

# **Assessing Competition In Meatpacking: Economic History, Theory, and Evidence**

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## PREFACE

Congress included \$500,000 in the U.S. Department of Agriculture's (USDA) Packers and Stockyards Administration (now Grain Inspection, Packers and Stockyards Administration (GIPSA)) 1992 fiscal-year appropriation to conduct a study of concentration in the red meat packing industry. GIPSA solicited public comments on how to conduct the study and formed an interagency working group to advise the Agency on the study. Based on the public input and comments of the working group, GIPSA selected seven projects and contracted with university researchers for six of them.

The findings of the study are summarized in Packers and Stockyards Programs, GIPSA, USDA, *Concentration in the Red Meat Packing Industry*, February 1996. The technical reports of the contractors are published as a series of Grain Inspection, Packers and Stockyards Administration Research Reports (GIPSA-RR). The technical reports of the contractors are:

- GIPSA-RR 96-1      Marvin L. Hayenga, Stephen R. Koontz, and Ted C. Schroeder, *Definition of Regional Cattle Procurement Markets*.
- GIPSA-RR 96-2      Slaughter Cattle Procurement and Pricing Team, Texas A&M Agricultural Market Research Center, *Price Determination in Slaughter Cattle Procurement*.
- GIPSA-RR 96-3      Clement E. Ward, Ted C. Schroeder, Andrew P. Barkley, and Stephen R. Koontz, *Role of Captive Supplies in Beef Packing*.
- GIPSA-RR 96-4      S. Murthy Kambhampaty, Paul Driscoll, Wayne D. Purcell, and Everett D. Peterson, *Effects of Concentration on Prices Paid for Cattle*.
- GIPSA-RR 96-5      Marvin L. Hayenga, V.J. Rhodes, Glenn A. Grimes, and John D. Lawrence, *Vertical Coordination in Hog Production*.
- GIPSA-RR 96-6      Azzeddine Azzam and Dale Anderson, *Assessing Competition in Meatpacking: Economic History, Theory, and Evidence*. This project reviewed relevant research literature.

The seventh project analyzed hog procurement in the eastern Corn Belt and was conducted by the Economic Research Service, U.S. Department of Agriculture. The findings of this project are included in the summary report on the study referenced above and are not published in a separate technical report.

This report is based on work performed under contract for GIPSA, USDA. The views expressed in this report are those of the authors and are not necessarily those of GIPSA or USDA.

## ***ASSESSING COMPETITION IN MEATPACKING:***

***ECONOMIC HISTORY, THEORY, AND EVIDENCE***

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# CHAPTER I

## INTRODUCTION

The state of competition in the U.S. meatpacking industry has long been a source of public concern and was a subject of lively debate as far back as the close of the nineteenth century when the "Big Five" of that era -- Armour, Cudahy, Morris, Swift, and Wilson -- had the major share of red-meat slaughter and trade. The concern prompted several investigations, culminating in a consent decree in 1920, which led to the divestiture of packer interests in stockyards, terminal railroads, cold storage warehouses, and retail meat markets.<sup>1</sup> That, along with subsequent advances in refrigeration and transportation technologies, and the rise of chain store distribution and federal grading of meat, lowered barriers to entry into the industry and led, until the 1970s, to a decline in concentration. Concentration increased during the 1970s and 1980s with the emergence this time of a "Big Three" -- IBP, ConAgra and Excel -- occasioning renewed interest in the industry and its competitiveness. The competitive concerns at present are much the same as those of the earlier era: the seeming threat to competition in livestock procurement and in the fabrication and sale of meat products posed by increasing horizontal and vertical integration.

While the present concerns may be the same as those of the past, today's industry and the environment in which it operates have changed in important respects. At the turn of the century, the industry was city-based, largely in Chicago. Meat packing and processing are now livestock-oriented and focused in smaller communities in the western Corn Belt.

The "Big Five" of the turn of the century, by integrating forward into the marketing of fresh and processed meat products through their ownership of refrigerated rail cars and branch cold storage houses, and through brand marketing of their products, had some measure of control over retail outlets. The present trend is toward backward integration, either through feeding of packer-owned livestock or through contractual arrangements with otherwise-independent feeders. Consumers now voice concerns about the safety and goodness of the industry's products, just as they did previously. But sanitation concerns of the earlier era have given way to apprehensions about more equivocal health issues such as the effects of synthetic growth hormones in beef, nitrosamine in cured pork, and cholesterol and saturated fats found in red meats generally.

Economists' views of competition also have diverged from those of the past. Before the neoclassical definition of competition came into vogue, economists generally defined competition in everyday terms familiar to the public. Thus, competition was rivalry. Underselling a rival was competitive strategy rather than predation. Growing business

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<sup>1</sup>*Packer Consent Decree*, Document No. 219, 68th Congress, 2nd Session, Serial 8413 (Washington, D.C.: Government Printing Office, 1924-1925).

concentration and large firm size were necessary for achieving efficiencies in production and distribution. Market dominance was transitory because the threat of entry would deter firms from charging monopoly prices. Hence, antitrust attacks on large-scale business were typically regarded by economists as interference with the natural process of competition. What was needed, in this earlier view, were legal limitations on unfair means of rivalry, not limitations on the size of the enterprise.

The dominant method of competitive analysis in the earlier period was descriptive and historical. Along with prices and profits, analysts examined an array of elements, often including the biographies of business leaders. Given the situational nature of the analyses, conclusions were not on the whole generalizable.

After the 1930s, the view of competition as the presence of rivalry was supplanted by the neoclassical view of competition as the absence of rivalry. The perfect competition model, where efficiency is judged by the equality of marginal cost and price, became an abstract benchmark for assessing the performance of firms and industries. Departures from the equality of price and marginal cost were evidence of imperfect competition. No longer were historical and institutional aspects of the firm principal considerations in assessing competition. The new firm-oriented theory concerned itself largely with price and output decisions and how they affected efficiency and economic welfare.

By 1939, theoretical relationships between market structure on the one hand, and such performance variables as prices, technical efficiency, and advertising on the other, had been developed into what was to become the dominant empirical model in industrial organization: the structure-conduct-performance (SCP) paradigm. Market structure was the determinant of competition and much of industrial organization, in the SCP tradition, has centered around testing the hypothesis that structure affects performance. Structure (usually concentration) and performance (usually profits or prices) correlations were indicative of some element of noncompetitive conduct. The exact nature of conduct need not be specified explicitly in empirical models.

The 1970s brought what have become known as new empirical industrial organization (NEIO) studies which, unlike their SCP precedents, attempt to examine conduct explicitly. These studies adapt and apply various models of imperfect competition including Cournot, Stackelberg's price leadership, and variants of game theory. Their starting point is an explicit theoretical model of firm optimization. This yields implications and theoretical restrictions that are used in turn to refine the empirical assessment of market power.

The historical evolution of empirical analyses of competition in the meat packing industry has been conditioned both by theoretical developments in industrial organization and by structural changes in the industry. Early attempts at analyzing competitive conditions in meatpacking used the historical case-study method which dominated industrial organization during the first 2 decades of the twentieth century. The 1919 *FTC Report on the Meat Packing*

*Industry*<sup>2</sup> is a classic example. Although historians produced a number of important early studies, the industry was mostly ignored by agricultural economists until Nicholl's work in the early 1940s,<sup>3</sup> 20 years after the Packer Consent Decree.<sup>4</sup> Virtually no published economic literature on competition in the industry would appear after Nicholls' work until the 1970s. Business historians have also shown interest in the industry since the 1970s, and their work has resulted in two notable books<sup>5</sup> and several articles.<sup>6</sup>

Growing concentration in the industry during the 1980s aroused the interest of livestock producer groups, policy makers, the general public, and even agricultural economists in the performance of the industry. Numerous congressional hearings were held, task force reports written, conferences assembled, and scientific articles published. At the turn of the century, they all explored the same issue and debated extensively the extent to which increasing concentration in the industry is harmful to meat consumers and livestock producers. This time, the issue is being debated concurrently with a major rethinking of theoretical and empirical propositions by industrial organization professionals. Two strands of scientific literature compete for attention. One strand is drawn from the SCP paradigm; the other from the NEIO.

Just as earlier research may have helped shape policy decisions affecting the industry at the turn of the century, contemporary research findings are making their way into current debates

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<sup>2</sup>U.S. Federal Trade Commission, *Report on the Meat Packing Industry, 1919*, parts 1-6 (Washington, D. C.: Government Printing Office, 1919).

<sup>3</sup>William H. Nicholls, "Market-Sharing in the Packing Industry," *Journal of Farm Economics*, vol. 22 (1940), pp. 225-240, and William H. Nicholls, *Imperfect Competition in the Agricultural Industries* (Ames: Iowa State University, 1941).

<sup>4</sup>*Packer Consent Decree, op. cit.*

<sup>5</sup>Mary Yeager, *Competition and Regulation: The Development of Oligopoly in the Meat Packing Industry* (Greenwich: JAI Press, 1981). Jimmy Skaggs, *Prime Cut: Livestock Raising and Meatpacking in the United States, 1607-1983* (College Station: Texas A&M University Press, 1986).

<sup>6</sup>See Chapter II.

and may influence future policies. An understanding of the theoretical and procedural bases of the literature, in the context of their historical evolution and the historical evolution of the meatpacking industry itself, is essential to balanced interpretations of empirical results. Thus the need for the present examination of the theories and methods, and their applications to meatpacking. The results have implications for public policies now and for investigations of competition in the meatpacking industry in the future.

Chapter II provides historical insights into the development of the meat packing industry since the colonial period. Its purposes are to 1) illuminate the issue of industry competition from the viewpoint of business historians, and 2) provide a perspective for the subsequent appraisal of economic literature on the meatpacking industry.

The third chapter provides historical insights into the contribution of industrial organization theory and practice to an understanding of market power. Findings add perspective to contemporary theoretical approaches and insights into the roots of public policies that have shaped U.S. industrial development in general and meatpacking in particular. The survey ranges from mid-nineteenth century thinking through that of the present.

The fourth and fifth chapters of the report summarize and synthesize the major meatpacking studies (SCP and NEIO), and their findings, respectively.

The sixth chapter provides a critical analysis of the findings from both strands of the literature, draws conclusions about the state of competition in the industry, and makes recommendations in light of (a) the history of the industrial organization of the meatpacking industry outlined in the second chapter, and (b) the state of theoretical and analytical arts of the analysis of industrial competitiveness.

## CHAPTER II

### INDUSTRIAL ORGANIZATION OF U.S. MEATPACKING: A HISTORICAL PERSPECTIVE

#### 1. From Pynchon to the Vest Report (1662-1890)

Meatpacking as a commercial enterprise in America began during colonial times in Springfield, Massachusetts. There, in 1662, William Pynchon, America's first meatpacker, set out to supply packed pork to plantations in the West Indies which, because of the Civil War in England (1640-1660), were cut off from English and Irish supplies of meat.<sup>7</sup> Packed pork, consisting of hand-rubbed, freshly-cut meat preserved with an assortment of salt-based compounds, was packed and shipped in large barrels called "hogs-heads."<sup>8</sup> Beef and mutton were rarely packed since, unlike pork, they did not preserve well. Moreover, cattle and sheep could be driven long distances, year around, to be slaughtered for fresh meat without major losses from shrinkage or deterioration in quality.

As settlers advanced westward across the mountains, the Ohio Valley became the center of the nation's livestock industry. Historians attribute the growth of cattle and hog production in the Valley in part to the Internal Revenue Act of 1794, which levied an excise tax on whiskey. No longer able to convert their corn efficiently into whiskey, farmers fed it instead to cattle and hogs.<sup>9</sup> Surplus meat moved south to markets as far as New Orleans by flatboats and keelboats on the Ohio-Mississippi River systems. River towns sprung up as local points of contact with down-river markets. Farmers lacking river access drove their herds east across the mountains for slaughter in Philadelphia, New York, or Baltimore, or sold them as stockers to farmers along the way.<sup>10</sup> Still, by some accounts,<sup>11</sup> meat trade was limited by a shortage of salt. Commercial

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<sup>7</sup>Rudolf A. Clemen, *The American Livestock and Meat Industry* (New York: Ronald Press, 1923), p. 23.

<sup>8</sup>Jimmy Skaggs, *Prime Cut: Livestock Raising and Meatpacking in the United States, 1607-1983* (College Station: Texas A&M University Press, 1986), p. 35.

<sup>9</sup>Clemen, *op. cit.*, p. 43.

<sup>10</sup>Mary Yeager, *Competition and Regulation: The Development of Oligopoly in the Meat Packing Industry*

meatpacking remained a small-scale enterprise in the hands of small merchants who packed farm-killed pork or meat from hogs driven by farmers to local markets.

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(Greenwich, CT: JAI, 1981), p. 4.

<sup>11</sup>Margaret Walsh, "The Spatial Evolution of the Mid-Western Pork Industry, 1835-75," *Journal of Historical Geography*, vol. 4 (1978), p. 10.

Meat packing as a distinct and significant industry would not appear in the Valley until the late 1820s. A major factor contributing to the evolution of the industry was the innovation of the upriver steamboat.<sup>12</sup> This gave the region access to imported salt from the south, facilitating increased commercial packing and trade. Improved river transportation had much more impact on the packing of pork than of beef.<sup>13</sup> The steamboat was better suited for carrying cured pork and provisions than bulkier, lower-valued live animals. Among other problems, "its belching noise and billowing smoke frightened animals, making loading and unloading difficult."<sup>14</sup> And it was too slow for transport of fresh meat. Beef slaughter remained largely in the hands of small, local butchers until the coming of the railroad.

The first slaughterhouse west of the mountains opened in Cincinnati in 1818.<sup>15</sup> Located on the Ohio River, a tributary of the Mississippi and the largest population center in the West before the Civil War, the city became the steamboat and commercial porkpacking capital of the world. Cincinnati pioneered in the manufacture and marketing of meat by-products which became sufficiently valuable that packers offered from 10 to 25 cents premium over competing valley locations for each slaughter hog.<sup>16</sup> Higher hog prices kept slaughter volume in the city ahead of that of its major rivals in Madison and Louisville, Kentucky. Cincinnati's larger population also may have contributed to relatively lower meatpacking wages.<sup>17</sup> By 1854, the 26 packing houses in the city slaughtered more than one-fourth of all hogs in the West.

