]Values in parentheses are weighted average standard errors.

Plant-level volume model results show that decreases in procurement of fed cattle through forward contracts, marketing agreements, and packer-owned sources result in a substitution into cattle purchased in the cash market. The aggregate results are as follows: A 1% decline in forward contract cattle resulted in a 0.0098% decline in the total volume of cattle purchased and a 0.9902% increase in the volume of cattle purchased in the cash market. A 1% decline in packer-owned cattle resulted in a 0.0120% decline in the total volume of cattle purchased and a 0.9880% increase in the volume of cattle purchased in the cash market. However, a 1% decline in marketing agreement cattle resulted in a 0.1744% decline in the total volume of cattle purchased and a 0.8256% increase in the volume of cattle purchased in the cash market. Packers readily substituted cash market cattle for cattle procured through forward contracts and packer ownership. Individual plant elasticities were similar to the aggregate elasticities reported in Table 2. From this result, and because the percentage of cattle that were forward contracted or packer owned was small, a policy that affects forward contracting or packer-owned procurement of fed cattle would have little effect on individual plants and the overall market. However, such a policy would have a large effect on some packers and some plants owned by specific packers.

Packers did not readily substitute cash market cattle for marketing agreement cattle. Most of the significant individual elasticities were between 0.1 and 0.4 whereas the aggregate elasticity is 0.1744. Therefore, a policy that affects procurement of cattle through marketing agreements likely would result in packers operating plants at lower volumes. Plants and firms that procure a substantial portion of their cattle through marketing agreements would be particularly affected. However, we do recognize that this result is from a reduced form model. It is possible that if AMAs are prohibited, then packers would change their behavior in the cash market. However, our results were what was observed in the sample period, and there were considerable variation in AMA numbers with a general reduction in AMA use. There was a definite need for many plants to procure additional cash market cattle due to reduced numbers of AMA animals. However, this did not occur. If behavior does change then these models are worst-case relationships and the volume changes may be overestimated.

Turning from levels to variability, the variability in plant-level cash procurement volumes were considerably greater than the variability in AMA procurement volumes. Cash volumes were two to six times more variable than the individual AMA volumes. However, some AMA volumes were small compared to cash volumes so there is the need to examine all AMAs as a group. Using Equation 6, if AMAs were prohibited and plants were required to procure all cattle from the cash market, and assuming the variability of plant-level cash volumes persisted after this policy change, then the variability of total plant volumes were between equal to twice as variable. Cash volumes were never less variable than AMA volumes at any plant. The weighted average variability of plant total volumes was 74% greater when cattle were procured only through the cash market compared with when cattle were procured through both the cash market and AMAs. These were statistically significant differences—a variance that is 10–15% larger is significant at the 5% level. The mean-preserving variance change suggests that if packers were required to purchase all cattle in the cash market, the volumes at the typical plant would be 74% more variable than current volumes.

