Concentration Measures for the Beef Packing Industry

Azzam and Anderson reviewed the literature on structure, conduct, and performance issues related to the meatpacking industry (USDA, GIPSA,1996). They reviewed studies under two classifications: Structure, Conduct, and Performance (SCP) and New Empirical Industrial Organization (NEIO). Results were not consistent across studies for either classification.

SCP Studies

Azzam and Anderson reported that several studies of beef and pork packing concluded that market power, the ability to affect prices because of quantities transacted or market share affected by one or a few firms, can arise from concentration. However, the studies they reviewed, which differed widely in time period and analytical method, arrived at conflicting results. Some studies were faulted in that their observed correlations could be due to shifts in supply or demand not properly specified. Specifically, Azzam and Anderson alleged that links between supply elasticity and prices were not addressed in the regional price-concentration studies they reviewed. They also pointed out that economies of size rather than noncompetitive behavior, may be the cause of firm growth and increases in concentration.

NEIO Studies

Azzam and Anderson likewise reported a lack of consistent results across NEIO studies they reviewed. A pattern of results suggested exercise of market power in live cattle markets, but price effects seemed small and perhaps more than offset by cost reductions associated with consolidation. Market power did not increase with concentration as theory would suggest, and evidence indicated that packers were unable to sustain cooperation in restraining prices paid for cattle. They also concluded that empirical implementation has not equaled theoretical rigor due to lack of appropriate data and model complexity.

GIPSA Conclusions

GIPSA reported its conclusions from the Azzam and Anderson study as follows:

> The researchers' description of historical industry evolution suggests that changes in the meatpacking industry have resulted from technological change and dynamic rivalry between firms. The basic question addressed by this project was whether the evidence from Structure-Conduct-Performance and New Empirical Industrial Organization studies is persuasive enough to warrant the conclusion that competition in the meatpacking industry is deficient. Taken as a whole, the literature review led to the conclusion that the answer is no.
>
> Many SCP studies indicated the existence and exercise of market power. However, the failure to use appropriate theoretical models of conduct in these studies makes industry generalizations questionable.
>
> The NEIO studies show a persistent gap between the actual price of livestock and the competitively determined price predicted by theory. However, the studies have not incorporated sufficient detail to prove noncompetitive behavior.

Empirical Measures of Packer Concentration

As discussed above, the CR-4 (four-firm concentration ratio) for steer and heifer slaughter as reported by GIPSA rose to 50 percent in 1985, 72 percent in 1990, and 80 percent in 1996 (preliminary GIPSA, table 3). The CR-4 for boxed fed beef production for the same years was 62 percent, 79 percent, and 84 percent (1994). Tables 3 to 6 summarize these and additional comparisons.

The Herfindahl-Hirshman Index

Another, generally preferred, measure of concentration is the Herfindahl-Hirshman Index (HHI), also reported by GIPSA. The HHI has the advantage of taking into account the number of firms and relative distributional shares of the market held by all firms, not just the largest few. The HHI is calculated by summing each firm's squared percentage of the market. If 100 firms each have a 1-percent share, the HHI will equal 100. If 1 firm has 100 percent of the market, the HHI equals 10,000.

