PRODUCTIVITY-CONCENTRATION RELATIONSHIP IN THE U.S. MEATPACKING INDUSTRY

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Abstract

Previous research found a positive relationship between concentration and total factor productivity in food manufacturing. One industry (i.e., meatpacking plants [SIC 2011]) was selected for independent analysis due to a relatively sharp increase in concentration in recent years. The methodology chosen was similar to previous studies. Total factor productivity increased 2.4 percent per year, and labor productivity increased 3.3 percent per year for meatpacking plants over the 1958–82 period. Concentration in meatpacking did not positively or negatively affect total factor productivity or labor productivity over the 25-year study period.

Key words: meatpacking, productivity, concentration, industry structure, economic performance.

Gisser (1982) questioned whether total factor productivity could be related to industry concentration. If the productivity-concentation relationship is positive, concentration would be a source of welfare gain rather than a welfare loss. He stated, "It appears that no one has studied the relationship between concentration and productivity in a single industry, such as food manufacturing." Gisser then described a methodology and tested the relationship between total factor productivity and concentration in food manufacturing over the 1963–72 period. Hazeldine and Cahill, in their response to Gisser's work, suggest that the concentration-productivity relationship be studied further with disaggregated data.

The purpose of this study was to examine the productivity-concentration relationship by isolating a single four-digit Standard Industry Classification industry within food manufacturing, namely SIC 2011, Meatpacking Plants. The meatpacking industry was singled out because of the sharp turn-around observed in industry concentration in recent years. Relative to previous work, this study (1) focuses on a narrower definition of an industry, (2) examines the productivity-concentration relationship over a longer time period (i.e., 1958–82 compared with 1963–72 in the Gisser study), and (3) utilizes alternative estimates of industry concentration.

MEATPACKING CONCENTRATION AND IMPACTS

Figure 1 shows industry concentration data published by the U.S. Departments of Commerce (for 1958–82) and Agriculture (for 1969–85) (see following section for specific data sources). Concentration for the meatpacking industry as a whole has been influenced most by the rapid increase in concentration among firms slaughtering steers and heifers.

Several agricultural economists have attempted to identify price impacts stemming from structural changes. Studies have examined price impacts from vertical integration (Aspelin and Engelman), changes in number of buyers in local or regional markets (Hayenga et al.; Love and Shuffett; Ward 1981, 1984), and increased concentration (Menkhaus et al.; Multop and Helmuth; Ward 1982). These studies varied widely in objectives, methodology, and data analyzed. However, there is evidence that prices are directly related to number of buyers and inversely related to concentration, though the evidence is not conclusive.

METHODOLOGY AND DATA

Gisser (1982) used Solow's approach involving a neutral shift in technology to measure total factor productivity (TFP) in food manufacturing and in all U.S. manufacturing in-

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The author acknowledges useful comments by anonymous *Journal* reviewers on earlier drafts of this article.

