Effect of Captive Supply on Farm-to-Wholesale Beef Marketing Margin

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Abstract

Debates about captive supplies have been ongoing for more than a decade. This study investigates the effects captive supplies have on the beef farm-to-wholesale marketing margin. A relative price spread (RPS) model is used to estimate beef farm-to-wholesale marketing margins. Estimates indicate that forward contracts and marketing agreements have a small positive relationship with margins that is marginally significant. Packer fed cattle may or may not be related to margins to depending upon model specification.

Key words: captive supplies, marketing margins, relative price spread (RPS) model

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Introduction

The debate regarding the impact of forward contracting and marketing agreements between cattle feeders and beef processors as well as packer-owned cattle feeding has persisted for more than a decade. Much of the debate has centered around captive supplies being negatively correlated with short-run fed cattle transaction prices.[1] This empirical result has been confirmed by several studies (e.g., Ward, Koontz, and Schroeder; Schroeder et al.; Azzam and Schroeter). Numerous policies have been proposed at the national level to limit or eliminate various ways beef packers procure slaughter cattle. Noteworthy among these was the Johnson Amendment proposed in the 2002 Farm Bill that would have eliminated beef packer ownership and control (see Hayenga for a discussion of how Agricultural Economists engaged in debate of this amendment).

One concern regarding captive supply is how it is related to the farm-to-wholesale margin. The objective of this research is to determine the relationship between the farm-to-wholesale margin and packer-owned cattle feeding and cattle procured by packers using agreements and contracts. This is the first study to estimate how monthly packer margins are related to packer feeding and marketing agreements and contracts. Two different possible relationships could exist. If use of packer feeding and/or marketing agreements increases packer efficiency, then we would expect to find a negative relationship between the farm-to-wholesale margin and these purchasing methods.

[1] Captive supplies are defined by USDA Grain Inspection, Packers and Stockyards Administration (GIPSA) as livestock that is 1) owned or fed by a packer, 2) procured by a packer through a contract or marketing agreement, or 3) otherwise committed to a packer more than 14 days prior to slaughter.

Alternatively, if these procurement methods enable packers to reduce prices they pay for cash market fed cattle, then we would expect a positive relationship. Real farm-to-wholesale margins have had a very small increase between 1988 and 1996, but have since had little trend (Figure 1). However, monthly margins vary a lot over time ranging between $3-$13/cwt. Figure 2 illustrates the monthly pattern over time in packer feeding of cattle and in marketing agreements and contracts for the largest 15 U.S. beef packers. Packer-owned fed cattle have represented a small and relatively stable percentage of slaughter over time averaging about 3-4%. Whereas, marketing agreement and contract cattle purchases have trended upward since the early 1990's typically representing 15-20% of slaughter by the late 1990's.

Previous Literature

The theoretical framework for farm-to-retail margins is grounded in work by Gardner in 1975. His model demonstrated the impacts of factor markets on determining the price spread. Most empirical work since then has been based upon his model specification. Brorsen, et al. (1985), built upon the marketing models by Gardner to determine the effect of changes in output risk using the U.S. wheat market. They demonstrated that increased price variability increases marketing margins in the wheat industry.

Wohlgenant and Mullen (1987) compared a markup-pricing spread model to a relative price spread (RPS) model. The difference between these two models is the markup-pricing model assumes a fixed relationship spread. Using annual beef margin data, they concluded the RPS model is preferred to the markup-pricing model. Numerous

studies have since used the RPS model including Faminow and Laubscher in the South Africa maize market; Lyon and Thompson in fluid milk markets; and Brester and Musick and Capps, Byrne and Williams in lamb markets.

Recent work by Marsh and Brester (1999) studied the effect of technological change on beef and pork marketing margins and real slaughter cattle and hog prices. Labor productivity, percentage of livestock marketed by firms, and average dressed weights were used as proxies for technological progress. They found technological progress in the meat-packing sector has been a significant contributor to declining real beef and pork farm-to-wholesale marketing margins. Technological progress in the packer industry had a positive effect on real cattle and hog prices.