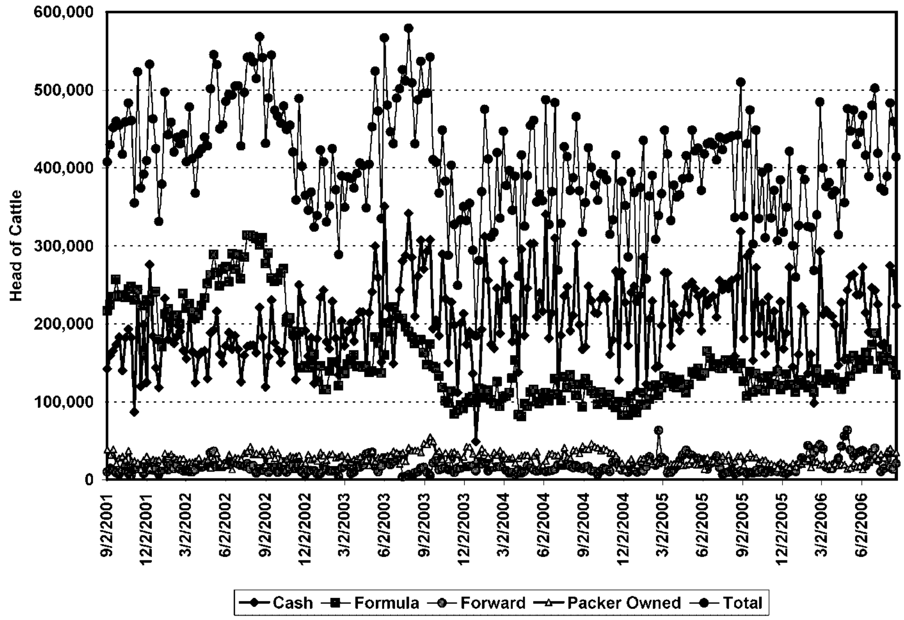

Figure 1 U.S. Department of agriculture agricultural marketing service reported volumes of cash and AMA cattle marketings.

This measure suffers from the same potential problem as the volume level model. The findings are a reduced-form result. It is possible that if AMAs are limited or prohibited, then packer behavior and the structure of the cash market variability would change. However, the conclusion about the relative magnitude of variability is supported by the uniformity of the plant-level results and by secondary data. The USDA Agricultural Marketing Service data provide information on the volume of fed cattle transacted through the cash market and AMA sources. Both are presented in Figure 1. There have been large changes in cash market and AMA volumes. The variability of cash volumes was significantly larger than for AMA volumes. Depending on the sampling interval, monthly cash market volume variability was two to four times larger than AMA volume variability and this is highly statistically significant. Reductions in AMA numbers does not result in a decrease in the variability within the cash market. The overall marketing volume variability reflects the relative proportion of cash to AMA cattle. We contend that it is unlikely if AMAs were prohibited that the variability of the cash series would decrease substantively.

6.3. Results of Average Total Cost, Gross Margin, and Profit Model Estimation

Results of the ATC, AGM, and PPH models are presented in Table 3. The model coefficients, standard errors, and summary statistics are weighted averages across all of the plants. The SUR results were more uniform than single equation methods, more coefficients for the AMA variables were significant across plants, and error correlations were as expected. Pooling was clearly useful.

TABLE 3. Weighted Average Results of the Average Total Cost per Head, Average Gross Margin per Head, and Average Profit per Head Equations

	Average total cost	Average gross margin	Average profit
Mean dependent variable	138.6078	140.0170	!2.3963
Standard deviation of model error	7.4986	34.5537	36.8929
Intercept	497.0765	!287.5320	–800.6312
	(88.53819)[a]	(384.0612)	(408.1619)
Ln(Volume)	–31.2401	37.0480	69.2281
	(7.6893)	(33.3851)	(35.4712)
Percentage of forward contract cattle[b]	–16.5507	–90.7020	–73.9346
	(30.5976)	(134.4086)	(141.2289)
Percentage of marketing agreement cattle[b]	–12.1548	30.6730	48.5780
	(20.2700)	(92.6972)	(98.5002)
Percentage of packer-owned cattle[b]	3.3190	1.3886	–1.7875
	(7.4724)	(27.6756)	(30.4790)
R^2	0.5763	0.3947	0.4567

[a]Values in parentheses are weighted average standard errors.
[b]Estimated coefficients represent estimated effects on a cents per head basis.

The primary result from the ATC model estimates shows that there are substantial economies of size for meat packing firms. Larger firms had substantially lower costs at higher slaughter volumes. The predicted values from the estimated equation fit through the center of the data for each plant. The predicted values did not miss the edges or the middle of the data ranges for each plant. Thus, the semilogarithm functional form is reasonable. The volume variable in the ATC models accounts for 80 to 90% of the model *R*-squares. The result for the representative firm has an *R*-square of 58%.

Based on the individual plant model results, when larger plants operated with smaller volumes, they had higher costs than smaller plants operating close to capacity. Thus, the importance of large plants operating at capacity is apparent. Also, small plants appeared to have cost advantages relative to large plants when volumes were smaller. However, smaller plants were at an absolute cost disadvantage compared with larger plants when both were operated at close to capacity. The lowest cost for larger plants was typically $1 to $3 per head lower than the lowest cost for smaller plants.