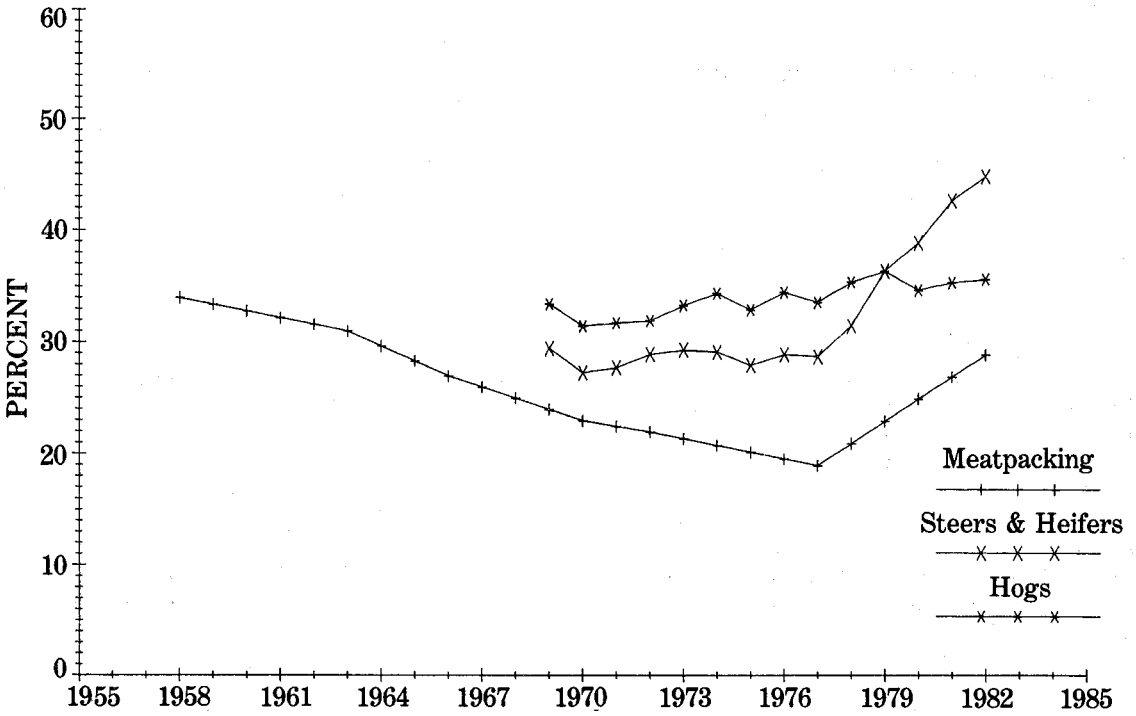

Figure 1. Four-Firm Concentration in Meatpacking.

dustries (Gisser 1984). Solow derived the following equation:

$$(1)\quad \dot{A}/A=\dot{Q}/Q-[\alpha_1(\dot{L}/L)+\alpha_2(\dot{K}/K)],$$

where the dot indicates a first-order derivative with respect to time. $\dot{A}/A$ is the rate of total factor productivity growth and measures the cumulative shift in the production function; $\dot{Q}/Q$ is the rate of real output growth; $\dot{L}/L$ and $\dot{K}/K$ are the rates of labor and capital input growth, respectively; and α_1 and α_2 are the relative shares of labor and capital inputs, respectively.

Data required to compute $\dot{Q}/Q$, $\dot{L}/L$, $\dot{K}/K$, α_1, and α_2 were obtained from the *Census of Manufactures, Industry Series for Meat Products*, 1967, 1972, 1977, and 1982 Preliminary Report, U.S. Department of Commerce. Annual percentage changes in real output growth ($\dot{Q}/Q$) were based on annual value of meat products shipments deflated by the index of prices received by farmers for livestock and products as reported in *Agricultural Prices, Annual Summary*, U.S. Department of Agriculture.

Annual percentage changes in labor input were computed as in Gisser (1982), with one exception noted below

$$(2)\quad \dot{L}/L=W(\dot{P}L/PL)+(1-W)(\dot{N}L/NL),$$

where $\dot{L}/L$ is the annual growth in labor input, W is the relative importance of production labor input, and $\dot{P}L/PL$ is the annual growth in non-production labor input. The Weight (W) used by Gisser was the ratio of the total wage bill for production workers to total wage payments, averaged for the beginning and ending years. In this study, W varied from year to year, ranging from .719 in 1958 to .783 in 1982. The increasing value of W over time reflects an increasing number of production workers relative to total employment in the meatpacking industry. Meatpackers have increased the amount of further processing which is more labor intensive than slaughtering, especially in beef where boxed primal cut sales (boxed beef) have increased relative to carcass sales.

Annual percentage changes in real capital input ($\dot{K}/K$) were calculated from new capital expenditures deflated by the producer price index. This procedure differed from Gisser's (1982) approach because data for a portion of the 1958–82 period were unavailable. Gisser added 10 percent of gross book value of depreciable assets to new plant and equipment expenditures plus rental payments.

Gisser (1982) used a single value for α_1 in equation (1), the 1969 estimate found in Kendrick and Grossman, for the entire 1963–72 period. In this study, the most recent esti-

mates reported in Kendrick and Grossman and in Kendrick were used whenever possible. Thus, α_1 ranged from .688 in 1958 to .781 in 1978. The increasing value of α_1 over time also reflects the move to more labor intensive operations in the meatpacking industry.