Table 3--Slaughter concentration for four largest firms, 1980-96

	Four-firm concentration				Herfindahl-Hirshman Index			
Year	Steer & heifer	Cow & bull	Cattle	Boxed fed beef	Steer & heifer	Cow & bull	Cattle	Boxed fed beef
	Percent				*Herfindahl-Hirshman Index*			
Concentration based on procurement data reported to GIPSA:								
1980	35.7	9.7	28.4	52.9	561	89	361	1,220
1981	39.6	9.6	31.4	57.1	643	96	410	1,359
1982	41.4	9.1	32.0	59.1	683	83	417	1,323
1983	46.6	10.3	36.0	60.2	862	96	522	1,382
1984	49.5	11.0	37.2	61.7	944	98	543	1,439
1985	50.2	17.2	39.0	61.5	999	160	617	1,527
1986	55.1	18.4	42.3	67.4	1,088	173	657	1,691
1987	67.1	20.0	54.2	79.5	1,435	206	946	1,981
1988	69.7	18.4	56.6	79.3	1,589	198	1,055	2,030
1989	70.4	17.5	57.0	79.2	1,602	188	1,055	1,979
1990	71.6	20.4	58.6	79.3	1,661	223	1,118	1,988
1991	73.5	21.1	60.6	78.7	1,766	236	1,204	1,958
1992	77.8	22.0	63.5	81.4	2,005	243	1,336	2,163
1993	79.8	24.0	66.0	82.7	2,052	276	1,393	2,236
1994	80.9	26.3	67.8	85.7	2,096	320	1,460	2,340
1995	79.3	23.4	67.3	84.3	1,982	293	1,437	2,208
Concentration based on federally inspected slaughter data:								
1991	74.5	21.1	NA		NA	NA	NA	NA
1992	79.0	23.6	NA		NA	NA	NA	NA
1993	81.9	25.1	NA		NA	NA	NA	NA
1994	81.8	24.9	NA		NA	NA	NA	NA
1995	81.1	26.1	NA		NA	NA	NA	NA
1996	80.0	27.2	NA		NA	NA	NA	NA

NA = Not applicable.

Source: U.S. Dept. of Agriculture, Packers and Stockyards Statistical Report: 1995 Reporting Year, GIPSA 97-1, September 1997, Tables 27, 28, and 29.

Table 4—Livestock slaughter plants, by type of inspection, 1972-95[1]

Year	Plants reporting to GIPSA[2]		Total	Under Federal inspection January 1	Non-Federal inspection January 1	Total Federal and non-Federal inspection
	Under Federal inspection	Non-Federal inspection				
			Number of plants			
1972	735	405	1,140	984	5,172	6,156
1973	753	357	1,110	1,364	4,627	5,991
1974	741	322	1,063	1,437	4,440	5,887
1975	767	274	1,041	1,485	4,602	6,087
1976	761	288	1,049	1,741	4,514	6,255
1977	776	224	1,000	1,682	4,454	6,141
1978	785	213	998	1,701	4,434	6,135
1979	760	207	967	1,687	4,445	6,127
1980	762	209	971	1,627	4,399	6,026
1981	714	187	901	1,542	4,330	5,872
1982	728	156	884	1,688	4,048	5,736
1983	749	144	893	1,652	4,037	5,689
1984	730	137	867	1,666	3,892	5,558
1985	687	117	804	1,608	3,835	5,443
1986	640	99	752	1,544	3,701	5,245
1987	620	102	722	1,483	3,523	5,006
1988	606	99	705	1,387	3,453	4,840
1989	552	87	639	1,364	3,325	4,689
1990	534	89	623	1,268	3,281	4,549
1991	497	90	587	1,186	3,140	4,326
1992	490	79	569	1,125	2,896	4,021
1993	457	77	534	1,090	2,797	3,887
1994	434	66	500	1,030	2,733	3,763
1995	429	58	487	968	2,627	3,595

[1]Slaughter plants came under Federal inspection in the following 20 States after 1972: AR-6/81; CA-4/76; CO-7/75; CT-10/75; ID-7/81; KY-1/72; ME-5/80; MA-1/76; MD-3/91; MI-10/81; MO-8/82; NV-7/73; NH-8/78; NJ-7/75; NY-7/75; OR-7/72; PA-7/72; RI-10/81; TN-10/75 and WA-6/73. Many non-federally inspected plants can only custom slaughter for others.

[2]Plants reporting to GIPSA include federally and non-federally inspected establishments. Firms purchasing less than 2,000 head of all livestock, or less than 1,000 head of cattle prior to 1977, or less than $500,000 of all livestock beginning in 1977 were not required to report to GIPSA.

Source: U.S. Dept. of Agriculture, Packers and Stockyards Statistical Report: 1995 Reporting Year, GIPSA 97-1, September 1997, Table 18.