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<sup>12</sup>Yeager, *op. cit.*, p. 4

<sup>13</sup>Charles T. Leavitt, "Transportation and the Livestock Industry of the Middle West to 1860," *Agricultural History*, vol. 7 (1934), p. 21.

<sup>14</sup>Yeager, *op. cit.*

<sup>15</sup>Howard C. Hill, "The Development of Chicago as a Center of the Meat Packing Industry," *The Mississippi Valley Historical Review*, vol. 10 (1923), p. 253.

<sup>16</sup>*Ibid.*, p. 255.

<sup>17</sup>Charles T. Leavitt, "Some Economic Aspects of the Western Meat-Packing Industry, 1839-1860," *Journal of Business of the University of Chicago*, vol. 4 (1931), p. 79.

Despite the appreciable growth of the industry, its characteristics were largely unchanged from those of colonial times. Slaughter, packing, and marketing were for the most part separate activities. Hog carcasses were delivered by wagon from slaughter houses to packing plants where they were disassembled, trimmed, preserved, and crammed in barrels for pickling. Until the invention of artificial refrigeration in the 1880s, packing houses operated only during the months of December and January, and then only when temperatures were not so cold as to hamper the cutting operations. The Ohio River and its tributaries were ideal locations for packing houses as winter temperatures in the area usually stayed above freezing.<sup>18</sup> Reliance on natural refrigeration meant more economies were gained from greater speed than from larger size in accommodating accelerated product flows during the fresh winter packing season. Thus the number of packers grew along with the volume of output. Between 1844 and 1855, the number of firms increased from 26 to 42, while output expanded from 240,000 to 424,000 hogs a year.<sup>19</sup> The short duration of the packing season also limited the potential for specialization. The industry was dominated by commission merchants who engaged in various other lines of business besides meat packing.<sup>20</sup>

Although the first stretch of U.S. railroad was built in 1830,<sup>21</sup> it was not until 20 years later that the new mode of transport began to have profound effects on the growth and location of livestock production and meat packing. By 1855, most farmers east of the Mississippi River and north of the Ohio had access to railroad lines.<sup>22</sup> The landlocked producers in those regions who previously relied on drovers to market their livestock now had a faster, more dependable, and less expensive means of land transport. Railroad charges for hauling cattle were as much as 50 percent lower than driving costs.<sup>23</sup> This led to higher net prices for farmers and to increased livestock production. Cattle numbers increased by 61 percent between 1850 and 1860, compared with growth of 28 percent during the prior decade.<sup>24</sup> Hog numbers grew by 27 percent, compared with only 5 percent during the earlier decade. Sheep numbers, however, which had increased by 93 percent during the forties, grew by less than 3 percent between 1850 and 1860.

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<sup>18</sup>Leavitt, "Transportation and the Livestock Industry of the Middle West to 1860," *op. cit.*, p. 23.

<sup>19</sup>Yeager, *op. cit.*, p. 9.

<sup>20</sup>Only 41 percent of meatpacking industry value added in the 1850s came from factories with steam- or water-powered methods of production. About 32 percent came from artisans (1-6 employees), 11 percent from sweatshops (7-25 employees), and 15 percent from manufactories (over 25 employees). See Jeremy Atack, "Industrial Structure and the Emergence of the Modern Industrial Corporation," *Explorations in Economic History*, vol. 22 (1985), p. 35.

<sup>21</sup>Skaggs, *op. cit.*, p. 43.

<sup>22</sup>Leavitt, "Transportation and Livestock Industry of the Middle West to 1860," *op. cit.*, p. 21.

<sup>23</sup>*Ibid.*, p. 28.

<sup>24</sup>*Ibid.*, p.27.

During the same period the locus of cattle raising shifted westward to the prairies of Illinois and Missouri where the ratio of cattle to rural population was twice that in other Midwest states.

By widening the area feasible for the production of livestock and speeding their shipment to the East, railroads fostered competition between Eastern and Western packers. By the late 1850s, about one-fifth of all the hogs marketed in the West were shipped outside the region.<sup>25</sup> No comparable figure is available for cattle, but records of Western animals shipped to the New York City cattle market indicate that 67 percent of total receipts were from the West.<sup>26</sup> The building of the railroads also made it more economical for porkpacking to move further west, closer to the source of supply. However, since fresh meat must be consumed soon after slaughter, the West remained locationally disadvantaged for the slaughter and shipment of fresh meat to distant markets until the invention of artificial refrigeration.

While the replacement of the drover by the railroad did increase both the speed and volume of livestock shipments, it did not totally resolve the shrinkage problem. Western cattle shipped to the East Coast lost about 10 percent of their initial tissue weight (much of it in the first 200 miles) and suffered from overheating, bruising, smothering, freezing, and disease.<sup>27</sup> To reduce these losses, railroads invested in feeding stations and stockyards, thus creating new catalysts for locational change in the meatpacking industry. The most important change was the emergence of Chicago as the transshipment center for Western cattle on their way east, a development that positioned it for its later emergence as the nation's foremost center of meatpacking. Having become a hub for the interchange of Eastern and Western railroads by the 1850s, Chicago offered an alternative to the southern Mississippi route as an exit for Western produce in general.

The closing of the Mississippi route during the Civil War cemented Chicago's pre-eminence in transshipment as well as packing of livestock. Hog receipts rose from 392,864 in 1860 to almost 2 million 3 years later.<sup>28</sup> During the same period, Chicago increased its share of Western porkpacking from 6 to nearly 25 percent of the total, thus taking the lead from Cincinnati.<sup>29</sup> The increase in livestock shipments, fueled to a significant extent by military demand during the war, overloaded the city's capacity to handle the traffic, leading, in 1865, to the establishment of the famous Union Stockyards, which would remain in operation until 1970.

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<sup>25</sup>Margaret Walsh, "Pork Packing as a Leading Edge of Midwestern Industry, 1835-1875," *Agricultural History*, vol. 51 (1977), p. 708.

<sup>26</sup>Leavitt, "Transportation and the Livestock in the Middle West to 1860," *op. cit.*, p. 28.

<sup>27</sup>Robert M. Aduddell and Louis P. Cain, "Location and Collusion in the Meat Packing Industry," in Louis P. Cain and Paul J. Uselding, eds., *Business Enterprise and Economic Change* (Kent, Ohio: Kent State University Press, 1973).

<sup>28</sup>Hill, *op. cit.*, p. 262.

<sup>29</sup>*Ibid.*, p.4.

As much as both the Civil War and railroads contributed to the rise of Chicago as an important meatpacking center, the packing business, prior to mechanical refrigeration, was still ". . . in the hands of those butchers who slaughtered in or near the community where the meat was to be consumed . . . Faster transportation could make but little difference, but regardless of the speed of the train the meat would spoil before it could be transported any great distance if mechanical refrigeration were not provided."<sup>30</sup>

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<sup>30</sup>U.S. Federal Trade Commission, Food Investigation, *Report on Private Car Lines* (Washington, D. C.: Government Printing Office, 1919), pp. 26-30.

Experimentation with mechanical refrigeration dates to the early 1850s when the first American patents were awarded for the production of artificial ice. However, it was not until 1867 and 1868 that the first refrigerator-car patents were issued. George Hammond, emerging packing giant, is credited with the first shipment of fresh meat to the East, shipping dressed beef in 1869 to Boston from his slaughter plant near Chicago.<sup>31</sup> To avoid direct contact with ice, which discolored the meat, carcasses were initially hung from the roof. However, "in rounding curves the meat was set in motion like a pendulum and started the car rocking; . . . [this] caused a number of wrecks and as result the railways objected to the use of the cars and they were discontinued."<sup>32</sup> Refrigerator-car technology would remain plagued with problems until the arrival of another future packer mogul, Gustavus Swift.

Swift, a cattle buyer from Massachusetts, moved to Chicago in 1874, where he took up his old trade. He soon recognized the superior cost efficiency of shipping dressed meat rather than live animals from Chicago to the East, and the critical need for an efficient system to distribute the perishable product.<sup>33</sup>

Swift saw the waste in paying freight on the inedible 45 percent of the animal in order to move the remaining 55 percent to market. Not satisfied with the technology of the refrigerator-cars he used in making his first shipments from his packing plant in Chicago in 1877, he and engineer Andrew J. Chase invented and patented in 1879 what would become the standard for refrigerator-car efficiency.<sup>34</sup> In 1881, Swift began establishing branch houses as transshipment points for fresh meat originating from his Chicago plants. Moving to counteract Swift's expansion, Armour, an already established trader in preserved meats, along with Hammond and Morris, all established branch houses in the East. By 1888, Swift, Armour, Hammond, and Morris accounted for about 89 percent of the cattle slaughtered in Chicago and produced two-

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<sup>31</sup>Skaggs, *op. cit.*, p. 91.

<sup>32</sup>Hill, *op. cit.*, p. 272.

<sup>33</sup>Mary Yeager Kujovich, "The Refrigerator Car and the Growth of the American Dressed Beef Industry," *Business History Review*, vol. 44 (1970), p. 465.

<sup>34</sup>Skaggs, *op. cit.*, p. 93.

thirds of the nation's dressed beef supply.<sup>35</sup> The four also owned slaughter and packing facilities in a number of other Midwestern cities.

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<sup>35</sup>Yeager, *op. cit.*, p. 67.

Aduddell and Cain<sup>36</sup> identified three sources of scale economies in the meatpacking industry of the late 1800s: ownership of a centralized distribution system, division of labor, and utilization of animal by-products. By owning their own refrigerator cars and branch houses, packers eliminated the need for brokers. Marketing became more efficient since meat could be moved from areas of excess supply to those with excess demand. The wider market and year-round production afforded by the introduction of refrigerated rail cars meant plants no longer needed to be built to the large capacity formerly required to meet seasonal demand.<sup>37</sup> Larger volume slaughter also led to by-product economies; large packers were adept at finding uses for these materials, purchasing even more from smaller packers, and using their own distribution systems to promote their by-products.<sup>38</sup>

Internal economies were significant but not as important in explaining the growth of concentration in the industry as packer ownership of refrigerator cars and control of the country's most important stockyards.<sup>39</sup> By moving large volumes of dressed meat in their own cars, the large packers were able to obtain favorable mileage allowances and better service. The initial mileage allowance was 3/4 of a cent per mile per car for east-bound traffic from Chicago and 1

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<sup>36</sup>Aduddell and Cain, *op. cit.*, pp. 980-102.

<sup>37</sup>In an empirical study of structural change in American manufacturing during the 1850-1890 period, James concluded that concentration in meat packing may have been more the result of economies in marketing and distribution than of economies of scale from production. See John A. James, "Structural Change in American Manufacturing, 1850-1890," *Journal of Economic History*, vol. 43 (1983), p. 450.

<sup>38</sup>Robert M. Aduddell and Louis P. Cain, "Public Policy Toward the Greatest Trust in the World," *Business History Review*, vol. 55 (1981), p. 227.

<sup>39</sup>Aduddell and Cain, "Location and Collusion in the Meat Packing Industry," *op. cit.*, p. 102.

cent for west-bound traffic.<sup>40</sup> Average daily miles traveled by cars owned by the large packers were twice those of other freight cars.<sup>41</sup>

The refrigerator car also made it more economical to slaughter near the source of supply. As further enticement for packers to locate west of Chicago, cities in the Midwest, including Omaha, St. Louis, Kansas City, and Saint Paul, offered the packers securities in the stockyards located in those cities.

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<sup>40</sup>*Ibid.*, p. 103.

<sup>41</sup>*Ibid.*, p. 104.

Along with exploitation of economies in production, distribution and transportation came lower meat prices, increasing consumption, and (initially) higher cattle prices. The average price of beef tenderloin, for example, dropped from 27¾ cents per pound in 1883 to 16¾ cents in 1889.<sup>42</sup> Per capita consumption of beef rose from an average of 77.8 pounds during the 1870s to 87.2 pounds during the 1880s. Cattle prices declined through most of the 1870s, but rose to unprecedented levels in 1884. Higher cattle prices led to larger cattle numbers, 70 percent more by 1890 than 15 years earlier. Larger numbers meant larger marketings, 152 percent more in the Chicago market in 1890 than 10 years earlier. The boom went bust by 1885. Cattle prices declined from a peak of \$25.56 per head in 1884 to \$16.49 in 1891, a 35-percent nominal decline, and a 24-percent decline in real terms.<sup>43</sup> The downturn in prices plus the inability of local butchers and slaughterhouses to compete with lower priced fresh beef from the major packers raised widespread concern. "Local slaughterhouses charged that the Chicago packers used diseased cattle and that dressed beef was unwholesome... One remedy, urged especially by midwestern cattle raisers, was federal meat inspection to promote demand."<sup>44</sup> At the same time, ". . . they feared market power of the Chicago packers, [and] believed that the Chicago packers were responsible for the severe fall in cattle prices after 1885."<sup>45</sup>

In response to demand for legislation, the U.S. Senate, in 1888, adopted a resolution to appoint five senators ". . . to examine fully all questions touching the meat products of the United States; and especially as to transportation of beef and beef cattle and the sale of same in the cattle markets, stockyards, and cities; and whether there exists or has existed any combination of any kind, either on the part of . . . transportation agencies, or on the part of those engaged in buying and shipping meat products, by reason of which the prices of beef and beef cattle have been so controlled, or affected as to diminish the price paid the producer without lessening the cost of meat to the consumer."<sup>46</sup> Thus began the first governmental investigation of meat packers. The investigation lasted 2 years and resulted in what is known as the *Vest Report*. The report charged that the "Big Four," Armour, Hammond, Morris, and Swift, colluded to fix beef prices, divide territories and business, divide the public contract business, and compel retailers not to buy from packers outside the Allerton Pool.<sup>47</sup> The "pool" evolved from an 1886 agreement involving the Big Four and Samuel Allerton, another Chicago packer, and resulted in the regulation of meat shipments and stabilization of prices, especially in the saturated Northeastern beef market. The pooling agreement marked the beginning of oligopolistic interdependence in the meatpacking

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<sup>42</sup>Yeager, *op. cit.*, p. 70.

<sup>43</sup>Gary D. Libecap, "The Rise of the Chicago Packers and the Origins of Meat Inspection and Antitrust," *Economic Inquiry*, vol. 30 (1992), p. 248.

<sup>44</sup>*Ibid.*, p. 244.

<sup>45</sup>*Ibid.*, p. 244.

<sup>46</sup>Quoted in Clemen, *op. cit.*, p. 748.