Several studies have also been conducted of various fed cattle marketing techniques and prices. Ward, et al. (1998) evaluated the impacts of captive supplies on fed cattle transaction prices. Three models were employed to determine how cash prices influence captive supply deliveries (model 1), the impact captive supply inventories have on prices (model 2), and the effect captive supply have on the difference between cash prices and captive supply prices (model 3). They concluded that cash price and captive supply deliveries had a small negative relationship (model 1). The second model produced mixed results, but found captive supplies had no significant effect on cash prices. The third model found that forward contract prices averaged a lower price than cash prices, while marketing agreements received a premium over cash prices. The third model also found cattle prices that were packer-fed were not significantly different than cash cattle prices.

Schroeder, et al. (1993) studied the impacts of forward contracting on cash market prices in the southwest Kansas marketing region. In the first model estimated, they used the sum of contract shipments across four firms in the region as one variable. In the second model, contract shipments were separated by individual firm. They found captive supply deliveries were associated with $0.15/cwt to $0.31/cwt reduced cash fed cattle transaction price.

Schroeter and Azzam utilized transactions data on fed cattle sales from the Texas Panhandle to determine the relationship between fed cattle prices and captive supply. Similar to the other studies, they found a small negative relationship between weekly fed cattle prices and captive supply. They went further to evaluate possible reasons for this negative relationship and concluded that one possible reason could be that cattle feeder strategic timing of cattle deliveries under marketing agreements vs. cash market trade could contribute to this observed inverse relationship between cash market prices and captive supply shipments.

Farm-To-Wholesale Beef Marketing Margin Model

This study employs a modified version of the RPS model developed by Wohlgenant and Mullen to estimate determinants of beef marketing margins. The RPS model for farm-to-wholesale margin is:

$$M = \alpha_1 P + \alpha_2 PQ + \alpha_3 IMC + \alpha_4 RISK + \alpha_5 POF + \alpha_6 PFCMA + \alpha_7 TECH + \alpha_8 CARCASS + \sum_{i=1}^{12} \delta_i D_i . \quad (1)$$

Where M is the farm-to-wholesale price spread between farm-level, slaughter beef prices and wholesale price of beef plus beef by-products ($/cwt), P is the wholesale price of

beef ($/cwt), *Q* is per capita quantity of beef produced (lbs. per person), *IMC* is an index of food marketing costs, *RISK* represents the output price risk faced by packers, *POF* is the percentage of fed cattle slaughter owned by packers, *PFCMA* is the percentage of fed cattle acquisitions packers procure through forward contracts and marketing agreements, *TECH* represents technological change over time in beef packing, *CARCASS* represents the average carcass weight ($/cwt), and D_i (i=1,2,…12) are monthly dummy variables. See table 1 for specific variable definitions.

Previous studies provide justification for the expected signs for many variables in equation (1). As wholesale prices or input costs increases this would be expected to lead to an increases in the price spread; hence, the expected signs of α_1, α_2, and α_3 are positive (Brester and Musick). The coefficient on the risk variable should also be positive. If packers are risk averse or if variability increases costs, then an increase in price risk would be expected to increase margins (Brorsen, et al.) The expected sign on technology should be negative (Marsh and Brester). If a slaughter plant produces output more efficiently through technology adoption, then farm-to-wholesale margins will decrease.

Packer fed cattle slaughter and marketing agreements could have coefficients with either positive or negative signs depending upon how they might influence the margin. The expected sign of α_5 and α_6 will be negative if these procurement methods increase packer efficiency. For example, if these procurement methods help ensure packing plant utilization, then increasing their use would be expected to reduce marketing margins over time. However, if packers were able to use these procurement methods to reduce prices they pay for cash market cattle through reducing competition in the cash market, then the signs of α_5 and α_6 might be positive (Kinnucan and Nelson). The expected sign on the

carcass variable should be negative. As carcass weights increase, packers would be expected to produce more output per hour of operation (up until the point where additional carcass size interrupted line speed or produced boxed cuts too large for standard merchandising).