Table 5--Steers and heifers: Slaughter by plant size, packers reporting to GIPSA, by plant size (head), 1972-95

Year	Less than 1,000		1,000-9,000		10,000 49,999		50,000 99,999		100,000 249,999		250,000 or larger[1]		500,000 or larger[2]		1 million or larger	
	Plants	Head	Plants	Head	Plants	Head	Plants	Head	Plants	Head	Plants	Head	Plants	Head	Plants	Head
	No.	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*
1972	173	75	319	1,209	174	4,132	73	5,257	48	7,682	20	7,778				
1973	192	84	302	1,127	166	4,001	75	5,464	37	5,876	23	8,657				
1974	178	80	281	1,037	156	3,893	68	4,781	47	7,153	22	8,457				
1975	159	77	288	1,127	150	3,685	67	4,617	49	7,530	22	8,536				
1976	147	71	300	1,134	144	3,301	71	4,857	52	8,187	17	6,074	5	3,334		
1977	130	61	270	1,030	142	3,225	74	5,303	49	7,646	20	7,085	7	4,700		
1978	155	73	256	910	141	3,256	56	4,125	49	8,083	17	6,079	9	5,851		
1979	182	78	238	843	109	2,795	44	3,117	47	7,420	15	5,103	9	6,256		
1980	201	87	212	715	107	2,644	43	3,063	37	5,813	18	6,280	8	5,877		
1981	177	79	185	660	80	1,984	33	2,332	32	4,998	22	7,920	10	7,521		
1982	181	75	172	590	69	1,771	31	2,293	28	4,497	20	7,119	12	9,131		
1983	183	73	172	540	68	1,625	29	2,093	25	3,836	19	6,746	14	11,133		
1984	178	71	155	511	64	1,559	24	1,686	27	4,515	16	5,665	15	12,232		
1985	157	63	146	445	56	1,439	19	1,366	27	4,276	14	4,999	17	14,434		
1986	137	54	133	460	45	1,109	19	1,328	20	3,204	12	4,295	13	9,955	5	6,232
1987	152	53	128	435	34	776	20	1,383	23	4,056	10	3,444	12	8,561	7	8,438
1988	151	50	121	388	37	819	16	1,167	17	2,759	13	4,338	12	8,661	7	8,993
1989	138	49	92	304	32	803	12	891	13	2,141	13	4,426	12	8,677	7	8,595
1990	142	49	86	248	29	690	7	477	13	2,058	15	5,223	10	7,245	8	9,770
1991	130	48	81	235	26	577	6	410	15	2,614	14	5,563	10	8,470	6	7,462
1992	127	51	78	240	17	420	4	281	13	2,006	9	3,133	13	10,499	7	8,661
1993	131	44	66	175	21	465	3	216	12	1,926	8	3,164	9	6,810	11	12,751
1994	98	31	72	207	21	479	4	318	7	1,100	6	2,351	11	8,079	11	13,562
1995	96	36	58	170	19	421	5	369	9	1,533	7	2,692	10	7,194	12	14,934

[1]Size limits are 250,000-499,999 beginning in 1976.

[2]Size limits are 500,000-999,999 beginning in 1986.

Source: U.S. Dept. of Agriculture, Packers and Stockyards Statistical Report: 1995 Reporting Year, GIPSA 97-1, September 1997, Table 20.

Table 6--Cows and bulls: Slaughter by plant size, packers reporting to GIPSA, by plant size (head), 1972-95