<sup>47</sup>Aduddell and Cain, "Public Policy Toward the Greatest Trust in the World," *op. cit.*, p. 227.

industry. Nonetheless, the *Vest Report* resulted in no actions against the packers. Its findings, however, probably influenced the passage of the Sherman Act in 1890.

## 2. From the Vest Report to the Consent Decree (1890-1920)

The pooling arrangement was soon undermined by the entry of the Cudahy Company in the meatpacking business in 1890. Cudahy's competitive strategy was to select the West as a marketing target rather than the East, where the "Big Four" had strong presence. Plants and branch houses were built in Los Angeles, Sioux City, Omaha, Lincoln, and Minneapolis and a fleet of 90 refrigerator cars was acquired by 1892.<sup>48</sup> A price war among the now "Big Five" led to the abandonment of the pool in May 1892.

Fierce price competition following the dissolution of the pool brought near financial ruin to some packers, especially as the 1893 depression shrunk the demand for meat. Armour, Morris, Swift, and Hammond tightened customer credit; Swift slashed wages; and Armour bought gold to settle wages.<sup>49</sup> Another pool was formed and expanded to include the Cudahy company. Each of the Big Five was assigned a territory and allotted a volume of business based on market share from the previous year. Attorney Henry Veeder was put in charge of compiling the statistics and levying penalties on cheaters. The new pooling arrangement, or what became known as the *Veeder Pool*, operated until 1902 except for a 1-year disruption starting at the middle of 1896. The disruption resulted from the entry of a new firm, Schwartzchild & Sulzberger (S&S). S&S, a New York-based packer in the kosher trade, realized that in order to compete with Western packers who tapped Eastern consumer markets, it had to expand to reach Western livestock markets. In 1893, the new firm purchased a packing company in Kansas City, built branch houses nationally, and purchased a fleet of refrigerator cars. The Big Five faced a dilemma. "If they shipped their allotted volume into the areas where S&S competed, they flooded the market and were forced to sell beef at such a low price that there was little or no return on investment. On the other hand, if they attempted to cut back shipments, S&S might increase its shipments."<sup>50</sup> Attempts by the pool to recruit S&S into membership were unsuccessful and the pool was suspended in May 1896.

In response to S&S's refusal to join, two of the former pool members, Swift and Armour, initiated pressure tactics. According to Yeager, "Swift spearheaded a drive to enlist the help of other pool members in establishing a kosher beef house in New York to compete with S&S . . . [Armour] tried to apply indirect pressure on S&S by wooing the Santa Fe Railroad, the main carrier of S&S business, out of Kansas City."<sup>51</sup> By 1898, S&S became a pool member. The pool

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<sup>48</sup>Yeager, *op. cit.*, p. 116.

<sup>49</sup>*Ibid.*, p. 117.

<sup>50</sup>*Ibid.*, p. 124.

<sup>51</sup>*Ibid.*, pp. 124-125.

resumed and operations continued until 1902 when the U.S. Attorney General filed suit seeking an injunction under the Sherman Act against the packers. The charge was conspiracy to restrain interstate commerce. The injunction came 3 years after the first Supreme Court ruling, in a case involving Addyston Pipe and Steel, that cartel-type devices were illegal under the Sherman Act.<sup>52</sup>

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<sup>52</sup>*Ibid.*, p. 135.

To evade the charge of collusion, the three largest packers in 1903 opted for a merger. Armour, Morris, and Swift formed the National Packing Company (NPC) as a holding company. The new company included Hammond and four other small firms. Its personnel, largely officers from the parent companies, held weekly board meetings. Consequently, NPC became "a central post to disseminate information and 'dressed' costs, closing prices, and margins," and a price leader for the two excluded packers, Cudahy and S&S.<sup>53</sup>

With the formation of NPC in 1903, the packing giants or "Beef Trust," as they had collectively become commonly known, extended from coast to coast. As reported by Walker,<sup>54</sup> the Armour Packing Company owned large plants in Chicago, Kansas City, South Omaha, East St. Louis, and Forth Worth, and slaughtered yearly 1.2 million cattle, 3.5 million hogs, and 1.5 million sheep. Swift and Company controlled plants in Chicago, Kansas City, South Omaha, East St. Louis, South St. Joseph, Forth Worth, and South St. Paul, and slaughtered 1.6 million cattle, 4 million hogs, and 2.3 million sheep yearly. Morris and Company slaughtered 800,000 cattle, 1.2 million hogs, and 800,000 sheep in plants located in Chicago, East St. Louis, and South St. Joseph. NPC operated in Chicago, Kansas City, St. Louis, Omaha, Hutchinson (Kansas), and New York, and slaughtered close to 1 million cattle, 3 million hogs, and 800,000 sheep a year. S&S was confined to New York City, Kansas City and Chicago and slaughtered fewer than 1 million in all categories. Finally, the Cudahy Packing Company slaughtered 1.3 million hogs, 500,000 cattle, and 400,000 sheep per year in South Omaha, Kansas City, Sioux City, and Los Angeles. The major packers also operated one of the largest transportation enterprises in the world. Armour alone had title to more than half of the 25,000 refrigerator cars owned by the 6 packers and operated over 300 million car-miles a year.<sup>55</sup>

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<sup>53</sup>Alfred D. Chandler Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge: Harvard University Press, 1977), p. 400.

<sup>54</sup>Francis Walker, "The Beef Trust and the United States Government," *The Economic Journal*, vol. 16 (1906), pp. 494-495.

<sup>55</sup>Chandler, *op. cit.*, p. 397.

The year 1903 also marked the beginning of a long and protracted series of investigations which would end 17 years later in a consent decree between the major packers and the Department of Justice.<sup>56</sup> The investigation had two sources. First was President Theodore Roosevelt, whose goal when he took office in 1901 was to protect the public from exploitation by the trusts. "To him, trusts were less an economic than a political, social and moral problem . . . and [he] singled out for condemnation . . . those which in his own judgement, engaged in unfair competitive practices."<sup>57</sup> Congress responded to the president by creating the Bureau of Corporations in 1903. The second source was the precipitous drop in cattle prices following an unprecedented high in the previous year, and an abnormally high price of beef. Responding to the demand from cattlemen for legislation, the House of Representatives passed a 1904 resolution requesting ". . . the Secretaries of Commerce and Labor [to] investigate the causes of the low prices of beef cattle, and the unusually large margins between the prices of beef cattle and selling prices of fresh beef."<sup>58</sup> One year later, the Bureau issued what became known as the *Garfield Report*, named after the commissioner of the Bureau. This report provided the first official data on concentration in the industry. Of the total slaughter in the country, the big packers accounted for 45 percent. Their share was 97.7 percent in the West.<sup>59</sup> The Bureau also concluded that, because of variations in the prices of hides and fats, the spread between the price of beef and the price of cattle was not a reliable indicator of industry performance. However, because the 1902 injunction against the packers was still before the courts, the report was devoid of any mention of monopolization or restraint of trade. The Bureau's favorable judgment of the industry was not well received by the public. Muckraker Charles Edward Russell described the National Packing Company as "reaching out, absorbing industry after industry, augmenting and building, by great brute strength and insidious, intricate, hardly discoverable windings and turnings, day and night monstrous thing flows and strengthens until its grip is at the Nation's throat."<sup>60</sup>

Less than a month after the Bureau's report, another indictment was brought against the packers in Chicago for violating the Sherman Act. Eventually, the defendants were declared immune from criminal prosecution, since they had already cooperated with the Bureau's investigation. In 1910, criminal antitrust action was taken against the National Packing Company. The government charged that during the 9 years of its operations, NPC had engaged in price fixing and maintained livestock pools which, according to a 1905 Supreme Court decree on combinations, were illegal. The jury acquitted the packers in 1912. The packers, however, dissolved the company 2 years prior to the verdict. Chandler believes the company was no

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<sup>56</sup>*Packer Consent Decree, op. cit.*

<sup>57</sup>Yeager, *op. cit.*, p. 185.

<sup>58</sup>From original text of resolution as quoted in Walker, *op. cit.*, p. 495.

<sup>59</sup>Francis, *Ibid.*, p. 499.

<sup>60</sup>Charles Russell, *The Greatest Trust in the World* (New York: Ridgway-Thayer, 1905), p. 5.

longer needed because by then the packers had learned much about each other's internal operations and tacit collusion would now substitute for overt measures.<sup>61</sup>

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<sup>61</sup>Chandler, *op. cit.*, p. 401.

When livestock prices slumped in 1915, despite an increase in exports and a decline in imports, feeders demanded an explanation.<sup>62</sup> In response, a resolution to investigate the meat industry was introduced in Congress in 1916 by representatives from Missouri and Kansas. The resolution was amended a year later to put the investigation in the hands of the Department of Agriculture. Troubled by the amendment, representatives from cattle states called on President Woodrow Wilson to direct the Federal Trade Commission to make the investigation. The President did so in February 1917 and the FTC released its report in July 1918. As summarized by Arnould, "Evidence was found of: (1) international allocation of sales in conjunction with the amount of space available on steamships; (2) a rotational process of local price cutting to eliminate small firms; (3) a division of purchases at leading terminal markets, awarding fixed percentages to each of the member companies; (4) an agreement to control meat prices; and (5) the use of branch house facilities to control substitute foods."<sup>63</sup>

Following the report, FTC commissioners called for public ownership of the packers' transportation and distribution network<sup>64</sup> through the Wartime Railroad Administration.<sup>65</sup> Congress held a series of hearings on bills calling for measures similar to those requested by the FTC commissioners. According to Virtue, the hearing may have been the product of ". . . the war psychology of the period, when no proposal for an extension of government activities seemed too extravagant."<sup>66</sup> The war notwithstanding, the bills failed to pass. Instead, the Department of Justice initiated Antitrust action against the Big Five, Armour, Cudahy, Morris, Swift, and Wilson.<sup>67</sup> Realizing the seriousness of the charges, the Big Five agreed in 1920 to the signing of a consent decree with the U.S. Attorney General. The decree required the packers to divest themselves of public stockyards, interests in railroads and terminals, market newspapers, cold storage warehouses, retail meat businesses, and stock adding to 50 percent or more in any corporation or business dealing with commodities unrelated to meat.<sup>68</sup> In 1921, Congress enacted

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<sup>62</sup>The United States has been the major world exporter of meats since the 1870s with England as the major market. The U.S. position was lost between 1900 and 1911 when domestic demand was so strong that there was no longer surplus fresh meat for the export market. In fact, cattle were admitted duty free to the U.S. in 1913 as cattle feeders were unable to supply sufficient beef cattle for urban markets. In response, U.S. packers purchased plants in Argentina, Uruguay, and Brazil to process beef for the European Market and, by 1913, the U.S. market as well. See Skaggs, *op. cit.*, p. 135; Chandler, *op. cit.*, p. 401; and G. O. Virtue, "The Meat-Packing Investigation," *Quarterly Journal of Economics*, vol. 34 (1920), pp.636-650.

<sup>63</sup>Richard J. Arnould, "Changing Patterns of Concentration in American Meat Packing, 1880-1963," *Business History Review*, vol. 45 (1971), p.24.

<sup>64</sup>Skaggs, *op. cit.*, p. 104.

<sup>65</sup>The United States entered World War I while the FTC inquiry was in progress.

<sup>66</sup>Virtue, *op. cit.*, p. 680.

<sup>67</sup>S&S, after a sale of its stocks in 1915 to a group of bankers, was renamed Wilson & Company after its president Thomas Wilson.

<sup>68</sup>*Packer Consent Decree, op. cit.*, p. 107.

the Packers and Stockyards Act. The Act established a code of fair trade practices in the purchase of livestock and sale of meat, regulated the business practices of all stockyards, and created an administrative unit within the Department of Agriculture to enforce these provisions.

### 3. From the Consent Decree to the 1970s

Although the consent decree and the creation of the Packers and Stockyards Act marked the beginning of a new period for the industry, some believe that neither policy had any significant, immediate, or direct impact on the meatpacking industry. The Big Four--Swift, Armour, Cudahy, and Wilson<sup>69</sup>--maintained their shares in cattle and hog slaughter until the 1930s, increased their shares in slaughter of calves and sheep, and engaged in market-sharing in livestock markets.<sup>70</sup>

What may have had a direct impact on the industry were the reduced barriers to entry occasioned by rapid developments in transportation and refrigeration technology, in-plant technology, the rise of the supermarket, increasing labor costs, and the federal grading system.<sup>71</sup> The introduction of the motor carrier and the construction of a nationwide highway system contributed to the rise of alternative livestock markets, reducing the locational advantage of terminal stockyards and plants owned by the larger packers. Improved refrigeration techniques allowed the development of low-cost mechanically-chilled trucks, reducing capital requirements for entry into the business of meat distribution. By 1946, two-thirds of the 100,000 meat-handling trucks on the road were mechanically-chilled, and one-third of the total were owned by independent transport firms.<sup>72</sup> The developments in transportation technology altered the competitive advantage of transporting fresh meat by rail. According to Maki, et al., between 1930 and 1956, transportation costs changed such that it became economical to ship fresh and processed meats by refrigerated trucks from packing houses west of Chicago.<sup>73</sup> That, along with

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<sup>69</sup>Morris and Company was acquired by a subsidiary of Armour and Company in 1923.

<sup>70</sup>William Nicholls, "Market-Sharing in the Packing Industry," *Journal of Farm Economics*, vol. 22 (1940), p. 240. Although the leading packers may have engaged in market sharing at terminals, they never integrated into cattle production. Harold G. Livesay and Patrick G. Porter, "Vertical Integration in American Manufacturing, 1899-1948," *The Journal of Economic History*, vol. 29 (1969), p. 496.

<sup>71</sup>Arnould, *op. cit.*, p. 26.

<sup>72</sup>Skaggs, *op. cit.*, p. 153.

<sup>73</sup>Wilbur R. Maki, William C. Motes and Charles Y. Lui, *Effects of Transportation on Plant Location in the Meat Packing Industry*, Iowa Agricultural Experiment Station Discussion Paper (Ames: Iowa State University, 1962).

lower wages, cheaper land, and new sources of fed cattle in the Western corn belt and Southern Plains, gave rise to independent packers in the rural Midwest, Southwest, and Far West.