Data

Monthly data from January 1988 to December 1998 were employed in this study. Farm-level beef prices ($/cwt) are reported by the Agricultural Marketing Services and obtained from the Livestock Marketing Information Center (LMIC). Wholesale beef prices (i.e., average of Choice and Select boxed beef ($/cwt)) and by-product prices ($/cwt) were also obtained from the LMIC. Price indexes of food marketing costs were acquired from the USDA Economic Research Service (ERS). The index measures changes in costs (i.e., employee earnings, prices of supplies used in processing, etc.) that are associated with transforming raw inputs into foods that are purchasable for at-home consumption.

Technology development in beef packing was measured using the proxy *Indexes of Output per Hour* for meat packing plant workers from the U.S. Bureau of Labor Statistics (USBLS). The technology data were only available on an annual basis. Therefore, monthly data were obtained by linear extrapolation. The coefficient of variation for 12-month rolling averages of wholesale beef prices used a relative measure of price risk in the farm-to-wholesale margin equation. Consequently, data for 1987 were used in determining the risk variable for the first year of the sample. Quantity was calculated by dividing total beef production by civilian population. Total beef production

data (in millions of pounds) for this study was reported by LMIC. Population for the United States was obtained from the U.S. Census Bureau. Each monetary variable is deflated by the Consumer Price Index (1982-84=100) reported by the U.S. Department of Commerce.

Captive Supply data were obtained from Grain Inspection, Packers and Stockyards Administration (GIPSA). Packer fed cattle that are owned and acquired through forward contracts and marketing agreements are reported as a percentage of the 15-largest beef packer slaughter. These data were only available from 1988-1998, thus limiting the time period selected for analysis.

Table 1 contains summary statistics of data used to estimate the margin model. The margin averaged $6.03/cwt with a standard deviation of $1.70/cwt.

Results

The model presented in (1) might possess simultaneity in the wholesale price variable. To determine whether it suffers from this bias, the Hausman test for contemporaneous correlation between the error term and the wholesale price of beef was employed (Pindyck and Rubinfeld). This test involved running two Ordinary Least Square (OLS) regressions. In the first regression, wholesale price of beef was regressed on the remaining exogenous variables and wholesale price of pork and retail prices of pork and chicken (instrument variables). The second regression consisted of estimating the farm-to-wholesale model including the residuals from the first regression as a regressor. The test statistic for the residual of wholesale beef prices was 0.42, which is

smaller than the critical student-t value of 1.98 at the 5% level. Therefore, the null hypothesis was not rejected and wholesale beef prices were considered exogenous.

The margin model was initially estimated using ordinary least squares regression. Results indicated the presence of residual autocorrelation. Therefore, the Yule-Walker procedure in SAS was used to correct for first-order autocorrelation. Table 2 presents the autocorrelation-corrected regression results (model 1). The model explained 50.17% of the variability in the farm-to-wholesale margin. Although theory suggests the model should be estimated without an intercept term included in the model (Wohlgenant and Mullen), one was implicitly included here by including all 12 monthly dummy variables in the model. The monthly dummy variables were included to account for seasonality.

Several of the theorized factors that are expected to impact farm-to-wholesale margins were not statistically significant. For example, during this time period, wholesale price was not associated with the margin. This suggests beef packer margins are invariant to the boxed beef price level over time. This contrasts what Wholgenant and Mullen found using annual data, but is consistent with other studies (e.g., Brester and Musick; Kinnucan and Nelson). Similarly, the wholesale price times quantity variable is not different from zero. [2]

The coefficient on *TECH* is statistically significant at the 5% level. A one percent increase in the output per employee hour index reduces the farm-to-wholesale margin by 4.6%. This result is consistent, though larger in magnitude, with Brester and Marsh who found an elasticity of -1.85% in annual beef farm-to-wholesale margins. From the late 1980s through the early 1990s, meat-packing plant output per worker declined by about

[2] To determine whether lack of significance of particular variables was caused by collinearity, equation (1) was also estimated excluding quantity times price and excluding wholesale price separately. However, in all cases the model gave qualitatively identical conclusions.