For all plants, ATCs increased sharply as volumes were reduced. Figure 2 illustrates the ATC function for the representative plant over the representative range of plant slaughter volumes. The representative plant operating at 95% of the maximum observed volume was 6% more efficient than the plant operating in the middle of the observed range of volumes and was 14% more efficient than the plant operating at the low end of the observed range. The ATC function displays some curvature, but it was slight. This was also observed in individual plant results: ATCs declined sharply and almost linearly over the observed slaughter volumes. The declining average total cost result is similar to much of the past research on meat packing economics and specifically to the results found by Ward (1990, 1993) and those summarized in MacDonald (2003). However, the result remains striking. The

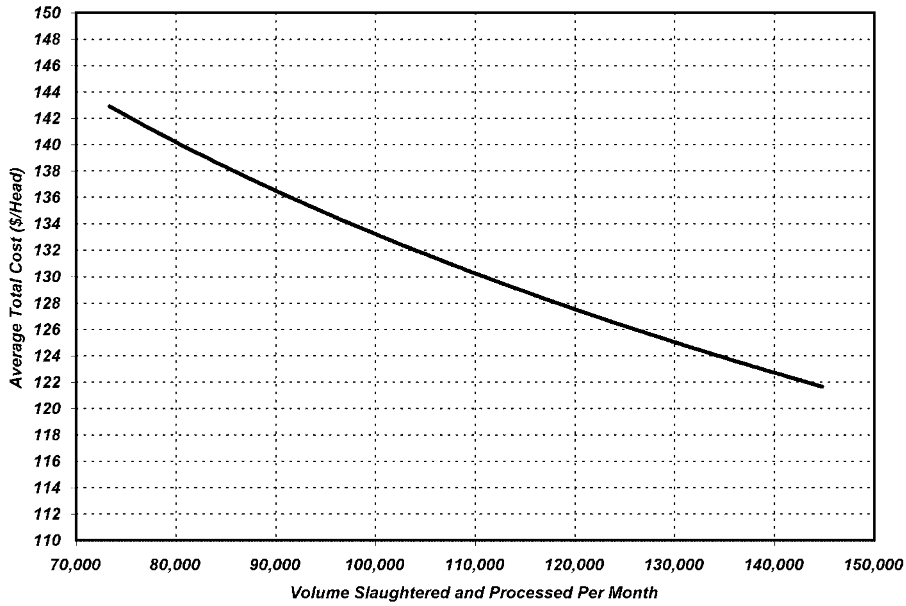

Figure 2 Average total cost per head curve for a representative fed cattle slaughter plant.

magnitude of scale economies is substantial and is likely one of the most important factors in the decision-making process of meat packing firms. We concur with Morrison-Paul (1999) that efforts to measure market power, especially longer-term measures, need to consider the impact that declining ATC has on that measurement, which is usually the gap between marginal cost and marginal revenue.

The effects of AMA volumes on ATC were mixed, but the significant results were largely as hypothesized. Approximately 49% of the coefficients on the AMA variables were negative, and 51% were positive. Negative signs were expected. Of the negative coefficients, 33% were statistically significant, and of the positive coefficients, 9% were statistically significant. In general, increases in the percentages of cattle procured through AMAs, while holding total volume constant, were associated with lower ATCs. Alternative marketing agreements appear to allow the packer to reduce slaughter and processing costs within the plant. However, for many plants and some firms AMAs had no direct effect on ATC.

Other variables were included in the ATC model, but most were found to be unimportant. For example, labor, energy, and capital input price indices were included initially. A number of interaction terms were also included. None of these variables were significant, so they were removed from the final model. However, we did include a trend variable. Based on the results, real average total costs increased for most plants over the sample period.