To empirically test the productivity-concentration relationship, Gisser (1982, 1984) offered an equation in which TFP (i.e., $\dot{A}/A$) was dependent on the rate of real output growth and industry concentration. The equation was modified in two ways in this study. First, Gisser included a dummy variable for increasing or decreasing concentration levels across industries which was not directly applicable to the single-industry analysis here. Second, a *Journal* reviewer noted that Gisser's model included the rate of real output growth on both sides of his estimated equation. Therefore, the following equation was specified and estimated as an empirical test of the productivity-concentration relationship:

$$(3)\quad \dot{A}/A=\alpha+\beta_1\, C+\beta_2\, DC,$$

where $\dot{A}/A$ is TFP as computed in equation (1); C is the industry concentration ratio; and DC is a zero-one dummy variable distinguishing the period of decreasing concentration from that of increasing concentration (i.e., 1958–77 and 1978–82, respectively). Variable DC is similar to the dummy variable Gisser included to measure productivity effects in industries with increasing or decreasing concentration.

Concentration data were obtained from two sources. First was the *Census of Manufactures, Subject Series, Concentration Ratios in Manufacturing*. Concentration data reported were the combined share of value of shipments by the i^{th} largest firms, where i equalled 4, 8, 20, and 50. The *Census of Manufactures* series represents a weighted average of concentration for all classes of livestock. The second source was Packers and Stockyards Administration (P&SA), USDA, which estimates the combined market share of each livestock species slaughtered for the i^{th} largest firms reporting to P&SA, where i equals 4, 8, and 20. Concentration ratios for steer and heifer slaughter and for hog slaughter were used in this study, both individually and as a two-species average.

EMPIRICAL RESULTS

Table 1 shows data for selected series and years over the 1958–82 period, as well as means and standard deviations for the 25-year period. The full data set is available upon request. Real output in meatpacking ($\dot{Q}/Q$) increased at an annual average rate of 1.5 percent. The average annual real capital growth rate ($\dot{K}/K$) was 1.6 percent, but annual average growth in labor ($\dot{L}/L$) was negative for both production ($\dot{P}L/PL$) and nonproduction ($\dot{N}P/NP$), workers, −1.5 and −2.8 percent, respectively. Total factor productivity ($\dot{A}/A$) in meatpacking averaged 2.4 percent per year, while labor productivity (LP), defined by Gisser (1982) as real output growth ($\dot{Q}/Q$) minus labor input growth ($\dot{L}/L$), averaged 3.3 percent per year.

Results of estimating equation (3) by ordinary least squares (OLS) regression are shown in Table 2. Estimation results include the full 25-year period (1958–82), the 10-year period in Gisser's food manufacturing study (1963–72), and the 14-year period for which P&SA concentration data were available in conjunction with other data for the model (1969–82).

None of the coefficients on the concentration variable (C), whether 4, 8, 20, or 50 firm ratios, were significant in the TFP equation. None of the coefficients on the dummy variable marking the turning point for industry concentration in meatpacking (DC) were significant. Thus, increasing concentration in meatpack-

TABLE 1. PARTIAL DATA SERIES FOR PRODUCTIVITY-CONCENTRATION STUDY IN MEATPACKING

	Variable						
Year	$\dot{Q}/Q$	$\dot{K}/K$	$\dot{P}L/PL$	$\dot{N}L/NL$	$\dot{L}/L$	$\dot{A}/A$	LP
1959	4.940	1.749	1.087	− 5.252	− .663	4.935	5.603
1963	3.490	−12.983	−3.076	− 3.529	−3.195	9.396	6.684
1968	.556	− 2.594	− .958	− 1.272	−1.035	2.023	1.591
1973	−13.660	− .445	−5.956	− 2.402	−5.058	−9.612	−8.602
1978	−1.063	−10.523	2.507	−10.821	− .442	2.010	− .621
1982	.567	− 5.737	−2.179	− 3.462	−2.457	3.880	3.024
Mean	1.498	1.645	−1.493	− 2.835	−1.824	2.394	3.322
Standard Deviation	5.349	9.524	3.791	3.687	3.223	4.684	4.454