Year	Less than 1,000		1,000-9,000		10,000 24,999		25,000 49,999		50,000 99,999		100,000 or larger[1]		150,000 or larger	
	Plants	Head	Plants	Head	Plants	Head	Plants	Head	Plants	Head	Plants	Head	Plants	Head
	No.	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*	*No.*	*1,000*
1972	279	110	359	1,272	82	1,340	47	1,604	18	1,235	6	801		
1973	268	107	333	1,138	74	1,208	44	1,563	23	1,702	3	481		
1974	248	94	316	1,140	68	1,133	39	1,362	31	2,240	6	927		
1975	206	83	302	1,107	83	1,298	57	2,046	36	2,440	22	2,959		
1976	202	85	298	1,149	74	1,183	74	2,558	41	2,740	17	2,104	5	917
1977	193	79	299	1,153	76	1,206	61	2,118	35	2,433	13	1,609	5	920
1978	206	82	295	1,172	65	1,066	57	1,942	38	2,648	9	1,074	5	917
1979	243	98	262	957	52	855	39	1,277	30	1,945	7	810	3	489
1980	250	93	240	832	56	926	46	1,609	21	1,539	4	482	5	807
1981	213	86	206	728	55	887	40	1,397	24	1,664	6	669	7	1,153
1982	207	86	195	741	44	744	45	1,594	25	1,700	9	1,063	6	1,012
1983	197	77	199	775	48	809	51	1,814	21	1,490	8	943	8	1,541
1984	192	73	171	648	48	800	48	1,745	27	1,874	12	1,400	8	1,661
1985	188	71	145	572	48	764	40	1,411	17	1,333	12	1,427	8	1,666
1986	149	55	133	478	43	680	41	1,430	16	1,124	20	2,320	8	1,770
1987	154	51	121	441	48	775	32	1,104	24	1,778	13	1,572	7	1,470
1988	146	48	127	483	36	588	29	934	21	1,541	13	1,618	7	1,402
1989	136	46	110	408	33	579	25	857	17	1,300	8	964	11	2,159
1990	140	45	99	330	28	500	17	597	19	1,311	11	1,349	10	2,001
1991	127	42	89	311	24	400	21	766	18	1,344	10	1,274	10	1,933
1992	120	42	77	300	25	435	15	526	15	1,104	10	1,263	12	2,238
1993	114	42	66	244	20	350	12	456	14	1,031	10	1,214	14	2,777
1994	104	38	53	212	19	313	13	474	18	1,372	10	1,282	12	2,596
1995	93	27	58	224	18	314	12	445	12	885	9	1,083	17	3,510

[1]Size limits are 100,000-149,999 beginning in 1976.

Source: U.S. Dept. of Agriculture, Packers and Stockyards Statistical Report: 1995 Reporting Year, GIPSA 97-1, September 1997, Table 21.

The U.S. Department of Justice and Federal Trade Commission Horizontal Merger Guidelines (April 1992) provide insight into the HHI levels considered important in determining whether mergers within a relevant market are likely to be challenged by the Justice Department:

> Post-Merger HHI below 1,000. The Agency regards markets in this region to be unconcentrated. Mergers resulting in unconcentrated markets are unlikely to have adverse competitive effects and ordinarily require no further analysis.
>
> Post-Merger HHI between l,000 and l,800. The Agency regards markets in this region to be moderately concentrated. Mergers producing an increase in the HHI of less than l00 points in moderately concentrated markets post-merger are unlikely to have adverse competitive consequences and ordinarily require no further analysis. Mergers producing an increase in the HHI of more than 100 points in moderately concentrated markets post-merger potentially raise significant competitive concerns depending on the factors set forth in Sections 2-5 of the Guidelines.
>
> Post-Merger HHI above l,800. The Agency regards markets in this region to be highly concentrated. Mergers producing an increase in the HHI of less than 50 points, even in highly concentrated markets post-merger, are unlikely to have adverse competitive consequences and ordinarily require no further analysis. Mergers producing an increase in the HHI of more than 50 points in highly concentrated markets post-merger potentially raise significant competitive concerns, depending on the factors set forth in Sections 2-5 of the Guidelines. Where the post-merger HHI exceeds 1,800, it will be presumed that mergers producing an increase in the HHI of more than 100 points are likely to create or enhance market power or facilitate its exercise. The presumption may be overcome by a showing that factors set forth in Sections 2-5 of the Guidelines make it unlikely that the merger will create or enhance market power or facilitate its exercise, in light of market concentration and market shares (Section 1.5).