The weighted average results in Table 3 indicate that a 1% increase in the percentage of cattle procured through marketing agreements was associated with a $0.12 per head (0.1%) decrease in slaughter and processing costs, holding the total volume slaughtered and processed constant. This result appears to be statistically insignificant, but the reported coefficient and standard error include all of the significant and insignificant results across all plants. The plants with statistically significant coefficients had estimates in the −\$0.12 to −\$0.18 per head range. Based on these individual plant-level estimates, some firms and some plants within those firms were able to reduce plant operating costs using AMAs, whereas other firms were not. There were firms with statistically significant and substantive cost reductions and there were also firms with essentially zero cost reductions. Aggregating across all plants does not eliminate the cost savings but makes it less important from an industry-wide perspective.[6]

Although the percentage of cattle procured through marketing agreements had the most significant effects on ATCs, the percentage of cattle procured through forward contracts also had a large effect. For the representative plant, a 1% increase in the percentage of cattle procured through forward contracts was associated with a \$0.17 per head (0.1%) decrease in slaughter and processing costs, holding the total volume slaughtered and processed constant. However, the percentage of cattle procured through forward contracts was much smaller than that for marketing agreements, so the total effect of forward contract cattle on costs was smaller. Most of the results for individual plants were insignificant, but some individual plants experienced reduced costs due to procurement of cattle through forward contracts.

Finally, the sign on the coefficient associated with the percentage of cattle procured through packer ownership was not as expected. For the representative plant, a 1% increase in the percentage of cattle procured through packer ownership was associated with a \$0.03 per head (<0.1%) increase in costs, holding the total volume constant. These results occurred for several individual plants but most of the estimated coefficients were statistically insignificant. The result is counterintuitive because if packer-owned cattle result in higher costs, it is not clear why packers would own cattle. But, it may be that cattle are owned for reasons other than improving plant operations. Very few firms owned cattle and, for firms that did own, these cattle supplied relatively few plants.

Further, the sample period is a time of disrupted flows of cattle and beef. Examining the data reveals that packers with packer-owned cattle appeared to have foreseen the small numbers of fed cattle in Fall 2003. They owned larger numbers of cattle than typical, and many of these cattle were slaughtered in Fall 2003. But the costs that appear in packer P&L statements during Fall 2003 were larger than typical, and not

[6]For example, suppose there are six plants in the industry and the plant-level results are as follows:

	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Weighted Average
Coefficient	−12	−18	−18	3	3	15	−4.4
SD	3	4	10	9	25	8	10.4
p-Value	0.0005	0.0001	0.0839	0.3333	0.9054	0.0725	0.6759
Volume	100,000	150,000	100,000	150,000	150,000	100,000	130,000

It is the weighted average results that must be reported, but it is individual plant results that are used to measure the impacts and it is the individual plant's results that are discussed to the extent possible. The weighted average results appear insignificant, but there are two plants (1& 2) where the cost reduction is significant, one plant (3) where the cost reduction is marginally significant, and one plant (6) where the marginally significant result is the incorrect sign. The impacts at Plants 1 and 2, and Plants 3 and 6, can be measured and aggregated to the industry level. The impacts at Plants 4 and 5 are the wrong sign and clearly zero. The individual plant results that are used in the simulation and all of the significant and marginally significant plants are used—correct or incorrect sign. So the simulation results are calculated and aggregated to an industry number. The industry number is smaller because of insignificant plant-level results, but the aggregate simulated result is not insignificant.

just because of the reduced volumes slaughtered during that period. It is likely that other factors affected costs, but the regression model assigns the higher costs to packer-owned cattle. It could be that packer-owned cattle were not higher cost cattle, but that firms with packer-owned cattle experienced higher costs associated with disruption. The firms and plants for which packer-owned cattle increased costs operate in regions that were more affected by the loss of Canadian fed cattle imports and beef products exports. Simply put, the unique market disruptions during the sample period appear to have caused higher costs within some firms.