3% and then jumped by about 6% by 1993. Since, 1993 this index has declined by about 2-3%. This variability in technology has had a noticeable impact on the marketing margin. Any changes like adoption of HACCP or other food safety protocols that affect labor productivity, at least in the short run until the technology makes compliance more efficient, affect the marketing margin.

Packer ownership of cattle had no statistically significant impact on margins. This is consistent with previous work that has found no impact of packer fed cattle on fed cattle prices (Ward, et al.). This result suggests that packer ownership of fed cattle does not increase beef packer market power to the extent that it is revealed in larger margins as supporters of banning packer ownership contend.

Forward contracting and marketing agreement cattle have a positive coefficient, although it is only marginally significant (at the 0.15 level). This suggests that packers might increase the farm-to-wholesale margin when contract and marketing agreement cattle increase. However, the elasticity indicates that a ten percent increase in the percentage of cattle procured under marketing agreements (e.g., increasing from 25% to 27.5% of cattle marketings) is associated with only a 1.8% increase in the margin (e.g., increase from $6/cwt carcass weight to $6.11/cwt), a very small economic impact. Previous studies have found that marketing agreement and contract cattle deliveries are associated with a small decline in fed cattle prices (e.g., Ward, Koontz, and Schroeder; Schroeder et al.; Azzam and Schroeter). Our results add to our understanding of this relationship in that the small reduction in fed cattle price associated with higher contract and marketing agreement deliveries does not appear to be fully passed on in the form of lower wholesale beef prices. However, it is important to keep in mind that this

coefficient is only marginally statistically significant suggesting we have a relatively low level of confidence in this claim. Other variables that were statistically significant in some previous studies (i.e., risk, marketing costs, and carcass weight) were not significant.

The dummy variables in equation (1) were included to account for seasonality; however, all the variables were insignificant. Therefore, the farm-to-wholesale beef marketing margin model was re-estimated without the monthly dummy variables. Table 2 presents the re-estimated autocorrelation-corrected regression results (model 2). Under this revised model specification, wholesale price, quantity, forward contracting and marketing agreement cattle, and technology were all significant at the 5% level and packer fed cattle slaughter was significant at the 10% level. Apparently, the monthly dummy variables were related to seasonal variation in the independent variables. Interestingly, the elasticities of packer fed slaughter and contracts and marketing agreements were the same at 0.19. This suggests that a 10% increase in each of these procurement methods increases farm-to-wholesale margin by 1.9% (a very small economic amount).

Summary and Conclusions

Farm-to-wholesale marketing margins in the beef industry were analyzed in this study. No previous empirical work has used monthly data on captive supply published by GIPSA to determine its impact on farm-to-wholesale marketing margins. The objective of this study was to determine if captive supplies had any effect on beef farm-to-wholesale marketing margin. The RPS model was used to allow for simultaneous

changes in supply and demand and measured the impacts on a few key factors of price margins in the beef industry. These factors include wholesale prices, wholesale price times quantity of beef produced, marketing costs, risk, technology, packer-owned fed cattle, acquisitions packers use through forward contracts and marketing agreements, carcass weight, and seasonality.

Conclusions from this study show acquisitions made by packers through forward contracts and marketing agreements had a small positive relationship with margins that were marginally statistically significantly different from zero (model 1) and statistically significant at the 5% level (model 2) . This indicates that packer margins widen by a small amount when packer-owned fed cattle (model 2) and marketing agreement and contract cattle (model 1) deliveries increase. This suggests that the small negative relationships found in previous studies between cash fed cattle prices and captive supply were apparently not all passed on to the wholesale market. However, fed cattle that are owned by packers had no significant relationship to margins (model 1), while model 2 shows that packer-owned fed cattle is statistically significantly different from zero at the 10% level Important to note is that these results do not suggest causality between captive supplies and wholesale margins, rather, they simply demonstrate the nature of their correlation. Addressing these issues is left for future research.