With the emergence of retail chain stores, the branch houses, which served smaller independent grocery retailers and local meat markets, became redundant. The new corporate chains relied instead on independent meat wholesalers or carlot packers to stock their meat shelves. The introduction of the federal grading system during World War II also helped bring down barriers to entry into the industry and may have put the big packers at a disadvantage. Unlike their smaller competitors, the big packers had large sums of capital tied to brand names and private labels.<sup>74</sup> In addition, improved in-plant refrigeration and slaughter technology, such as powered rails, knives, and hide pullers, made single-story plants more practical and efficient than multistory, multi species packing plants, making specialization in one species or even classes within species possible.<sup>75</sup>

#### **4. From the 1970s to the Present**

By 1960, most of the plants in Chicago were idle, and by 1970, the Chicago Stockyards had closed. The closing marked the end of an era during which the guiding economic principle was that it was more efficient to slaughter cattle near their source and ship carcasses rather than live animals to Eastern markets. Interestingly, the new era in meatpacking, which started in the 1960s, is a further extension of the principle that it is even more efficient to ship cattle as "boxed beef" than to ship carcasses to wholesalers and retailers. The traditional function of the beefpacker had changed very little prior to the fundamental realignments of the 1960s. Animals were slaughtered and carcasses were shipped to "breakers" who disassembled the carcasses into primal cuts. Virtually no processing of the carcass of any sort took place at the slaughter stage. But increasing labor costs, emerging technologies, and new specialized demands by hotels, restaurants, institutional buyers, and variously situated retail stores combined to make the process of shipping whole carcasses from the packing plant increasingly outmoded.<sup>76</sup>

In the revised system, beef carcasses are broken, boned, and cut in primals and sub-primals, and individual cuts vacuum packed in plastic and shipped in boxes. Iowa Beef Processors (IBP), founded in 1961, gets much of the credit for pioneering large-scale boxed-beef

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<sup>74</sup>Arnould, *op. cit.*, p. 29.

<sup>75</sup>Owing to these developments, Cudahy, Armour, and Swift asked a federal court in 1956 for relief from the Consent Decree, arguing that business conditions during the 1920s were no longer the same in the 1950s. The request was denied. See Robert M. Aduddell and Louis P. Cain, "The Consent Decree in the Meatpacking Industry, 1920-1956," *Business History Review*, vol. 55 (1981), p. 362, ff. Aduddell and Cain reported 12 antitrust suits were filed against the packers between the signing of the Consent Decree and 1956.

<sup>76</sup>U.S. Congress, House of Representatives, Subcommittee on SBA, SBIC Authority, and General Small Business Problems, *Small Business Problems in the Marketing of Meat and Other Commodities: Changing Structure of the Beef Packing Industry*, pt. 4, 96th Congress., 1st Session (Washington, D.C.: Government Printing Office, 1980), p. 68.

production, building the first plant for that purpose in 1967 in Dakota City, Nebraska.<sup>77</sup> The process resulted in significant economies from labor specialization and substitution of capital for labor in large-scale disassembly operations. Soon, other firms, including Dubuque, Missouri Beef Packers (MBPXL), and American Beef Packers (ABP), joined the boxed-beef bandwagon. None, however, would grow as fast as IBP which, by the 1970s, became the leader in beef-packing, a position it continues to enjoy.

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<sup>77</sup> Armour, however, initiated the concept of boxed beef in the mid-1950s. U.S. Congress, House of Representatives, Subcommittee on SBA, SBIC Authority, and General Small Business Problems, *Small Business Problems in the Marketing of Meat and Other Commodities: Anticompetitive Practices in the Meat Industry*, pt. 5, 96th Congress, First Session (Washington, D.C.: Government Printing Office, 1979), p. 8.

IBP's quick rise to the top raised concerns over possible abuses of market power. In 1970, the company entered into a consent decree requiring it to halt for 10 years further acquisitions of packing plants in its 4-state area of operations.<sup>78</sup> Special congressional hearings were held in the late 1970s, directly focusing on the packing company and its alleged misconduct in the boxed-beef market.<sup>79</sup>

The rise of IBP during the 1970s was concurrent with the integration of major old-line packers into large conglomerates (IBP was itself bought in 1981 by Occidental Petroleum, remaining an Occidental subsidiary until 1991). Wilson and Co. (Schwarschild & Sulzberger in the nineteenth century), founded in 1916, changed its name to Wilson Foods in 1976 after being acquired by Ling-Temco-Vought (LTV). Armour and Co. became part of Greyhound in 1970. Swift and Co. became a subsidiary of the Esmark conglomerate. Cudahy was acquired by General Hosts. Excel, another old-line, if less visible packer, would later play a prominent role following the industry shakeout in the 1980s. Founded in Chicago as Excel Packing Co. in 1936, it merged in 1969 with the Kansas Packing Co. and three other smaller firms to form the Kansas Beef Industries (KBI) and marketed boxed beef under the label XL. In 1974, KBI merged with Missouri Beef Packers, creating MBPXL.

The decline in the production and consumption of red meats as a group and of beef in particular in the late-1970s left the industry with excess slaughter capacity. The excess capacity, by making consolidation a more attractive means of growth than building new capacity, triggered a wave of mergers and acquisitions lasting from 1977 to 1988.<sup>80</sup> The result was a drastically changed industry structure for the slaughter of cattle, hogs, and sheep. Evidence of change in beefpacking is apparent at both firm and plant levels.

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<sup>78</sup>*Ibid.*, p. 1.

<sup>79</sup>*Ibid.*, pp. 1-83.

<sup>80</sup>Wayne D. Purcell, "Structural Change in the Livestock Sector: Causes, Implications, Continuing Issues," in Wayne D. Purcell, ed., *Structural Change in Livestock: Causes, Implications, Alternatives*, (Blacksburg, VA: Research Institute on Livestock Pricing, 1990), p. 11.

The top 4 spots in beefpacking in 1977 were occupied by IBP, Swift, MBPXL, and Spencer. Together they held about 30 percent of total beef slaughter capacity (IBP 13, Swift 6.9, MBPXL 4.9, and Spencer 4.3 percent.)<sup>81</sup> By 1982, the top four had 45 percent of industry capacity. IBP led with 20.9 percent. Excel, (MPBXL before its acquisition by Cargill in 1979) followed with 12.1 percent, SIPCO (Swift Independent Packing Co., Swift in 1977) had 6.3 percent, and Spencer 5.6 percent. ConAgra entered the beef slaughter industry in 1983 in a major way by acquiring, among many other firms, SIPCO and Monfort. By 1988, Conagra edged Excel to become the second largest beefpacker with 21.1 percent of industry capacity. IBP remained first with 27 percent, Excel was third with 17.1 percent, and Beef America fourth with 4.5 percent. As of 1990, these 4 companies were still in the lead with respective daily slaughter capacities of 22.9, 15.1, 13.7, and 4.1 percent.<sup>82</sup> Table 2.1 shows the chronology of the major acquisitions and expansions by the top 3 packers -- IBP, Conagra and Excel.

The 1994 share of the top 4 firms in total slaughter was estimated at 82 percent, the highest concentration in the history of the beef packing industry (table 2.2).<sup>83</sup> The top 4 firms also produced about 80 percent of all the boxed beef in 1990, up from 53 percent a decade earlier. Four-firm concentration ratios for boxed-beef after 1990 are not available. Concentration in hog slaughter also has increased, but not as dramatically as in beef or sheep and lambs.

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<sup>81</sup>Bruce W. Marion and Donghwan Kim, "Concentration Change in Selected Food Manufacturing Industries: The Influence of Mergers vs. Internal Growth," *Agribusiness*, vol. 7 (1991), p.424.

<sup>82</sup>Marvin Hayenga and Kevin Kimle, "The Changing Structure of the Beef and Pork Slaughter Industries," *Agricultural Input and Processing Industries*, Agriculture and Home Economics Experiment Station Bulletin RD-05, (Ames: Iowa State University, 1992).

<sup>83</sup>Concentration figures on a regional basis are usually much higher than those reported at the national level. In some regions they are more than 95 percent. Gwen Quail, Bruce Marion, Frederick Geithman and Jeffrey Marquardt, *The Impact of Packer Buyer Concentration on Live Cattle Prices*, NC117 Working Paper No. 89 (Madison: University of Wisconsin, 1986).

The shakeout in the industry also is apparent at the plant level. The number of steer and heifer slaughter plants reporting to Packers and Stockyards Administration<sup>84</sup> declined from 810 in 1972 to 310 in 1990, a drop of about 62 percent (table 2.3).<sup>85</sup>

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<sup>84</sup>Although the Packers and Stockyards Administration (P&SA) became Packers and Stockyards Programs (P&S), Grain Inspection, Packers and Stockyards Administration (GIPSA) in 1994, the earlier acronym is used throughout this section since most of the aggregate statistics from the Agency cited here were published prior to the reorganization.

<sup>85</sup>Plant numbers data for the two periods are not fully comparable owing to a change in reporting requirements. Prior to 1977 all firms purchasing 1,000 or more head of cattle or 2,000 or more head of all species were required to report. Beginning in 1977, reports were required of firms purchasing livestock worth \$500,000 or more.

Table 2.1. Chronology of Consolidations and New Plant Construction by IBP, ConAgra, and Excel.

IBP	ConAgra	Excel
1961: Begins operations at Dennison, Iowa. Slaughter capacity = 2,075 head per day.		1936: Excel Packing Co., Wichita, Kan., founded by Sam Marcus.
1962: Buys Fort Dodge beef plant. Slaughter capacity = 1,860 head.		
1966: opens Dakota City, Neb., plant. Slaughter capacity = 4,216 head. Begins operations at Luverne, Min. Slaughter capacity = 1,581 head.		1966: Missouri Beef Packers (MBP), Rock Port, Mo., starts operations.
1967: Processing begins at Dakota City plant. Processing capacity = 7,363 head.		
1968: Buys Armour plant at West Point, Neb. Slaughter capacity = 2,124 head.		1968: MBP opens Friona, Tex., plant.
1969: Buys Armour plant at Emporia, Kan. Slaughter capacity = 3,255 head. Buys Blue Ribbon Beef plants at Le Mars and Mason City.		
1970: Starts boxed beef operations at Emporia. Processing capacity = 4,650 head.		1970: Excel Packing, Kansas Packing Co, Dodge City, Kan., and Dunn Packing Co. merge as Kansas Beef Industries (KBI).
1974: Sells Le Mars plant to Dubuque Packing after U.S. Justice Dept. ruling in 1972.	1971: Changes name to ConAgra, Inc.	1971: MBP opens Plainview, Tex. plant.  1974: MBP and KBI merge to form MBPXL Corp.
1975: Opens Amarillo, Tex., plant. Slaughter capacity = 5,038 head. Begins boxed beef operation in Amarillo. Processing capacity = 4,689 head.		
1976: Sells Mason City plant to Hyplains Dressed Beef. Buys Columbia Foods plants at Pasco, Wash., and Boise, Idaho. Pasco's slaughter capacity = 2,050 head, processing capacity = 3,294. Boise's slaughter capacity = 1,450 head.		
1980: Opens Finney Col., Kan. plant. Slaughter capacity = 5,275 head, processing capacity = 5,541 head.		1979: Cargill, Inc. buys MBPXL.
1981: Occidental Petroleum Corp. buys Iowa Beef for \$800 million.		1982: Company renamed Excel Corp. Combined slaughter capacities of Excel's

<b>IBP</b>	<b>ConAgra</b>	<b>Excel</b>
<p>1983: Iowa Beef officially becomes IBP, Inc. IBP commences operations at Joslin, Ill., plant. Slaughter capacity = 3,100 head, processing capacity = 3,875.</p> <p>1984: Closes Fort Dodge slaughter plant.</p> <p>1990: IBP starts operating new 4,000 head slaughter and processing beef plant at Lexington, Neb.</p>	<p>1983: Buys Armour Food Co., including a beef plant at Nampa, Idaho, for \$182 million. Slaughter and processing capacity = 850 head.</p> <p>1985: Buys Northern States Beef, Inc., Omaha, Neb., for \$19 million. Slaughter capacity = 950 head.</p> <p>1987: Buys Ernest J. Miller Enterprises, Inc. and Interstate Feeders, Inc., Malta, Idaho, for \$30 million. The acquisition includes E.A. Miller, Inc's beef plant at Hyrum, Utah. Slaughter and processing capacity = 1,600 head. Buys Monfort of Colorado for \$300 million. Monfort has two beef slaughter plants, at Greeley, Colo., and Grand Island, Neb. Combined slaughter and processing capacity = 10,000 head. Buys 50 percent of Swift Independent Packing Co. (SIPCO), Dallas, Texas, with option to buy the remaining 50 percent within four years. SIPCO has six beef slaughter plants: Amarillo, Hereford, and Dumas, Texas; Guymon, Okla; Garden City, Kan.; Des Moines, Iowa. Daily capacities at operating plants include: Dumas, 4,600 head; Garden City, 3,200 head; Des Moines, 2,400 head.</p> <p>1988: Swift moves headquarter to Greeley, the location of the head offices of ConAgra Red Meat Companies. ConAgra closes Swift's Amarillo, Texas beef plant. ConAgra announces expansion plans for its five Monfort and Swift beef plants. It plans to increase their total daily capacity by 4,500 head within 18 months.</p>	<p>Friona, Plainview, and Dodge City plants = 13,000 head.</p> <p>1983: Excel proposes to buy three Spencer Beef plants at Schuyler, Neb., and Oakland and Spencer, Iowa, from Land O'Lakes Corp. Blocked by antitrust suit filed by Monfort of Colorado.</p> <p>1986: Excel begins to process branded beef products. Excel wins Supreme Court appeal to acquire Spencer Beef.</p> <p>1987: Excel completes purchase of Spencer Beef an estimated \$60 million. Reopens Schuyler plant, slaughter capacity = 3,200 head, processing capacity = 3,500 head. Excel buys Sterling Beef Company, Ft. Morgan, Colo. with 2,300 head slaughter capacity at Sterling, 2,000 head capacity at Ft. Morgan plant. Processing capacity at Ft. Morgan = 1,800 head.</p> <p>1988: Excel closes Cozad, Neb. slaughter-only plant. Cozad's slaughter capacity = 900 head.</p>

Source: Bill Eftink, "Pac-Man Packers Gobble up the Competition," *Successful Farming*, March 1989, pp. 6-7.

Table 2.2. Concentration of U.S. Commercial Livestock Slaughter, 1909-1994.