Table 3 also reports results of the AGM and PPH models. As with the ATC models, the AGM and PPH models showed changes in those variables in response to larger volumes of cattle. In general, plant-level margins and profits increased when volumes, and consequently fed cattle and beef supplies, were relatively large. Gross margins increased because, although beef product prices were lower, reductions in cattle costs were proportionally greater. Profits per head were greater because margins increased and costs decreased. The magnitude of the change was greater for gross margins than it was for costs, although this conclusion should be made cautiously. The volume variables in the AGM models were primarily insignificant, but the coefficients themselves were larger than the estimated coefficients in the ATC models. There is a clear conclusion though that PPH was higher when fed cattle supplies were large due to increased margins, but primarily due to cost economies. However, the farm-to-wholesale beef price spread variable accounted for 50 to 60% of the *R*-square in the AGM and PPH models. Thus, market conditions were the primary determinants of gross margins and profitability. Cattle slaughter volumes were the next most important variable, followed by the AMA variables.

The effects of AMAs on gross margins and profits was much more mixed than the ATC results, but the direction of significant effects was largely as hypothesized. Increased percentages of cattle procured through AMAs were associated with higher gross margins and higher profits. There were also many plants at which cattle procurement through AMAs had no effect on gross margins and profits and some particular cases in which cattle procurement through AMAs were associated with lower gross margins and profits. As with ATC model results, some firms clearly used AMAs to enhance the value of meat sold relative to the fed cattle cost and profits and some did not.

Specifically, a 1% increase in the percentage of cattle procured through marketing agreements was associated with a $0.31 per head increase in AGM and a $0.49 per head increase in PPH, holding the total volume constant. Although the weighted average results in Table 3 appear to be insignificant, for some plants, the percentage of cattle procured through marketing agreements was associated with higher AGM and PPH, and the estimated coefficients were statistically significant. Approximately 35% of the coefficients on the AMA variables in the AGM models were positive and 65% were negative. Positive signs were expected. Of the positive coefficients, 40% were statistically significant, and of the negative coefficients, 14% were statistically significant. Approximately 62% of the coefficients on the AMA variables in the PPH were positive and 37% were negative. Positive signs were expected. Of the positive coefficients, 44% were significant, and of the negative coefficients, 11% were significant.

In contrast to the effects of marketing agreements, the percentage of fed cattle procured through forward contracts appears to have a negative effect on AGM and

PPH. For the representative plant, a 1% increase in the percentage of fed cattle procured through forward contracts was associated with a \$0.91 per head decrease in AGM and a \$0.74 per head decrease in PPH, holding the total volume constant. At first, it appears that packers are poor market timers with respect to forward contracting decisions. However, an examination of the data for the plants in which the percentage of fed cattle procured through forward contracts has the greatest effect on margins and profits, the number of forward contracts for these plants increased during the time when total fed cattle supplies were the smallest. In any case, the total volume of fed cattle procured through forward contracts was small; therefore, the total effect of forward contracted cattle was small, even though the marginal impacts were large.

Finally, the effect of the percentage of fed cattle procured through packer ownership on AGM and PPH is mixed. Specifically, the effect on AGM is positive and the effect on PPH is negative. However, the results are primarily statistically insignificant. Thus, the results for packer ownership were generally consistent with the ATC model, and limitations in the analysis discussed above apply.

7. SIMULATION RESULTS

Results from the plant-level models were used to simulate changes in costs, margins, profits, and volume levels and variability associated with hypothetical restrictions on AMAs. The scenarios included were (a) a 25% reduction in volumes of cattle procured through AMAs, and (b) a 100% reduction in volumes of cattle procured through AMAs. These two scenarios were similar to proposed legislation. One piece of legislation proposed to place a limit on and a second proposed to prohibit AMA use. We simulated the effects of these scenarios in the models for each plant, which hold constant other variables in each model and then incorporated the volume and variance results for each plant. The simulated effects are multiplied by the percentage of total cattle volumes slaughtered and processed by each plant, calculated a cumulative percentage for the four firms, and weighted the four-firm result by 82%– the four-firm average proportion of the industry. Variables were used in the simulation to calculate an effect if the coefficient estimate was significant at the 10% level. Otherwise, the effect was zero.