References

Brester, G.W., and J.M. Marsh. "The Effects of U.S. Meat Packing and Livestock Production Technologies on Marketing Margins and Prices." *J. Agr. and Res. Econ.* 26(2001):445-62.

Brester, G.W., and D.C.Musick. "The Effect of Market Concentration on Lamb Marketing Margins." *J. Agr. and Applied Econ*. 27(1995):172-183.

Brorsen, B.W., J.-P. Chavas, W.R. Grant, and L.D. Schnake. "Marketing Margins and Price Uncertainty: The Case of the U.S. Wheat Market." *Amer. J. Agr. Econ*. 67(1985):521-528.

Capps, O. Jr., P.J. Byrne, and G.W. Williams. "Analysis of Marketing Margins in the U.S. Lamb Industry." *J. Agr. Res. Econ. Rev*. 24(1995):232-240.

Faminow, M.D., and J.M. Laubscher. "Empirical Testing of Alternative Price Spread Models in the South African Maize Market." *Agr. Econ*. 6(1991):9-66.

Gardner, B.L. "The Farm-Retail Price Spread in Competitive Food Industry." *Amer. J. Agr. Econ.* 57(1975):399-409.

Hayenga, M.L "Cutting Vertical Down to Size: Congress, the Farm Bill, and Packer Control." Choices, Summer 2002, pp. 36-39.

Elitzak, H. Agricultural Economist. United States Department of Agriculture. Economic Research Service. *Total Monthly Food Marketing Cost Index Data*. Personal Email. Washington, D.C. June 10, 2003.

Kinnucan, H.W., and R.G. Nelson. "Vertical Control and the Farm-Retail Price Spread for Eggs." *Rev. of Agr. Econ.* 15(1993):473-481.

Livestock Marketing Information Center (LMIC). Lakewood, Colorado.

Lyon, G.D., and G.D. Thompson. "Temporal and Spatial Aggregation: Alternative Marketing Margin Models." *Amer. J. Agr. Econ*. 75(1993):523-536.

Marsh, J.M., and G.W. Brester. "Technological Change in the U.S. Beef and Pork Sectors: Impacts on Farm-Wholesale Marketing Margins and Livestock Prices." Research Discussion Paper No. 31. Montana State University, July 1999.

Pindyck, R.S., and D.L. Rubinfeld. "Econometric Models and Economic Forecasts, 4th Edition." Boston: Irwin McGraw-Hill. 1998.

SAS Institute, Inc. SAS/ETS User's Guide. Version 6. Second Edition. Cary, NC: SAS Institute, Inc. 1993.

Schroeder, T.C., R. Jones, J. Mintert, and A.P. Barkely. "The Impact of Forward Contracting on Fed Cattle Prices." Rev. Agr. Econ. 15(1993):325-37.

Schroeter, J.R., and A. Azzam. *Econometric Analysis of Fed Cattle Procurement in the Texas Panhandle*. USDA, Grain Inspection, Packers and Stockyards Administration. November 1999. Available at http://www.usda.gov/gipsa.

U.S. Department of Agriculture. *Captive Supply of Cattle and GIPSA's Reporting of Captive Supply*. Grain Inspection, Packers and Stockyards Administration. Washington, D.C. January 11, 2002. Available at: http://www.usda.gov/gipsa/pubs/captive_supply/captivesupplyreport.pdf. Accessed on June 5, 2003.

_____. *Packer's Forward Purchases of Fed Cattle, 1988-97*. . Grain Inspection, Packers and Stockyards Administration. Washington, D.C. January 21, 1999. Available at: http://www.usda.gov/gipsa/programspsp/csnews3.pdf. Accessed on June 5, 2003.

U.S. Department of Commerce. *Total Monthly Population Estimates.* U.S. Census Bureau, Population Division. Washington, D.C. Available at: http://eire.census.gov/popest/archives/national/nation1/intfile1-1.txt. Accessed on June 6, 2003.