Year	Species or Type						Hogs
	Cattle	Steers and Heifers	Cows and Bulls	Boxed Beef	Calves	Sheep	
	<u>Percent<sup>1</sup></u>						
1909	36	--	--	--	--	44	34
1910	38	--	--	--	--	46	32
1911	38	--	--	--	--	49	35
1912	38	--	--	--	--	49	34
1913	41	--	--	--	--	54	35
1914	40	--	--	--	--	55	36
1915	44	--	--	--	--	56	38
1916	47	--	--	--	--	57	39
1917	53	--	--	--	--	60	41
1918	55	--	--	--	--	59	45
1920	49	--	--	--	34	62	42
1930	48	--	--	--	46	68	38
1940	43	--	--	--	46	66	44
1950	36	--	--	--	35	64	41
1951	32	--	--	--	35	63	41
1952	34	--	--	--	36	64	39
1953	34	--	--	--	39	63	38
1954	32	--	--	--	38	62	39
1955	31	--	--	--	37	61	41
1956	30	--	--	--	37	62	40
1957	29	--	--	--	35	58	39
1958	27	--	--	--	32	57	36
1959	25	--	--	--	30	54	34
1960	24	--	--	--	29	53	35
1961	24	--	--	--	30	55	34
1962	24	--	--	--	29	55	34
1963	23	--	--	--	29	55	34
1964	23	--	--	--	32	57	35
1965	23	--	--	--	32	58	35
1966	22	--	--	--	30	59	32
1967	22	--	--	--	30	58	30
1968	22	--	--	--	29	54	30
1969	23	30	20	--	27	60	34
1971	21	28	13	--	27	53	32
1972	25	29	12	--	22	57	32

Year	Species or Type						Hogs
	Cattle	Steers and Heifers	Cows and Bulls	Boxed Beef	Calves	Sheep	
	<b>Percent<sup>1</sup></b>						
1973	24	29	11	--	24	56	33
1974	24	29	14	--	24	56	34
1975	22	28	13	--	25	57	33
1976	22	29	12	--	25	53	35
1977	22	29	11	54	25	55	34
1978	24	30	10	59	28	56	34
1979	29	37	10	51	30	64	34
1980	28	39	10	53	31	56	34
1981	31	43	10	57	29	52	33
1982	32	45	9	59	28	44	36
1983	36	47	10	61	28	44	29
1984	37	50	11	62	29	42	35
1985	39	50	17	62	31	51	32
1986	42	54	18	68	26	51	33
1987	54	67	20	80	30	75	37
1988	57	70	18	79	33	77	34
1989	57	70	18	79	34	74	34
1990	59	72	20	79	32	70	40
1991		73	23	N/A		77	42
1992		78	24	N/A		78	44
1993		80	26	N/A		74	43
1994		82	N/A	N/A		73	46

<sup>1</sup> From 1909 to 1918, the percent held by the Big Five packers (Armour, Cudahy, Morris, Swift and Wilson), where commercial slaughter includes federally- inspected and other wholesale-retail establishments. From 1920, the percent held by the four largest firms in each species or type (however, in 1923 Armour acquired Morris, so from 1923 to 1959 the top four cattle-slaughtering firms equal the former Big Five).

Source: Johnson et. al., *Competitive Issues in the Beef Sector: Can Beef Compete in the 1990s?* Hubert Humphrey Institute of Public Affairs, University of Minnesota, pp. 79-80, and USDA, Packers and Stockyards Administration, *Packers and Stockyards Statistical Report*, P&SA SR, No. 92-1, November 1992. Estimates for 1991-1994 were provided by Industry Analysis Staff, GIPSA/Packers and Stockyards Programs.

Table 2.3. Number and Size Distribution of Steer and Heifer Slaughter Plants, Packers Reporting to P&SA, 1972-90.

Year	Plant Size (head)--															
	Less than 1,000		1,000-9,999		10,000-49,999		50,000-99,999		100,000-249,999		250,000 or larger <sup>86</sup>		500,000 or larger <sup>87</sup>		1,000,000 or larger	
	Plants	Head	Plants	Head	Plants	Head	Plants	head	Plants	Head	Plants	Head	Plants	Head	Plants	Head
	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.
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	5,256		
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

Source: USDA, P&SA.

<sup>86</sup> Size limits are 250,000-499,999 beginning in 1976.

<sup>87</sup> Size limits are 500,000-999,999 beginning in 1986.

The trend is clearly toward plants of larger size. Plants slaughtering 500,000 head or more per year accounted for 66 percent of total beef slaughter in 1990. Although the packaging technology of boxed beef has found its way into porkpacking as well, it has been less important in influencing the structure of the industry than in beef. Integrated slaughter and processing involving small as well as large firms has been characteristic of porkpacking for decades.<sup>88</sup> Smaller porkpackers do not rely on larger packers for further processing as do smaller beefpackers, some of the latter having become dependent on boxers to sell their products at retail.<sup>89</sup>

By the early 1980s, Wilson (one of the early line packers) was still the largest porkpacker in the industry. It, along with Swift Independent, Morrell, and Hormel, accounted for 37 percent of federally inspected slaughter in 1984.<sup>90</sup> According to Hayenga and Kimle, that percentage had changed marginally by 1992 to 42.4 percent of total slaughter capacity, but in the meantime the largest beefpackers--IBP, ConAgra, and Excel--had joined the ranks of the largest porkpackers. Through a combination of acquisition, renovation, and building of new plants IBP had moved to the first spot in hog slaughter, holding by 1990 about 12.5 percent of total industry capacity. ConAgra moved into the pork slaughter business when it acquired plants from Swift, Armour, and Monfort. ConAgra ranked second behind IBP in 1990, its total share of industry capacity being 11.2 percent. The third-leading packer, John Morrell (a subsidiary of Chiquita Brands), had a 6.2 percent market share. Excel (the Cargill subsidiary) has also acquired two plants in the Midwest and ranks number four with a market share of 5.7 percent.

The number of porkpacking plants reporting to P&SA declined by 44 percent from 1972 to 1990 from 597 to 335 (table 2.4). The number of plants slaughtering 1,000,000 head or more

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<sup>88</sup>Richard J. Crom, *Economics of the U.S. Meat Industry*, USDA, ERS, AIB No. 545 (Washington, D.C.: Government Printing Office, 1988), p. 38.

<sup>89</sup>Testimony by a former IBP employee before U.S. Congress, Committee on Small Business, *Small Business Problems in the Marketing of Meat and Other Products: Anticompetitive Practices in the Meat Industry*, *op. cit.*, p. 23, and U.S. Congress, Subcommittee on Nutrition and Investigations of the Committee on Agriculture, Nutrition, and Forestry, *Economic Concentration in the Meatpacking Industry*, 101st Congress, Second Session (Washington, D.C.: Government Printing Office, 1990).

<sup>90</sup>Marvin Hayenga and Kevin Kimle, *Packing Industry Competitive Structure and Pork Slaughter Capacity*, Bulletin No. 7 (Ames: Iowa State University, 1992).

increased from 23 in 1972 to a peak of 41 in 1980, then declined to 31 by 1990. The share of the 1,000,000-or-more category in total hog slaughter, however, increased from 25 percent in 1972 to about 77 percent in 1990.

Lamb slaughter has historically been the most concentrated of the red meat slaughters. As shown in table 2.2, the four-firm concentration ratio reached a high of 68 percent in 1930, a figure not surpassed until 1987, after acquisitions of some large lamb slaughter plants by some of the large packers during the foregoing decade of acquisitions. A case in point is ConAgra; when it acquired Armour & Co., Swift, and Monfort, it also acquired their lamb slaughter plants, which were some of the largest in the business. By 1987, ConAgra, Denver Lamb/Iowa Lamb, Farmstead, and Superior Lamb together accounted for 75 percent of all lamb slaughter in the United States,<sup>91</sup> the highest concentration since 1909.

Lamb slaughter plant numbers have greatly diminished. Those reporting to P&SA dropped from 230 in 1972 to 140 in 1990 (table 2.5). The decline has been across all plant-size categories, as total lamb slaughter dipped from about 10 million in 1972 to less than 5 million in 1990. The six 1990 plants in the 300,000-or-more category contributed about 74 percent of all lamb slaughter, up from 66 percent in 1972.

Another development in the meatpacking industry receiving increasing attention is a trend toward backward vertical integration and coordination.<sup>92</sup> This recent trend contrasts with that at the heyday of the old packers at the turn of the century, when forward integration into transportation and branch houses for wholesale distribution was commonplace.

P&SA reported that in 1990 about 5 percent of total U.S. steer and heifer slaughter was fed by reporting meatpackers (table 2.6). Between 1972 and 1990, the percentage ranged from a high of 6.3 percent of total slaughter (1974) to a low of 2.9 percent (1984). Although the proportion that was packer-owned versus contracted is not available, a report by Schroeder, et al.,<sup>93</sup> indicates that in 1988, 1989, and 1990, packer-owned and/or contracted cattle accounted for 19.3, 22.4, and 18.9 percent of total cattle slaughter, respectively. The packer-owned proportion was about 5 percent. In a 1990 survey, Azzam and Wellman<sup>94</sup> reported "captive" supplies

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<sup>91</sup>Clement Ward, *Packer Consolidation in the Sheep Industry*, Department of Agricultural Economics, Oklahoma State University, 1989.

<sup>92</sup>Indicative of the interest was a recent congressional hearing on vertical integration. See U.S. Congress, House of Representatives, Government Information, Justice, and Agriculture Subcommittee, *Integration of the Meatpacking Industry: Its Effects on the Farmer and Consumer*, 101st Congress, 2nd Session (Washington, D.C.: Government Printing Office, 1990).

<sup>93</sup>Ted Schroeder, James Mintert, Andrew Barkely and Rodney Jones, "Implications of Captive Supplies in the Fed Cattle Industry," in Wayne D. Purcell, ed, *Pricing and Coordination in Consolidated Livestock Markets, Captive Supplies, Market Power, IRS Hedging Policy*, (Blacksburg, VA: Research Institute on Livestock Pricing, April, 1992) p. 30.

<sup>94</sup>Azzeddine Azzam and Allen Wellman, *Packer Integration into Hog Production: Current Status and Likely*

ranging from 9 percent for beefpackers slaughtering 10,000 head or less, to more than 12 percent for packers slaughtering 300,000 or more.

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*Impacts of Increased Vertical Control on Hog Prices and Quantities*, IANR Agricultural Research Division Research Bulletin 315-F (Lincoln: University of Nebraska, 1992), pp. 20-21.

Kimle and Hayenga reported that in 1987 a total of 7 packers fed about 97,000 hogs, less than one-tenth of 1 percent of all U.S. hogs.<sup>95</sup> Hog packers in the 10,000-or-less category in the 1990 Azzam and Wellman survey<sup>96</sup> were reported having forward contracted 2.67 percent of their hogs, and owned and fed about 0.13 percent. Packers in the 10,000-to-100,000 category controlled about 1.07 percent of their supply; those in the 300,000-or-more category contracted 3.64 percent of their supplies, while 2 percent came from custom facilities and 1.86 percent from packer company-owned feeding facilities.

Lamb feeding by packers historically has been much higher than for cattle and hogs (table 2.6). P&SA data indicate that as much as 28 percent of recent total lamb and yearling slaughter was fed by the 4 packers reporting, a level appreciably higher than the 17 percent by the 7 packers reporting in 1976.

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<sup>95</sup>Hayenga and Kimle, *op. cit.*, p. 15.

<sup>96</sup>Azzam and Wellman, *op. cit.*

Table 2.4. Number and Size Distribution of Hog Slaughter Plants, Packers Reporting to P&SA, 1972-90.

Year	Plant Size (head)--															
	Less than 1,000		1,000-9,999		10,000-24,999		25,000-49,999		50,000-99,999		100,000-299,999		300,000-999,999		1,000,000 or larger	
	Plants	Head	Plants	Head	Plants	Head	Plants	head	Plants	Head	Plants	Head	Plants	Head	Plants	Head
	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.
1972	84	31	211	941	83	1,330	52	1,821	33	2,257	47	9,410	64	37,894	23	30,120
1973	82	33	202	849	78	1,257	46	1,696	25	1,795	51	9,970	61	35,933	19	24,661
1974	82	30	194	830	74	1,152	40	1,444	27	1,908	43	8,153	64	38,452	19	25,646
1975	83	27	178	769	58	917	38	1,373	23	1,565	45	8,748	65	38,961	12	16,418
1976	97	32	165	706	60	948	34	1,151	26	1,766	45	9,216	56	36,169	14	18,828
1977	81	25	153	684	63	1,043	36	1,351	23	1,676	39	7,754	52	34,132	22	28,219
1978	88	23	145	634	60	972	37	1,394	24	1,827	40	8,073	48	30,137	25	31,787
1979	111	33	146	598	61	972	31	1,115	25	1,850	34	6,446	41	22,970	36	48,236
1980	116	34	154	623	63	1,022	32	1,078	29	2,065	32	5,601	42	23,998	41	58,504
1981	98	32	150	646	73	1,183	29	1,008	30	2,265	25	4,666	43	24,950	37	51,151
1982	97	32	142	608	67	1,037	30	1,046	27	2,025	27	5,359	41	23,180	35	48,788
1983	100	26	149	649	54	881	33	1,184	26	1,796	31	6,402	36	20,279	32	47,491
1984	78	25	148	626	60	945	28	972	27	1,733	31	5,859	37	23,522	30	48,937
1985	76	22	137	550	54	842	25	913	25	1,650	23	4,540	29	17,920	34	53,979
1986	68	18	111	517	49	766	27	980	23	1,560	20	3,930	31	17,589	31	54,398
1987	71	17	106	478	47	737	35	1,233	19	1,249	16	1,992	25	14,946	32	55,900
1988	70	22	105	470	43	667	37	1,282	22	1,551	15	2,720	24	13,826	33	62,952
1989	52	18	101	450	39	611	32	1,167	25	1,717	19	3,250	19	12,287	32	63,687
1990	57	16	121	505	38	588	31	1,081	25	1,594	16	2,861	16	9,798	31	63,651

Source: USDA, P&SA.

Table 2.5. Number and Size Distribution of Sheep and Lamb Slaughter Plants, Packers Reporting to P&SA, 1972-90.