TABLE 2. MEATPACKING PRODUCTIVITY-CONCENTRATION REGRESSION RESULTS

Concentration Ratio Series	Intercept	C	DC	n	R^2
		1958-82			
CR4	− .433[a]	.020	− .367	24	.002
	(.08)	(.09)	(.15)		
CR8	− 1.561	.103	− .514	24	.005
	(.10)	(.27)	(.10)		
CR20	− 7.687	.196	−1.248	24	.013
	(.38)	(.50)	(.42)		
CR50	−20.814	.365	− .256	24	.025
	(.64)	(.72)	(.66)		
		1963-72			
CR4	.371	.090	NA	10	.004
	(.03)	(.17)			
CR8	− 8.958	.302	NA	10	.014
	(.26)	(.34)			
CR20	−33.414	.704	NA	10	.039
	(.53)	(.57)			
CR50	−56.062	.922	NA	10	.061
	(.69)	(.72)			
		1968-82			
CR4 − Steers and Heifers	− 7.451	.341	−3.745	14	.038
	(.50)	(.66)	(.60)		
CR4 − Hogs	2.754	−.013	.197	14	.000
	(.05)	(.01)	(.04)		
CR4 − Average	−15.550	.578	−3.94	14	.032
	(.52)	(.60)	(.57)		

[a]Numbers in parentheses are absolute values of calculated t-statistics.

ing, and especially the relatively rapid increase in concentration among firms slaughtering steers and heifers, has had no significant effect on TFP for the meatpacking industry.

Equation (3) was also estimated substituting labor productivity (LP) for TFP. Though not presented here, results were similar in that neither the concentration variable (C) nor the dummy variable distinguishing periods of decreasing and increasing concentration (DC) significantly explained changes in LP.

Independent variables in estimated equations explained virtually none of the variation in either TFP or LP, as noted by low R^2 values. Gisser's formulation had higher R^2 values, due in part to including real output growth as an independent variable.

IMPLICATIONS AND CONCLUSIONS

Previous researchers relating concentration to production costs and productivity for various industries have hypothesized that positive relationships suggest concentration may be a source of welfare gain (Gisser 1982, 1984; Lustgarten; Peltzman). Peltzman found that increased concentration meant reduced production costs and increased efficiency, as larger firms apparently capitalized on economies of scale. Lustgarten modified Peltzman's methodology somewhat but also confirmed the positive relationship between concentration and reduced industry costs. Gisser (1984) found a positive relationship between concentration and total factor productivity for a larger number of U.S. industries (i.e., 314).

Similar positive productivity-concentration results were hypothesized in this study of the meatpacking industry. Logan and King and later work by Cothern et al. (1978a, 1978b) found economies of scale in cattle slaughtering and beef processing. Ball and Chambers examined the meat products industry cost function derived from the industry production function and found increasing returns to scale for the 1954-76 period. Sersland used statistical cost analysis and found significant economies of size in steer and heifer slaughtering and carcass beef fabricating. These studies suggest a positive relationship could be expected between productivity and concentration as larger firms capitalize on economies of scale and size and thereby lower their production costs.

No significant positive or negative relationship was found in this study between productivity (either total factor productivity or labor productivity) and concentration in meatpack-

ing over a 25-year period. Thus, empirical results reported here for a single industry conflict with those of previous interindustry studies. They also conflict with expected results based on economies of scale and size studies of meatpacking.

Possible explanations are offered for conflicting results. First, interindustry analyses may mask relationships in specific industries due to an aggregation bias. Interindustry analyses may indicate relationships *on the average* for several industries, but those relationships may vary among specific industries. This explanation parallels the regression fallacy criticism of statistical cost analysis (Mansfield).

Second, even within meatpacking, it would have been desirable to estimate productivity by species of livestock slaughtered, but such data were unavailable. Disaggregated data by livestock species may have provided additional insight into the apparent discrepancy between economies of scale and size studies (especially in cattle slaughtering and beef processing) and results of this analysis. A conceivable hypothesis is that higher productivity increases in beefpacking, resulting from larger firms capitalizing on economies of scale and size and leading to increased concentration, were offset by lower productivity increases (or even decreases) in other meatpacking segments where concentration had not increased.

Third, additional data and alternative methodologies may be required. In particular, the assumption of neutral technological change may be inappropriate. Data series on such variables as concentration, meat products shipments, number of production and nonproduction employees, and capital inputs may be too highly aggregated to satisfactorily measure the productivity-concentration relationship for a single industry using a procedure similar to that used by Gisser (1982, 1984). Consequently, more research is needed to adequately determine whether concentration in meatpacking has led to increased efficiency, thereby positively contributing to social welfare.

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