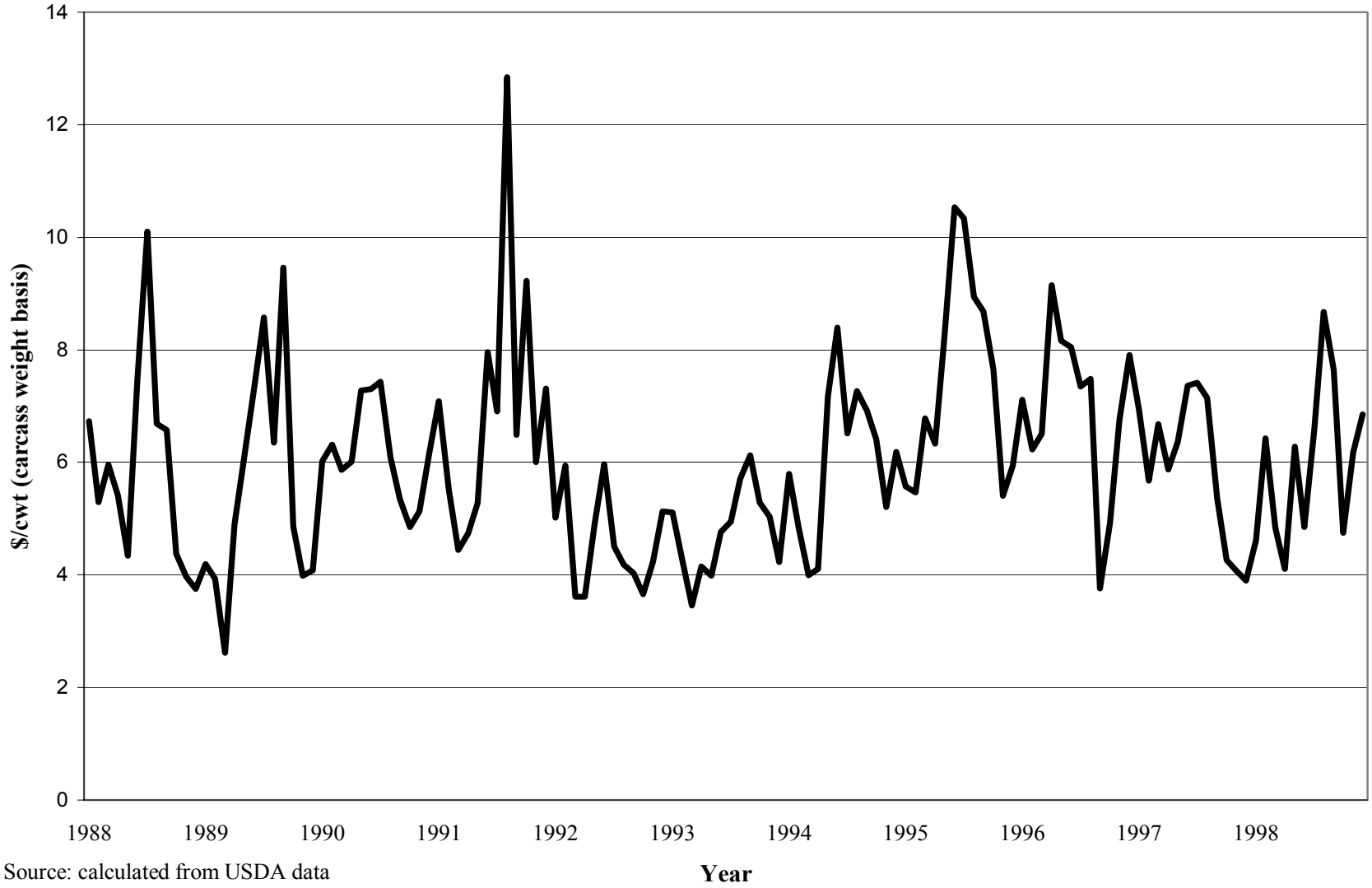
U.S. Department of Labor. *Indexes of Output per Hour*. Bureau of Labor Statistics. Washington D.C. Available at: ftp://ftp.bls.gov/pub/special.requests/opt/dipts/oaeh3din.txt. Accessed on June 5, 2003.