The estimated cost, revenue, and profit changes for each scenario are presented in Table 4. Three types of cost changes are presented. The first cost change is the direct change, which was measured by the coefficients on $\%FC$, $\%MA$, and $\%PO$. For example, in the scenario in which all AMAs were eliminated, the variables were replaced with zero, the change in ATC for each plant was calculated, and the change in ATC was converted to a percentage basis. The second cost change is implied by the volume change. The volume models were used to calculate a change in plant volumes under each scenario. This estimated change in volume for each plant was then used in the ATC equation to calculate a change in ATC, and then the change was converted to a percentage. This change in cost due to change in volume does not include the direct change in ATC; the direct effect was netted out. The third cost change is due to increased volume variability. We stochastically simulate these results. First, we made random draws from the distribution of plant volumes. Each distribution has a variance implied by the simulation scenario. Increased cash market procurement results in using a distribution with a larger variance. Each random

TABLE 4. Estimated Effects of Restricting Fed Cattle AMA Volumes on Monthly Average Total Costs per Head, Average Gross Margins per Head, and Average Profit per Head

Effect	25% Reduction in AMA volumes	100% Reduction in AMA volumes
Percentage change in average total cost		
Direct change	+0.0022	+0.0088
Change due to reduced volumes	+0.0049	+0.0257
Change due to increased variability	+0.0015	+0.0123
Total percentage change in average total cost	+0.0086	+0.0468
Percentage change in total volume	–0.0196	–0.0804
Percentage change in volume variability	+0.1090	+0.7390
Percentage change in revenue (i.e., gross margin)	–0.0095	–0.0380
Percentage change in profit	–0.0149	–0.0595

Note. AMA = Alternative marketing agreements.

draw from the distribution of volumes was used in the ATC equation to calculate an expected value. Randomness in the ATC equation was added by including a random draw from the distribution of error terms from the ATC model. The number of random draws used was 10,000. The change in cost due to changes in variability does not include the direct change in ATC; again the direct effect was netted out. The change in variability also did not include a change in volume. The mean volume was preserved and only the variance was changed.

For the stochastic simulation, the distribution of cattle volumes at each plant was assumed to be a generalized beta distribution unique to that plant. The distribution of ATC model errors was normal, but the plant volumes were not. If a normal distribution was used to simulate plant volumes, the random draws at the top end of the distribution would be much larger than any volumes observed in the data. Using a generalized beta distribution addresses this problem. The maximum parameter was chosen to be 5% more than the observed maximum and the minimum parameter was chosen to be zero. The other two parameters in the distribution, α and β, were estimated for each plant using maximum likelihood. The variance was then increased by the simulation prescribed amount through changing these parameter values. In all cases, the distributions were broader, with more mass in the top end of the distribution and more mass in the lower end of the distribution over the center of the volume range. Example distributions are shown in Figure 3. One distribution uses parameters similar to actual plants (i.e., "before"), and the second shows the distribution shape after the variance was increased by 74% (i.e., "after").

There were no volume or variability effects in the AGM and PPH simulations. There were direct effects only. Because the volume coefficients in the AGM models were primarily insignificant and because the curvature was relatively flat, any simulated volume or variability effects were quite small. The simulated effects with PPH reflect the small AGM results and the ATC results. Thus, the ATC results are almost all of the volume and variability effects.

The simulated effects of a 25% reduction in AMA use were as follows: a total increase in ATC of 0.86% resulting from a 0.22% direct increase in ATC, a 0.49% increase in ATC due to reduced volumes, and a 0.15% increase in ATC due to increased variability in slaughter and processing volumes. There was also a