Year	Plant Size (head)--									
	Less than 1,000		1,000-9,999		10,000-49,999		50,000-299,999		300,000 or larger	
	Plants	Head	Plants	Head	Plants	Head	Plants	head	Plants	Head
	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.	No.	Thous.
1972	137	31	41	138	23	562	15	2,700	14	6,539
1973	141	32	40	134	16	365	17	2,288	12	5,439
1974	124	28	33	127	20	463	15	2,882	14	5,967
1975	128	24	33	130	16	344	19	2,700	10	4,442
1976	131	22	32	123	16	377	16	2,636	8	3,637
1977	136	23	17	68	14	338	17	3,089	5	2,551
1978	126	20	27	95	10	238	14	2,207	5	2,545
1979	142	19	19	53	12	279	10	1,497	7	3,068
1980	146	20	25	75	9	232	8	1,302	7	3,823
1981	140	22	23	67	9	261	7	883	8	4,264
1982	136	20	29	92	8	295	6	1,126	8	4,143
1983	132	18	27	90	9	255	7	810	9	4,835
1984	116	19	25	87	11	272	7	1,130	9	4,974
1985	110	17	24	73	8	181	6	901	9	4,781
1986	97	17	16	46	7	169	6	1,026	8	3,885
1987	92	17	16	52	7	156	5	562	9	4,052
1988	89	14	23	63	8	209	4	655	8	3,890
1989	84	12	25	69	7	143	8	1,057	8	3,831
1990	95	17	24	70	9	230	6	882	6	3,467

Source: USDA, P&SA.

Table 2.6. Packer Feeding of Steers and Heifers, and Lambs as Percentage of Total Slaughter, 1972-1990.

Year	Cattle	Lamb
	Percentage	Percentage
1972	5.8	
1973	6.1	
1974	6.3	
1975	6.0	
1976	6.2	17.3
1977	5.5	12.3
1978	5.1	15.5
1979	4.8	14.6
1980	3.6	10.1
1981	4.7	4.2
1982	3.2	16.3
1983	3.4	21.6
1984	2.9	22.3
1985	3.3	27.0
1986	3.0	27.8
1987	4.3	28.0
1988	3.6	30.1
1989	4.2	28.7
1990	4.9	28.3

Source: USDA, P&SA.

## 5. Summary

The earliest reference to meatpacking as a commercial enterprise in America dates to William Pynchon of Springfield, Massachusetts, in 1662. Back then and for the next 150 years, the industry was small-scale and meat trade was limited to curing and packing pork. Movement of the American frontier westward across the mountains shifted the center of livestock production to the Ohio Valley but meat trade remained limited by a shortage of salt. Only after the innovation of the upstream river boat in the 1820s, which gave the Valley access to salt from the South, would meatpacking rise as a distinct and significant industry. Cincinnati became the steamboat and commercial pork packing capital of the world. Still, packing houses remained small scale. Because of reliance on natural refrigeration, more economies were gained from greater speed than from large size in managing the product flow during the winter packing season.

By the 1950s, the spread of railroad transportation had profound effects on the growth and location of livestock production and meatpacking. Railroads provided a less expensive mode for hauling cattle to producers located further away from rivers, shifted the locus of cattle raising further west, and fostered competition between Eastern and Western packers. However, only pork packing moved further west. Until the introduction of artificial refrigeration, beefpacking in the West remained locationally disadvantaged for the slaughter and shipment of dressed beef to distant markets.

To reduce the shrinkage problem, railroads invested in feeding stations and stockyards, thus effecting locational change in the meatpacking industry. One manifestation of that change is the replacement of Cincinnati by Chicago as the preeminent center for transshipment and packing of livestock, especially after the closing of the Mississippi River route during the Civil War. The increase in livestock shipments to Chicago overloaded the city's capacity to handle the traffic, leading to the establishment of the Union Stockyards in 1865.

The advent of the refrigerator-car in the 1880s was the decisive factor in shaping the structure and location of the meatpacking industry, especially beefpacking. The costly method of shipping live cattle to Eastern markets was abandoned for slaughtering cattle in Chicago and shipping the dressed beef instead. To manage the distribution of fresh meat from Chicago to Eastern markets, packers invested in refrigerator cars and established branch houses as transshipment points. Significant economies were achieved from improved marketing and distribution, division of labor, and utilization of animal by-products. By 1888, Swift, Armour, Hammond, and Morris produced about two-thirds of nation's beef supply. The refrigerator car also enabled packers to locate west of Chicago in Omaha, St. Louis, Kansas City, and Saint Paul.

Increased derived demand for cattle following the introduction refrigerated beef initially pushed cattle prices to unprecedented levels during the early 1880s. Higher prices triggered significant increases in cattle numbers leading to the "bust" in 1885. Cattle raisers demanded federal legislation, believing packers were responsible for the downturn in cattle prices. The

U.S. Senate responded in 1888, adopting a resolution to examine pricing conduct of the meatpacking industry. Thus began the first federal investigation of the industry.

To avoid pricing competition for market shares, especially in the lucrative Eastern markets, the four dominant packers experimented with various pooling arrangements until 1902 when packers were charged with conspiracy to restrain trade. To evade the charge of collusion under the Sherman Act, the four packers formed the National Packing Company in 1902. Several other investigations took place in the next 18 years, culminating in the Packer Consent Decree in 1920. Packers were required to divest of their interests in stockyards, railroads, branch houses, and retail meat markets.

The 1920s marked the beginning of a deconcentration period in the industry that would last until the 1970s, especially in cattle slaughter. The extent to which the Consent Decree contributed to deconcentration is debatable. However, several other developments in the meat industry altered the competitive advantage of the dominant packers. Developments included the rise of the supermarket, the federal grading system, the introduction of the motor carrier, the construction of the national highway system, and the shift of cattle feeding to the Western Corn Belt and Great Plains. The traditional function of the packing business, however, changed little until the 1960s. Animals were slaughtered and carcasses were shipped further up the marketing channel for further disassembly.

With emerging new technologies, specialized demands for meat, and rising labor costs, packers, beginning with IBP in 1967, adopted boxed-beef technology as an alternative to shipping carcasses from plants. Significant economies from labor specialization and substitution of capital for labor were achieved. Concurrent with new processing technology were some fundamental realignments in the industry in the 1960s and early 1970s. The old-line packers were integrated into larger conglomerates or merged with other packers. The decline in red meat demand in the late 1970s left the industry with excess capacity, triggering a wave of mergers and acquisitions. Concentration levels have dramatically increased across all species, raising the same competitive concerns that were raised at the beginning of the century.

What transpires from tracing the historical events that have brought commercial meatpacking from its modest colonial beginnings in the seventeenth century to today, is that although consumer pressures and government responses have undoubtedly had some impact on structural changes over the years, economic factors, manifested most especially in technological change, appear to have been a good deal more significant. Some of the latter developments have no doubt been spurred or facilitated by institutional or social changes, such as increasing labor costs, Federal meat grading, and population growth and distribution. Most of the developments had a combination of antecedents. The boxed-beef innovation resulted, for example, from a combination of customer demand pressures, rising labor costs, and technical advances. But technologies have been critical to most of the changes. Technologies, especially transportation improvements, the invention of mechanical refrigeration, and the development of labor-saving plant technologies, have given clear and significant impetus to larger, vertically coordinated plants with a livestock supply and feed grain orientation.

## CHAPTER III

### MARKET POWER IN INDUSTRIAL ORGANIZATION: A HISTORICAL SURVEY OF THEORY AND PRACTICE

#### 1. Pre-Bainian Approaches

Although the economic foundation of the industrial organization (IO) is at least as old as the *Wealth of Nations*,<sup>97</sup> it was not until the 1870s and 1880s that investigations of market power issues began to emerge as a distinct field of inquiry. Monopoly concerns ran high during the latter period. Policy makers and academics debated the appropriate response to the rise of giant businesses, like meat packing (see chapter II). The policy debate revolved around the political, economic, social and moral consequences of trusts. The economic debate, which eventually gave rise to an economic theory of IO, centered on classical versus neoclassical definitions of competition, and the proper domain of deductive theory versus empirical observation in analyzing the conduct of business organizations.

Classical economists did not understand and therefore were not concerned with cost/price relationships and properties of equilibria as elements central to the competitive theory of their neoclassical successors. Classical theory was concerned instead with rivalry, liberty, and freedom of choice as means for limiting the power of the state in allocating resources, particularly the allocation of exclusive commercial privileges so common in the Mercantilist period.<sup>98</sup> Rivalrous behavior or oligopolistic interdependence, which is anti-competitive by modern neoclassical standards, was competitive in the classical view. As late as 1888, prominent economists such as

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<sup>97</sup>Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (London, 1776). Smith discussed "competition" at length in his book but used the term to denote what modern economists term rivalry as did classical economists for more than 100 years after him. Smith also discussed the familiar conditions necessary for perfect competition excepting only product homogeneity. Although he never called it imperfect competition, Smith referred to problems of monopoly and collusion in a casual manner. See Mark Blaug, *Economic Theory in Retrospect* (Cambridge: Cambridge University Press, 1978), pp. 44-45.

<sup>98</sup>Herbert Hovenkamp, "The Sherman Act and the Classical Theory of Competition," in E. Thomas Sullivan, ed., *The Political Economy of the Sherman Act: The First One Hundred Years* (New York: Oxford University Press, 1991).

J. B. Clark and Irving Fisher viewed price cutting to undersell a rival producer as a competitive weapon and saw merger as a way of protecting businesses from its undesirable effects.<sup>99</sup> Liberty and freedom meant people and businesses should be free in their decisions about what price to charge, or with whom to deal and contract. Within this definition of competition and freedom of contract, forming a cartel to raise prices did not justify legal action. Consumers were free to refuse to buy if prices were raised too high, just as businesses were free to set their prices.<sup>100</sup> Capturing profits was itself part of the competitive process. Hence, monopoly pricing by a firm or group of firms would always be undermined by potential competition -- or the possible entry of new firms attracted by profits. Only when the law, not the market, creates barriers to entry does collusion become a problem.

Following the publication of Alfred Marshall's *Economics of Industry*<sup>101</sup> in 1881, and *Principles of Economics*,<sup>102</sup> in 1890, the term competition took on a more precise meaning, no longer referring to rivalry between particular firms in particular industries. Now it became a hypothetical market structure comprised of abstract, indivisible firms making abstract output and price decisions in such a manner that rivalry was ruled out by definition. Whether the firm had any resemblance to an actual firm in an actual industry is of no consequence. The important thing was the internal consistency and universality of the new theories of price and output -- their applicability to all firms in all industries.

The division between the classical and neoclassical views of competition naturally led to a division on how to study firms and industries. Thus, two analytical systems soon emerged -- the historical/empirical/practical and the neoclassical/classical/deductive/theoretical. In his essay on the historical development of IO, Hovenkamp characterized the empirical camp as "suspicious of theory . . . hostile toward simplification, opposed to universalism, highly

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<sup>99</sup>Thomas J. Dilorenzo and Jack C. High, "Antitrust and Competition, Historically Considered," *Economic Inquiry*, vol. 26 (1988), pp. 423-435.

<sup>100</sup>Hovenkamp, *op. cit.*, p. 151.

<sup>101</sup>Alfred Marshall and Mary P. Marshall, *Economics of Industry* (London, 1881).

<sup>102</sup>Alfred Marshall, *Principles of Economics* (London: MacMillan, 1890).

committed to the use of statistical evidence, and much more tolerant of ad hoc government intervention in the market."<sup>103</sup> The neoclassical school was "highly theoretical, ideologically conservative, suspicious of empirical research, and inclined to reject the opposing view as merely "anecdotal" --one of the worst of scientific pejoratives."<sup>104</sup> The two schools are still the principal sources of much of today's received wisdom in industrial organization theory and practice.

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<sup>103</sup>Herbert Hovenkamp, "The Antitrust Movement and the Rise of Industrial Organizations," *Texas Law Review*, vol. 68 (1989), p 112.

<sup>104</sup>*Ibid.*, p. 112.

The origins of the historical/empirical/practical approach date to the German school of political economy where the historical case-study was the prevailing method for economic analysis. During the 1870s and 1880s, several students, eventually to become prominent economists and founders in 1885 of the American Economic Association (AEA), received their graduate training in German universities. Among them were F.W. Taussig, Frank Fetter, John Bates Clark, Richard T. Ely, Simon Patten, and Edwin R. A. Seligman.<sup>105</sup> One of the major commitments of the newly formed AEA, as recorded in its constitution, was the promotion of "economic research, especially the historical and statistical study of the actual conditions of industrial life."<sup>106</sup> Numerous case studies soon permeated the AEA's publications and continued to do so for the next 3 decades. The best examples of those case studies may be found in the famous Harvard Economic Studies series published by the Harvard Economics Department under the leadership of Edward Mason. Numerous industries, including leather, starch, glucose, salt, cotton, asphalt, glue, shipbuilding, and iron were studied. The Federal Trade Commission also published a series of historical studies including one on the meatpacking industry.<sup>107</sup>

Case-study inquiries into the conduct of industries required painstakingly detailed description of how firms actually make business decisions. Schmalensee,<sup>108</sup> no champion of the case-study approach, acknowledged that much was learned from it of real-world business strategies and their effects, including price leadership, rigidity, price and non-price rivalry, and price rigidity, but thought little could be generalized. The case-study research program "was better at generating interesting examples and observations than useful general rules."<sup>109</sup> Generating "general rules" was at the core of neoclassical activity during the "case-study era."

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<sup>105</sup>*Ibid.*, p. 110.

<sup>106</sup>Quoted in *Ibid.*, p. 110.

<sup>107</sup>U.S. Federal Trade Commission, *Report of the Meat Packing Industry, 1919, op. cit.*

<sup>108</sup>Richard Schmalensee, "Empirical Studies of Rivalrous Behavior," in Giacomo Bonanno and Dario Brandolini, eds., *Industrial Structure in the New Industrial Economics* (Oxford: Clarendon Press, 1990).

<sup>109</sup>*Ibid.*, p. 144.