_____. *Consumer Price Index Report*. Bureau of Labor Statistics. Washington D.C. Available at: http://data.bls.gov/servlet/SurveyOutputServlet. Accessed on June 5, 2003.

Ward, C.E., S.R. Koontz, and T.C. Schroeder. "The Impacts of Captive Supplies on Fed Cattle Transaction Prices." *J. Agr. and Res. Econ.* 23(1998):494-514.

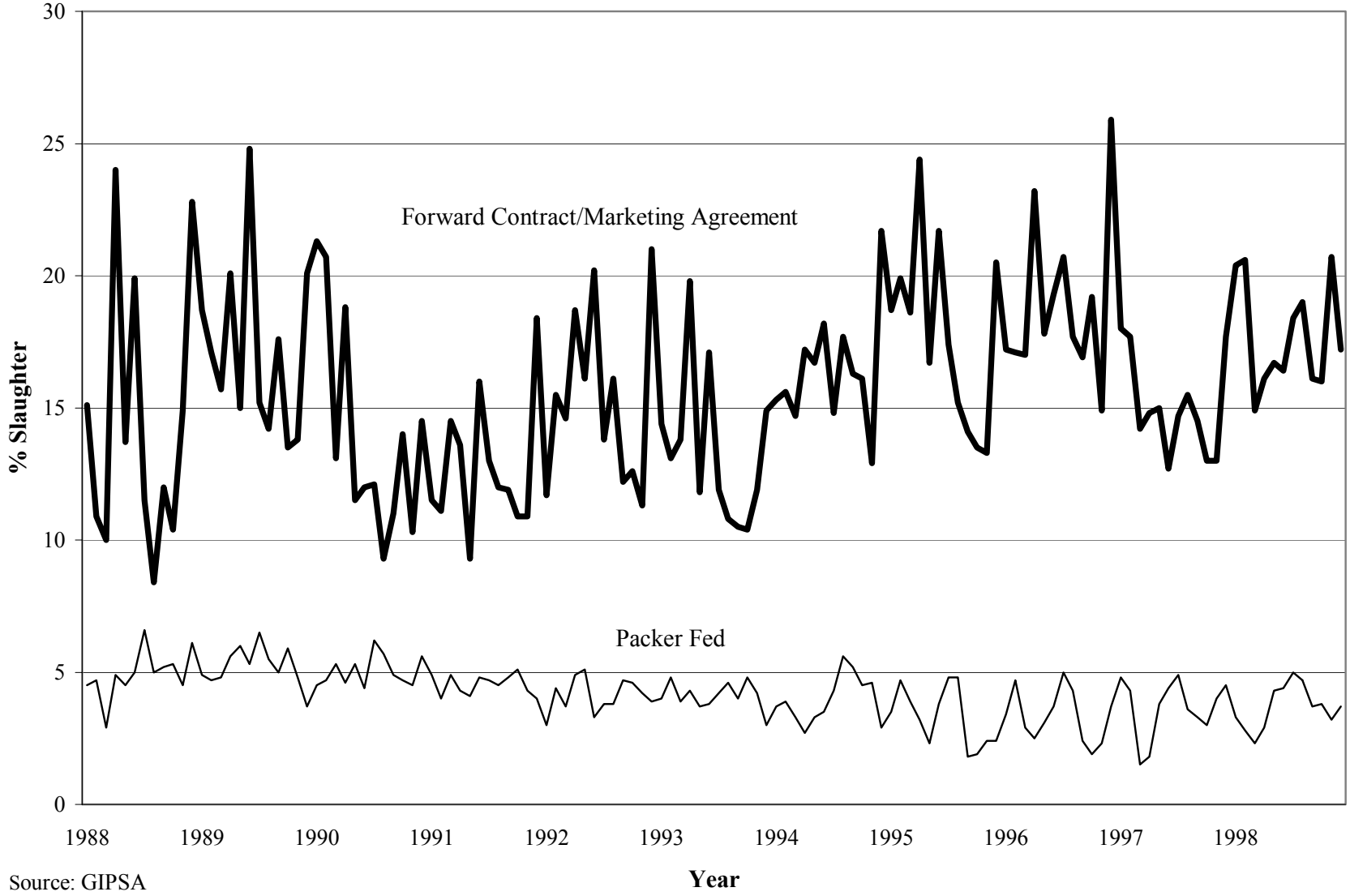
Wohlgenant, M.K., and J.D. Mullen. "Modeling the Farm-Retail Price Spread for Beef." *West. J. Agr. Econ.* 12(1987):119-25.