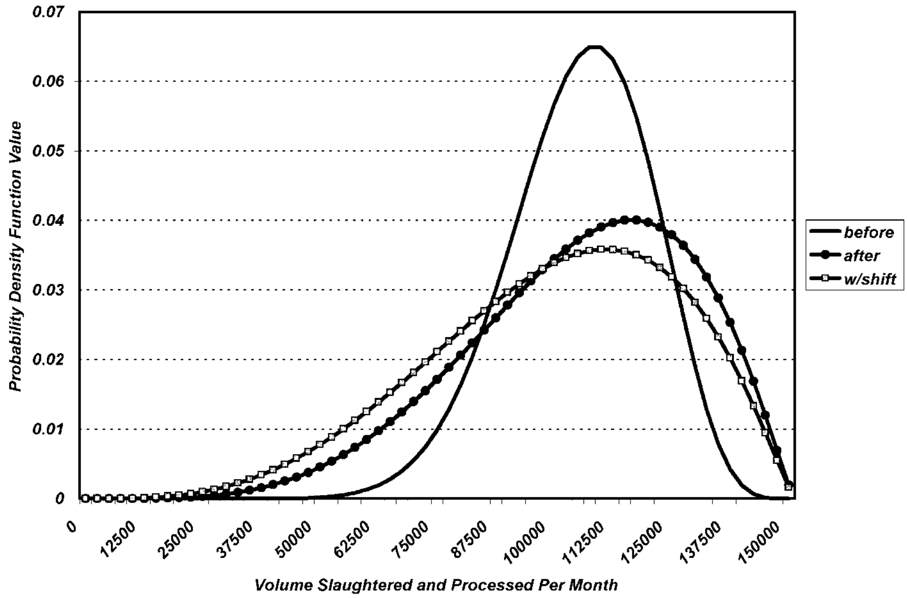

Figure 3 Example beta distributions for fed cattle procurement volumes at a representative plant before, after a 74% increase in procurement variance holding the mean value held constant, and after a 74% increase in procurement variance with an 8% reduction in the mean value.

decrease in cattle procurement volume of 1.96%, an increase in cattle procurement variability of 10.90%, a decrease in AGM of 0.95%, and a 1.49% decrease in PPH. Each of these results is additive and ceteris paribus.

The simulated effects of a 100% reduction in AMA use were as follows: a total increase in ATC of 4.68% resulting from a 0.88% direct increase in ATC, a 2.57% increase in ATC due to reduced volumes, and a 1.23% increase in ATC due to increased variability in slaughter and processing volumes. There was also a decrease in cattle procurement volume of 8.04%, an increase in cattle procurement variability of 73.90%, a 3.8% decrease in AGM, and a 5.95% decrease in PPH.

Our results find that if AMAs were eliminated then plant volumes would decrease by about 8%. The result does appear large. But the analysis is limited to the four largest packers. The 8% decline is not in overall cattle supplies, but volumes procured by these firms. These four packers procured 82% of USDA FI Fed Steer and Heifer slaughter during the sample period, but not 100%. There remains a residual packing industry that procures on average 18% and at times significantly more—periodically it was 30%—and there is substantial excess capacity, which will discussed next. Our plant-level volume models find that volumes for each plant in the four largest firms have declined substantively following the general reduction in the use of AMAs through the mid-2000s. More so than can be explained by actual declines in the USDA FI fed cattle slaughter. These four firms have not offset the reduced use of AMAs with increased cash market purchases. It is likely that an increased portion of the supplies will go to the residual packing industry. In Figure 3, we also show a distribution where the variance increases and the mean is reduced

8%. This is an insignificant change in the mean and a moderate change in the distribution. This distribution is not used in any simulation, but is for illustrative purposes. A final point for effects presented in Table 4 is that the impacts are additive. Doubts about the volume or variability effects, for example, imply the reader can ignore those results without impacting other results.

8. EFFICIENCY AND MULTIPLANT COORDINATION EVIDENCE

The P&L data also allowed us to draw conclusions regarding efficiency within the beef packing industry. Although the results were specific to individual plants and firms, we can discuss the general results. The ATC equation was estimated separately for plant costs only, labor costs only, and procurement and sales costs only for the packing firms that provided detailed data. For plants with statistically significant AMA variables in the ATC model, the same variables were significant in the models that were estimated using fixed costs instead of total costs. The AMA variables were also more likely to be significant in the fixed cost models where the same variables were not significant in the total cost models. The AMA variables were almost never significant in the models of variable costs, such as labor, or in the models of fixed costs that were not related to production, such as corporate management or sales costs. Approximately 85 to 100% of the reduction in ATC that was associated with the AMA use was due to reductions in plant-related fixed costs. Although, for some individual plants, labor costs also were lower with procurement of cattle through AMAs. Plants with lower labor costs tended to be plants with very large and relatively stable volumes of cattle procured through AMAs.