Neoclassical theory, the foundation of static microeconomics, was itself a product of the "marginalist revolution" which was inspired by the discovery of the principle of diminishing marginal utility by Jevons, Menger, and Walras.<sup>110</sup> In particular, Jevon's utility concept of demand provided the basis for Marshall's integration of demand and supply in the analysis of market price determination. But the analysis was limited to the polar extremes of perfect competition and monopoly, and continued to be so for the period between Alfred Marshall and Frank Knight.<sup>111</sup> This dichotomous perspective drew sharp criticism during the 1920s and early 1930s. Real-world markets, it was argued, lie somewhere between perfect competition and monopoly. The period of mounting criticism corresponded with the merger movement of the 1920s, the collapse of the stock market in 1929 and the onset of the Great Depression, all of which provoked renewed interest in the implications of monopoly, thrusting the empirical camp into the forefront of research. The work of Adolph Berle and Gardiner Means, relating to the implication of the separation of business ownership and control for the firm's objective, is one of the more noteworthy products coming from the empirical camp during that era.<sup>112</sup>

The first serious efforts to bridge the gap between neoclassical theory and reality were undertaken by Sraffa, Hotelling, Chamberlin and Robinson.<sup>113</sup> Chamberlin's work on monopolistic competition, in particular, helped to fill the gap between the polar extremes of perfect competition and monopoly, bringing theoretical and institutional perspectives on industries closer together, and prompting further theoretical as well as empirical research in what would later become known as imperfect competition.

Chamberlin's work on the influence of industry concentration, entry, and product differentiation on performance provided the basis for the structure-conduct-performance (SCP) paradigm of industrial organization theory.<sup>114</sup> The paradigm itself was created by Mason who hypothesized that differences in market structures lead to differences in price responses, which in turn lead to differences in how the general economy functions. The emergence of industry-level Census data (concentration ratios first appeared in the Census of 1935, published in 1939)

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<sup>110</sup>Blaug, *op. cit.*, p. 309.

<sup>111</sup>Frank Knight, *Risk, Uncertainty and Profit* (New York: Harper and Row, 1921).

<sup>112</sup>Adolf A. Berle and Gardiner C. Means, *The Modern Corporation and Private Property* (New York: Macmillan, 1932).

<sup>113</sup>Pierro Sraffa, "The Laws of Returns Under Competitive Conditions," *Economic Journal*, vol. 36 (1926), pp. 535-550; Harold Hotelling, "Stability in Competition," *Economic Journal*, vol. 39 (1929), pp. 41-57; Edward H. Chamberlin, *The Theory of Monopolistic Competition* (Cambridge, MA: Harvard University Press, 1933), 8th ed., 1965; and Joan Robinson, *The Economics of Imperfect Competition* (London: Macmillan, 1933).

<sup>114</sup>Donald Hay and Derek J. Morris. *Industrial Economics and Organization* (Oxford: Oxford University Press, 1991).

opened the way for empirical studies. Case studies by the Temporary National Economic Committee (TNEC) and by E. S. Mason and his students at Harvard were most prominent.<sup>115</sup>

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<sup>115</sup>See Edward S. Mason, "Price and Production Policies of Large-Scale Enterprise," *American Economic Review*, vol. 29, supp. (1939), pp. 61-74; and Mason, "The Current State of the Monopoly Problem in the United States," *Harvard Law Review*, vol. 62 (1949), pp. 1265-85. The best of the TNEC work is reported in Walton Hamilton and Irene Till, *Antitrust in Action*, vol. 16, and Clair Wilcox, *Competition and Monopoly in the American Economy*, vol. 21 (Temporary National Economic Committee, Washington D.C.: U.S. Government Printing Office, 1940).

Although the SCP approach rapidly occupied the mainstream of IO<sup>116</sup> thinking upon its emergence in the 1930s, it has had its detractors. Some have even denied the existence of a monopoly problem. Schumpeter's defense of monopoly in 1942 was widely read and debated.<sup>117</sup> World War II brought a resurgence of economic activity and public confidence in the competitiveness of the American economy was high at war's end in 1945. Economists, including most prominently, Morris Adelman, Warren Nutter, George Stigler, and Fred Weston, taking their cues from these events, and in a bid to roll back the convictions of the 1930s, focused increasing attention on competitiveness as opposed to monopoly.<sup>118</sup> Arnold Harberger did a widely-quoted study that concluded that the total misallocation costs to the economy from monopoly were only 0.2 percent of national income.<sup>119</sup> Structuralist views came under attack as public-utility economics was buffeted by new views of the effects of regulation.<sup>120</sup> Stigler and others were part of the regulatory reevaluation and of a broader assault on structuralist traditions.<sup>121</sup>

## 2. Bainsian Approaches

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<sup>116</sup>Industrial organization was not called such until sometime in the late 1930s, its genesis credited to the Mason group at Harvard University.

<sup>117</sup>Joseph A. Schumpeter, *Capitalism, Socialism and Democracy* (New York: Harper, 1942).

<sup>118</sup>See Morris A. Adelman, "The Measurement of Industrial Concentration," *Review of Economics and Statistics*, vol. 33 (1951), pp. 269-96; G. Warren Nutter, *The Extent of Enterprise Monopoly in the United States: 1899-1939* (Chicago: University of Chicago Press, 1951); George J. Stigler, *The Organization of Industry* (Homewood, IL: Irwin, 1968); and Harvey J. Goldschmid, H. Michael Mann and J. Fred Weston, eds., *Industrial Concentration: The New Learning* (Boston: Little, Brown, 1974).

<sup>119</sup>Arnold Harberger, "Monopoly and Resource Allocation," *American Economic Review*, vol. 44 (May 1954), pp. 77-87.

<sup>120</sup>See, for example, Alfred E. Kahn, *The Economics of Regulation*, 2 vols. (New York: Wiley, 1970).

<sup>121</sup>George J. Stigler, *The Organization of Industry* (Homewood, IL: Irwin, 1968).

The early SCP studies by Mason and his followers focused mainly on price and production policies at the level of a single large industrial firm. Following Bain's work from 1951 and 1959,<sup>122</sup> the IO research agenda in the 1960s shifted from firm-level to inter-industry, cross-section analyses. The focus, which would dominate empirical industrial organization until the 1970s, was that high concentration and other structural deficiencies facilitated collusive conduct and impaired efficiency.<sup>123</sup> Hence, a positive correlation between seller concentration and say, profits, was theorized to be associated with some degree of collusion, either tacit or overt (see section A.1 of the Mathematical Appendix). The empirical findings of the SCP studies supported the case that concentration is the basis for monopoly power and pushed Harberger's estimate of allocative losses toward 2 percent of national income.<sup>124</sup> The studies also had an effect on antitrust policy in the late 1960s. The celebrated monopoly suits against IBM and the ready-to-eat breakfast cereal industry were brought during the heydays of SCP influence and the call for deconcentration in the 1969 Neal Report was apparently influenced by empirical SCP findings.<sup>125</sup> The major policy influence of SCP studies soon made them a visible target for dissent. A series of arguments arose over interpretation of profitability-concentration correlations and concerning various biases allegedly associated with measurement of structural parameters.

First and foremost among the dissenters was Demsetz,<sup>126</sup> who argued that firms become large because they are efficient. Larger size and larger profits both result from superior performance originating in greater managerial skills and innovativeness leading to superior products or reduced costs.<sup>127</sup> Larger profits, by this view, lead to larger firms, implying joint determination of profits and concentration. Demsetz's empirical evidence was criticized on two counts--for its reliance on IRS data, which often classify plants in the wrong industries, and for

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<sup>122</sup>Joe S. Bain, "Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940," *Quarterly Journal of Economics*, vol. 65 (1951), pp. 488-500; and Joe S. Bain, *Barriers to New Competition* (Cambridge: Harvard University Press, 1956).

<sup>123</sup>Other aspects of industry structure in the SCP paradigm include product differentiation, barriers to entry, vertical integration, cost conditions, scale economies, and diversification. Concentration seems to have received by far the most empirical attention in the literature.

<sup>124</sup>William G. Shepherd, *Market Power and Economic Welfare* (New York: Random House, 1970).

<sup>125</sup>Michael A. Salinger, "The Concentration-Margins Relationship Reconsidered," in *Brookings Papers on Economic Activity, Microeconomics* (Washington, D. C.: Brookings Institution, 1990), p. 287.

<sup>126</sup>Harold Demsetz, "Industry Structure, Market Rivalry, and Public Policy," *Journal of Law and Economics*, vol. 16 (1973), pp. 1-9.

<sup>127</sup>This is referred to as the efficiency of Ricardian rent explanation of the correlation between profits and concentration. Two other explanations have not received as much attention as that of Demsetz's. One view measured profits as arising from the deviation of short-term rents from long-run equilibrium, meaning that even concentrated markets can be perfectly competitive. The other views profits as returns to innovative activity, making short-term oligopolistic equilibrium part of a dynamic competitive process. See Michael Salinger, *op.cit.*, p. 288.

being based on accounting rather than economic profits.<sup>128</sup> A stronger test would require information on market shares of a sample of firms, either within an industry or across industries. The FTC Line of Business (LB) Data provided just that. Ravenscraft, perhaps the first to use the newly-available data, found that when market share was included along with seller concentration as explanatory variables for profits, the former had a much stronger positive correlation with profits than the latter. In fact, the correlation between concentration and profits became negative.<sup>129</sup>

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<sup>128</sup>Leonard W. Weiss, *Concentration and Price* (Cambridge, MA: MIT Press, 1989), p. 8.

<sup>129</sup>David J. Ravenscraft, "Structure-Profit Relationships at the Line of Business and Industry Level," *Review of Economics and Statistics*, vol. 65 (1983), pp. 22-31.

Subsequent studies using LB data also tended to weaken the apparent significance of concentration and raised new questions of the role of industry-specific versus firm-specific determinants of individual firms' profits. The findings are varied. When Richard Schmalensee decomposed returns into industry effects, firm effects, and share effects, he found industry-specific explanations for differences in profitability that were more significant than market share, in seeming contradiction to Demsetz's hypothesis.<sup>130</sup> More convincing support for the hypothesis would come 10 years later from a theoretical paper by Clarke and Davies.<sup>131</sup>

Other criticisms of SCP inter-industry studies concerned problems of measurement of key variables, misspecification, causality, and simultaneity. The essence of those arguments is extensively discussed in Schmalensee's extensive review of SCP studies, and they need not be repeated here.<sup>132</sup> Suffice to say that the arguments prompted demand for empirical alternatives.<sup>133</sup>

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<sup>130</sup>See, especially, Richard Schmalensee, "Do Markets Differ Much?" *American Economic Review*, vol. 75 (June 1985), pp. 341-51.

<sup>131</sup>Roger Clarke and Stephen W. Davies, "Market Structure and Price-Cost Margins," *Economica*, vol. 49 (1984), pp. 277-287.

<sup>132</sup>Richard Schmalensee, "Inter-Industry Studies of Structure and Performance," In Richard Schmalensee and Robert Willig, eds., *Handbook of Industrial Organization* (New York: North Holland, 1989)

<sup>133</sup>Another contentious issue in the structure-performance nexus is the relationship between potential competition and market performance. Gilbert identified four competing models (or schools of thought) in the literature: limit pricing, dynamic limit pricing, contestable markets, and market efficiency. Under limit pricing, structural features of the industry protect incumbent firms from entrants. Protection from entry is only temporary, according to the dynamic limit pricing model. In the theory of contestable markets, effects of potential competition on market performance are the same as effects of actual competition. The market efficiency hypothesis asserts that gains from incumbency are transient, and industry structure is the result of differences in cost efficiencies. Richard J. Gilbert, "The Role of Potential Competition in Industrial Organization," *Journal of Economic Perspectives*, vol. 3 (1989),

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pp. 107-127.

One alternative for empirical research was to examine the relationship between the components of profits, namely prices and costs, rather than profits themselves. The underlying hypothesis about costs is that they can both affect and be affected by concentration. Some studies have found that cost biases affect industry profits negatively, while others have found positive effects.<sup>134</sup> Monopoly power may lead to inflated costs and to understatement of the effects of concentration on profitability. Thus high prices might draw small and inefficient producers into the industry, inflating industry cost averages and reducing profitability. X-inefficiency may increase as reduced competitive pressures make firm management less concerned about efficiency, and more concerned about their personal welfare. Most empirical evidence supports the conclusion that X-inefficiency is an important source of cost inflation in concentrated markets.<sup>135</sup> There also is evidence that unionized workers capture sizeable amounts of the excess profits in the more concentrated industries, estimates ranging to as much as 60 percent of the excess.<sup>136</sup> There are problems in sorting out the effects of excess costs since the more profit, the higher the expected wage; but the higher the wage, the lower the realized profit. Simultaneous estimation procedures are clearly in order. And of course the issue is even more complex since concentrated industries may also have lower costs owing to economies of scale or other efficiencies achieved by larger firms.

The underlying price-concentration hypothesis is that output prices increase with seller concentration. To test the hypothesis, cross section prices, rather than profits, are regressed against concentration in geographically separated markets within a single industry. As the next chapter will demonstrate, some of the more convincing SCP studies of meatpacking<sup>137</sup> have employed the price-concentration procedure.<sup>138</sup>

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<sup>134</sup>For an example of the former, see Leonard W. Weiss, "Optimal Plant Size and the Extent of Suboptimal Capacity," in Robert T. Masson and P. David Qualls, eds., *Essays on Industrial Organization in Honor of Joe S. Bain* (Cambridge: Ballinger, 1976), pp. 123-42; and for one of the latter effect, see Harry Bloch, "Prices, Costs and Profits in Canadian Manufacturing: The Influence of Tariffs and Concentration," *Canadian Journal of Economics*, vol. 7 (1974), pp. 594-610.

<sup>135</sup>See, for example, Hans P. Binswanger and Vernon W. Ruttan, *Induced Innovation: Technology, Institutions and Development* (Baltimore: Johns Hopkins University Press, 1978), p. 28; and T. Y. Shen, "The Estimation of X-Inefficiency in Eighteen Countries," *Review of Economics and Statistics*, vol. 66 (1984), pp. 98-104.

<sup>136</sup>Thomas Karier, "Unions and Monopoly Profits," *Review of Economics and Statistics*, vol. 67 (1985), pp. 34-42.

<sup>137</sup>For example, Gwen Quail, Bruce Marion, Frederick Geithman, and Jeffrey Marquardt, *The Impact of Packer Buyer Concentration on Live Cattle Prices*, NC 117 Working Paper No. 89 (Madison: University of Wisconsin), and Charles Matthew Heyneman, *Changing Buyer Structure and its Impact on the Performance of the Market for Finished Hogs*, unpublished M.S. Thesis (Madison: University of Wisconsin, 1992).