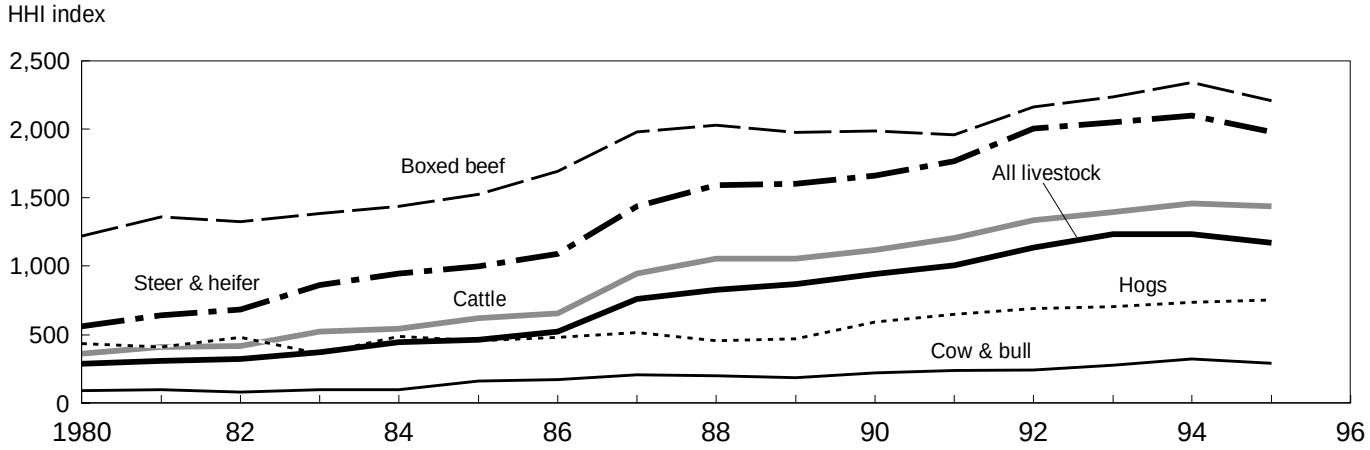
The HHI for U.S. steer and heifer slaughter was 999 in 1985, 1,661 in 1990, and 1,982 in 1995, above the threshold 1,800 level (fig.15). For all cattle slaughter combined, the HHI's are much lower, reaching only 1,437 in 1995. For U.S. boxed fed beef, the HHI's are 1,527; 1,988; and 2,208, respectively. If the relevant market were defined as steer and heifer slaughter or boxed fed beef production by the U.S. Department of Justice, it would seem that future major mergers would be candidates for challenge. On the other hand, if the relevant market were defined as cattle slaughter or all livestock purchases, merger challenges would be less likely (tables 3 to 6).

HHI and Our Asymmetric Model

It is clear that steer and heifer slaughter concentration and fed boxed beef concentration is high by several standards. It is far less clear what caused industry consolidation or what effects stem from high concentration, and whether any effects constitute market distortions adverse to producers.

We tested for the effects of concentration by including the HHI in our asymmetric model. We had HHI measures for only a limited part of the sample. The HHI was statistically significant in the sub-sample, but its effects were opposite from what one would expect. If packers were using market power to gain an unfair advantage over producers, one would expect market power to lead to lower farm prices and/or higher farm-to-wholesale spreads. However, in our results, increasing HHI was associated with higher farm prices and lower farm-to-wholesale spreads. This type of unexpected result is common in other studies of market concentration's effects on livestock markets.

Figure 15
Herfindahl-Hirshman Index for the meatpacking industry, by category, 1980-96



Source: USDA, ERS, from data provided by USDA's, Grain Inspection, Packers and Stockyards Administration.

While the estimated HHI effect is counter-intuitive, it is also small. As we move from the smallest HHI to the largest HHI, the farm-wholesale spread drops by less than 1 cent. This drop in the farm-wholesale spread translates into a 2-cents-per-pound increase in the live price of choice cattle; retail and wholesale prices are basically unaffected by the HHI. The large amount of data in the asymmetric model make it able to measure relatively small effects with great accuracy. The small measured effect of the HHI is very statistically significant even though it has little practical effect.

There are a number of reasons why the HHI could give this counter-intuitive result. Market concentration may be driven in part by economies of size. Farm-to-wholesale spreads could be dropping as concentration rises because some part of the cost-savings from larger slaughter operations are shared with producers. Also, the HHI may not be the most appropriate measure of market power. There is a difference between the ability to exercise market power, for example, concentration, and the actual exercise of market power (Jones, Purcell, Driscoll, and Peterson, 1996). The HHI is meant to measure the ability to exercise market power. It is generally assumed in the literature that the exercise of market power by an industrial organization is reliably related to the ability to exercise it. The reality may be more complex.