Other interesting efficiency-related conclusions can also be drawn. Monthly plant slaughter and processing volumes were highly positively correlated across plants within firms. Volumes were positively correlated in levels and first differences. That is, when a firm increased or decreased volumes, it did so at all plants. Thus, firms did not appear to be making multiplant production decisions. Even if a firm has two plants that are reasonably close geographically, volumes increased and decreased at both plants simultaneously. We did not observe many instances in which one plant was operating at a high capacity while another plant was operating at a lower capacity. Very few firms appear to conduct any degree of multiplant coordination. For the firms that did, volumes appeared to be reduced most frequently at one or two specific small plants. Multiplant coordination was simply not strong.

During part of the sample period, it was clear that many plants were operating at relatively low capacity and experiencing losses. However, even small plants that were close to large plants where both were owned by the same firm continued to operate, but both plants operated at substantially reduced volumes. It is interesting to note that some plants operated with persistent losses throughout most of the sample. In addition, some firms operated all plants at less than 60% of capacity for several months during the market disruption period. Based on these observations, it appeared that multiplant coordination was lacking and that individual plants may have been operated as separate profit centers.

However, for two reasons, it is difficult to draw strong conclusions about multiplant coordination. First, cattle transportation costs were ignored and were not included in packer P&L data. Cattle transportation costs are largely paid by the cattle feeder—either directly or indirectly in price—and it may be cost prohibitive to ship to neighboring plants even if they are nearby. Second, the ATC equations did not have much curvature and were rather steep. Thus, a small reduction in volume at all plants may have roughly the same cost impact as a large reduction at one plant.

The cattle feeding industry may also have been the beneficiary of substantial excess capacity in the packing industry. If all plants simultaneously slaughtered and processed the maximum observed monthly volume, then the four-firm volume would have been 2.6 million head. If the four firms maintained their 82% of USDA FI Fed Steer and Heifer slaughter, then the industry volume would be 3.2 million head per month. Examining the USDA FI Fed Steer and Heifer slaughter monthly data since 1980 reveals that this volume is at least 15% excess capacity and reasonably 20 to 30% excess capacity.

9. SUMMARY

In conclusion, this analysis of P&L data from beef packers is the first of its kind. The data provide an opportunity to examine economies of size and for evidence of cost economies related to procurement of cattle through different types of AMAs. The results clearly document economies of size in beef packing. Average total cost functions are downward sloping over the entire range of plant volumes. There appears to be substantial cost savings to firms when plants operate at high capacities. In addition, excess capacity is present in the industry.

Procurement of cattle through AMAs results in cost savings to the beef industry. However, the results differ across firms. Some firms benefit substantially from AMA use and other firms do not capture any benefits. We draw these conclusions from beef packing firms' own accounting data. The industry-level direct cost savings from AMAs was approximately 0.9% of ATC or $1.22 per head. Packers also experienced additional cost savings from reduced variability in cattle supplies ($1.70 per head) and increased slaughter volumes ($3.56 per head). The total industry-level cost savings associated with AMAs was approximately $6.50 per animal. For an industry with an average loss of $2.40 per head during the 30-month sample, this is a substantial benefit.

Packers also receive higher average gross margins from AMA cattle. The source of the increased revenue is not identifiable, but it is clear that AMA cattle are more valuable to some packers than cash market cattle. The cost and gross margin results also translate into increased profits for packers.

Thus, the results indicate clear evidence that procurement of cattle through AMAs results in reduced costs and increased profitability for the firms that use them, although it is important to keep in mind that the results differ across firms. Although some firms appear to be reducing costs and increasing margins and profits through some means by procuring cattle through AMAs, others do not. Alternative marketing agreements do provide an economic benefit to the beef industry.

It is also important to keep in mind that within the beef industry, AMAs are largely marketing agreements. Forward contracts and packer ownership are used, but to a lesser extent. Thus, restrictions on the use of marketing agreements would have the greatest negative effects on the beef industry. Restrictions on the use of packer ownership and forward contracts for cattle would have lesser effects.

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