Figure 1. Real Monthly Farm-to-Wholesale Beef Marketing Margins, January 1988-December 1998.



Source: calculated from USDA data

Figure 2. Monthly Slaughter Packer Fed Cattle and Marketing Agreements and Forward Contracts, 15 Largest Packers, January 1988-December 1998.



Source: GIPSA

Table 1. Variables, Description of Variables, Means, and Standard Deviations**.**

Variable	Description	Mean	Standard Deviation
M	Dependent variable: Deflated wholesale boxed beef price plus by-product price minus slaughter fed cattle price ($/cwt carcass weight basis)[a]	6.03	1.70
P	Deflated average price of Choice and Select boxed beef ($/cwt)[a]	76.80	12.13
PQ	Deflated wholesale price of beef, *P* multiplied by per capita quantity produced ($/capita)[a]	5.82	0.88
IMC	Deflated price index of food marketing costs[a]	296.70	9.11
RISK	Coefficient of variation for 12 month rolling average of wholesale price (%)	3.38	0.97
POF	Percentage of cattle that are owned and fed by the packer, 15 largest packers, (% of slaughter)	4.17	1.03
PFCMA	Percentage of cattle that are acquired through marketing agreements and contracts, 15 largest packers (% of slaughter)	15.73	3.64
TECH	Technological change measured by the output per meat packing plant worker (1987=100)	100.97	2.09
CARCASS	Average fed cattle slaughter carcass weight (lbs.)	694.64	17.86

[a] Deflated to constant dollars 1982-84=100

Table 2. Parameter Estimates of Monthly Farm-to-Wholesale Beef Marketing Margins

Independent Variables	Model 1		Model 2	
	Farm-to-Wholesale Marketing Margin	Elasticity Estimates	Farm-to-Wholesale Marketing Margin	Elasticity Estimates
P	-0.052 (0.041)	-0.67	-0.099** (0.036)	-1.26**
PQ	0.29 (0.59)	0.28	0.011** (0.0036)	1.02**
IMC	0.019 (0.047)	0.95	-0.0076 (0.043)	-0.37
RISK	0.22 (0.17)	0.011	0.079 (0.17)	0.0039
POF	0.0414 (0.17)	0.029	0.27* (0.15)	0.19*
PFCMA	0.068 (0.046)	0.18	0.075** (0.037)	0.19**
TECH	-0.27** (0.093)	-4.55**	-0.25** (0.094)	-4.24**
CARCASS	0.015 (0.017)	1.74	0.016 (0.014)	1.89
D_1	17.30 (21.47)			
D_2	17.12 (21.49)			
D_3	16.77 (21.41)			
D_4	16.93 (21.37)			
D_5	18.01 (21.34)			
D_6	18.71 (21.37)			
D_7	18.82 (21.45)			
D_8	18.73 (21.49)			
D_9	17.79 (21.59)			
D_{10}	16.88 (21.50)			
D_{11}	16.81 (21.48)			
D_{12}	16.92 (21.49)			

Table 2. Continued. Parameter Estimates of Monthly Farm-to-Wholesale Beef Marketing Margins

Independent Variables	Model 1		Model 2	
	Farm-to-Wholesale Marketing Margin	Elasticity Estimates	Farm-to-Wholesale Marketing Margin	Elasticity Estimates
R^2	0.50		0.41	
Number of Observations	132		132	
ρ	-0.32** (0.090)		-0.31** (0.086)	

**Indicates significant at the 5% level, * indicates significant at the 10% level, ρ is a first-order autoregressive parameter and standard errors are in parentheses.