<sup>138</sup>In his review of the more recent NEIO techniques for testing for market power, Bresnahan regards price-concentration studies as being a subset of NEIO, classifying them with models of "comparative statistics in industry structure." Schmanelsee, however, includes them in his survey of SCP models.

Whether prices or profits are the dependent variable, the nature of pricing conduct is never explicit in the SCP studies. Collusive behavior is accordingly thought to be reflected in significant positive correlations between structure and some measure of performance. Such implicit treatment of conduct is attractive intuitively, but unsatisfactory on theoretical grounds. The first clear (neoclassical) statement on the subject was Stigler's seminal paper<sup>139</sup> in which he asserts that "a satisfactory theory of oligopoly cannot begin with assumptions concerning the way in which each firm views its interdependence with its rivals. If we adhere to the traditional theory of profit maximizing enterprises, then behavior is no longer something to be assumed but rather something to be deduced." Stigler's alternative starts with the assumption that a market-sharing cartel is in place. To deter cheating, members search for information on prices and rivals' market shares. The optimal search is determined by comparing the benefits of deterring cheating to the costs of the information search. The probability of detection is then determined by the optimal degree of search which, in turn, depends among other things on the number of sellers and buyers. Hence, the effectiveness of collusion in Stigler's theory is determined by the calculus of costs and benefits associated with collusive conduct. Using the Herfindahl index as a proxy for the effectiveness of collusion, Stigler correlated both profits and prices with the Herfindahl index, finding empirical support for his theory.

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<sup>139</sup>George Stigler, "A Theory of Oligopoly," *Journal of Political Economy*, vol. 72 (1964), pp. 44-61.

Stigler's work on collusion was an important stepping stone for Cowling's theoretical paper on industrial structure-performance relationships, and an empirical paper by Cowling and Waterson.<sup>140</sup> In the theoretical paper, Cowling argues that Stigler's theory lacked precision because little was said about the relationship between the Herfindahl index and the degree of collusion.<sup>141</sup> So rather than assert, as Stigler did, the presence of a collusive environment and explore how profit-maximizing firms assess the costs and benefits of collusive behavior, Cowling assumes the presence of an oligopolistic environment and uses a conduct model to derive the equilibrium condition for a profit-maximizing firm which conjectures about its rivals' responses to its own output decision. Summation of the equilibrium conditions across the firms in the industry yields an expression relating industry profitability to the elasticity of demand, the number of firms, and the degree and effectiveness of collusion, otherwise known as the conjectural variation (see section A.2 of the Mathematical Appendix).

The significance of Cowling's work is that it brought together the contributions of 4 influential works shedding light on the anatomy of SCP work: a) Stigler's attempt to find a theory of collusion,<sup>142</sup> b) Lerner's price-cost margin,<sup>143</sup> c) Kalecki's formula relating Lerner's price-cost margin and the elasticity of demand<sup>144</sup> and d) Cournot's theory of strategic choice by non-cooperative oligopolists.<sup>145</sup> The result provides both comfort and concern for SCP

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<sup>140</sup>Keith Cowling, "On the Theoretical Specification of Industrial Structure-Performance Relationships," *European Economic Review*, vol. 8 (1976), pp. 1-14. Keith Cowling and Michael Waterson, "Price-Cost Margins and Market Structure," *Economica*, vol. 43 (1976), pp. 275-286.

<sup>141</sup>*Ibid.*, p. 2.

<sup>142</sup>Stigler, *op. cit.*

<sup>143</sup>A. P. Lerner, "The Concept of Monopoly and the Measurement of Monopoly Power," *Review of Economic Studies*, vol. 1 (1934), pp.157-75.

<sup>144</sup>M. Kalecki, *Essays in the Theory of Economic Fluctuations* (London: George Allen and Unwin, 1939).

<sup>145</sup>Cournot's contribution to oligopoly theory is discussed at the conclusion of this chapter.

practitioners. On the one hand, the structure-performance relationship is shown to be consistent with an underlying theoretical model of profit-maximizing firms whose actions are interdependent. On the other hand, "when the theoretical model is spelled out it becomes obvious that inter-industry relationships of this sort are meaningless because of certain omitted variables"<sup>146</sup> such as the elasticity of demand and conduct as measured by the conjectural variation. To mitigate the effect of the omitted variables, Cowling and Waterson express the structure-performance relationships in difference form, and assume them constant through time but not necessarily identical across industries. The latter procedure eliminates the need for estimating inter-industry demand elasticities and conjectural variations (see section A.3 of the Mathematical Appendix).

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<sup>146</sup>Cowling and Waterson, *op. cit.*, p. 267.

Clarke and Davies<sup>147</sup> have shown that when Cowling and Waterson's work is extended to model the joint determination of margins and concentration, the results support the efficiency argument advanced by Demsetz a decade earlier--that a positive correlation between concentration and profitability may reflect, in part, the superior efficiency of the largest firms (see section A.4 of the Mathematical Appendix).

### 3. Post-Bainian Approaches

Although Cowling and Waterson used an explicit conduct model to establish the link between concentration and performance, their focus on inter-industry variation in margins left the issue of estimating the conduct unresolved. Iwata, however, in an influential paper which preceded Cowling's work by 2 years (but not cited by Cowling), had already made the first attempt to measure the conjectural variation.<sup>148</sup> Iwata first posited a noncooperative equilibrium of the Japanese glass industry and then proceeded to compute the conjectural variation implied by that equilibrium, given estimates of demand, cost functions, and price cost margins. Iwata's work became the first in a series of empirical alternatives<sup>149</sup> to the profit-concentration regression as a model for detecting market power. Those empirical alternatives comprise what has become known as the New Empirical Industrial Organization (NEIO).

NEIO and SCP have the same premise: oligopoly market power or departures from the neoclassical perspective of competition can be measured by the gap between output price and marginal cost (or, for oligopsony, the difference between factor prices and marginal value product). The two differ, however, in their approach to detecting market power.

As noted earlier, the gap between price and marginal cost in SCP studies is measured by the price-cost margin. A positive correlation between the price-cost margin and industry concentration is taken as evidence of market power. The nature of conduct is either implicit in the found correlation, or is assumed to be of a particular type such as Cournot.

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<sup>147</sup>Clarke and Davies, *op. cit.*

<sup>148</sup>G. Iwata, "Measurement of Conjectural Variations in Oligopoly," *Econometrica*, vol. 42 (1974), pp. 947-966.

<sup>149</sup>The most influential were by Frank M. Gollop, "Firm Interdependence in Oligopolistic Markets," *Journal of Econometrics*, vol. 10 (1979), pp. 313-31; Richard E. Just and Wen S. Chern, "Tomatoes, Technology, and Oligopsony," *The Bell Journal of Economics*, vol. 11 (1980), pp. 584-602; and Elie Appelbaum, "The Estimation of the Degree of Oligopoly Power," *Journal of Econometrics*, vol. 19 (1982), pp. 287-299.

In contrast, NEIO studies take the gap between prices and their shadow values as an unknown parameter to be estimated from observable prices and outputs. Equation (18) in the Mathematical Appendix is a typical estimating equation. The typical NEIO model posits a (dual) cost function from which is derived an expression for marginal cost,  $c$ , in equation (18). A demand equation is added to the structural model to estimate the demand elasticity, and factor demand equations are added. The conjectural elasticity is either posited to be a function of factor prices,<sup>150</sup> a function of concentration,<sup>151</sup> or a constant.<sup>152</sup> The range for the conduct parameter is between zero (perfect competition) and one (cartel). Given the standard errors, a range of statistically plausible conduct outcomes is calculated. Given the estimate of the market demand elasticity, the Lerner index of market power (or price-cost margin) can also be estimated.

Discussion of NEIO so far has used, as does most of the literature, the terms conduct and price-marginal cost gap interchangeably. Some IO economists<sup>153</sup> concur in such usage as long as (a) it is assumed that firms actually make conjectures, or (b) "one remains agnostic about the precise game the firms are playing and only attempts to measure the amount of market power in the equilibrium."<sup>154</sup> To other IO economists, namely game theorists, the two views are not in harmony with each other. To assume firms use conjectural variations, as derived from a static profit-maximization model, and to proceed to interpret the empirical results as an outcome of some game, is theoretically vacuous. Since a static game implies a firm's choice is independent of its rivals' choices, any conjecture about one's rivals' reactions that differs from no reaction is irrational.<sup>155</sup> To remain agnostic about the game and regard the difference between price and marginal cost as merely a gap also is troublesome. As Geroski<sup>156</sup> points out, the idea of a gap is only helpful in ascertaining whether an industry is a price-taker or not. If the industry is found not to be a price-taker, the question of what type of behavior has generated the data still remains. Answering the latter question requires detailed information about individual firm prices, costs,

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<sup>150</sup> Appelbaum, *op. cit.*

<sup>151</sup> Ramon E. Lopez, "Measuring Oligopoly Power and Production Responses of the Canadian Food Processing Industry," *Journal of Agricultural Economics*, vol. 35 (1984), pp. 219-230.

<sup>152</sup> V. Borooah and F. Van Der Ploeg, "Oligopoly Power in the British Industry," *Applied Economics*, vol. 18 (1986), pp. 583-598.

<sup>153</sup> Jeffrey Perloff, "Econometric Analysis of Imperfect Competition and Implications for Trade Research," in Ian M. Sheldon and Dennis Henderson, eds., *Industrial Organization and International Trade: Methodological Foundations for International Food and Agricultural Market Research*, North Central Regional Research Publication No. 334, NC-194 Research Monograph No. 1, 1992.

<sup>154</sup> *Ibid.*, p. 75-76.

<sup>155</sup> Jean Tirole, *The Theory of Industrial Organization* (Cambridge: MIT Press, 1988), p. 244.

<sup>156</sup> Paul A. Geroski, "In Pursuit of Monopoly Power: Recent Quantitative Work in Industrial Economics," *Journal of Applied Econometrics*, vol. 3 (1988), p. 113.

and outputs. Detailed oligopoly models relating the price and/or output response of each individual firm and its rivals are also necessary. Still, one must impose *a priori* structure on the model for tractability and for reducing the number of parameters to be estimated. In the end, one cannot be sure whether the observed gap is generated by the game, is a consequence of the imposed *a priori* structure, or stems from measurement or misspecification problems.

To avoid the interpretation problems associated with conjectures and reactions, other NEIO alternatives seek to identify market power by posing a different question. Rather than asking what type of game must have been played to generate the equilibrium prices and quantities, these studies ask what type of market structure is consistent with equilibrium outcomes following an exogenous shock to the firm or industry. The result is an exercise in comparing the comparative statics of models of monopoly power with models of perfect competition. Since the former have predictions at variance with the latter, observed market data can be used to test whether the implications of perfect competition have been rejected.

In his review, Bresnahan<sup>157</sup> discusses in detail four categories of comparative statics NEIO models use to identify market power: (1) comparative statics in demand (supply), (2) demand (supply) shocks, (3) comparative statics in oligopolistic (oligopsonistic) industry structure, and (4) comparative statics in costs. Since some of the meatpacking applications reviewed in chapter III fall in the third category, and some in chapter V fit in one or another of the first three categories, each of the categories will be discussed.

Analysis of market power in factor markets involves the comparative statics of factor supply rather than output demand. To illustrate, consider the equilibrium condition for a monopsonist processor where the profit-maximizing factor quantity is determined by the intersection of derived demand and marginal factor cost.<sup>158</sup> The price of the factor is mapped from the factor supply schedule. Because the analyst observes only equilibrium price and quantity, and not the complete demand and supply schedules, the data could also be consistent with “demand equals supply” equilibrium of a competitive industry. This poses an identification problem: does the equilibrium factor price and quantity stem from a competitive or a noncompetitive equilibrium? One way to find out is to examine how equilibrium responds to changes in the supply curve. It turns out, however, that a parallel shift in the supply curve does not solve the identification problem. The new equilibrium can be reconciled with either a

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<sup>157</sup>Bresnahan, *loc. cit.*

<sup>158</sup>The monopsony case we present here follows the same line of reasoning presented for monopoly in a theoretical paper by Timothy F. Bresnahan, "The Oligopoly Solution Concept is Identified," *Economic Letters*, vol. 10 (1982), pp. 87-92. The first application of Bresnahan's comparative static model to a factor market was in meatpacking by Azzeddine Azzam and Tim Park, "Testing for Switching Market Conduct," *Applied Economics*, vol. 25 (1993), pp. 795-800. Selected empirical applications in oligopoly include D. L. Alexander, "An Empirical Test of Monopoly Behavior: An Application to the Hardwood Case," *Applied Economics*, vol. 20 (1988), pp. 1115-1127; D. E. Buschena and Jeffrey M. Perloff, "The Creation of Dominant Firm Market Power in the Coconut Oil Export Market," *American Journal of Agricultural Economics*, vol. 73 (1992), pp. 1000-1008; and S. Shaffer, "Competition in the U.S. Banking Industry," *Economic Letters*, vol. 29 (1989), pp. 321-323.

competitive or a cartelized market. But, if the factor supply schedule is rotated around the original equilibrium rather than shifted, the elasticity of supply is changed. Under perfect competition, changes in equilibrium price and quantity would not occur. Under a monopsony, marginal factor cost also shifts, resulting in a new equilibrium price and quantity, thus disclosing monopsony power.

The idea behind using supply or demand shocks to identify market power is that if an industry behaves like a cartel, then unobservable or unanticipated movement in the supply or demand schedules will trigger alternating periods of monopoly and competitive pricing.<sup>159</sup> Suppose cartel firms experience a decline in sales. If member firms are unable to determine whether the decline was caused by diminishing industry demand or by rivals cheating on their output agreements, members may retaliate by behaving more competitively for a time, returning thereafter to collusive pricing.<sup>160</sup>

Models relying on the comparative statics of industry structure compare prices across geographically separated markets within a single industry. The intuitive idea of such comparisons is that a positive statistical correlation between output price and seller concentration is evidence of oligopoly power. The procedure is an extension of the SCP view that competition is inversely related to market share. Price-concentration studies are believed to offer a way out of the gridlock over whether market power or efficiency is responsible for positive correlations between profits and concentration, and, since they deal with single industries in geographically separated markets, the bias from omitting market-specific characteristics is minimized.

Most of the meatpacking studies reviewed in chapter IV are of the price-concentration sort. Because the potential for market power being exerted is generally agreed to be greatest on the buying side of the market, most meatpacking studies have analyzed oligopsony power issues, whereas the main focus of practically all price-concentration studies in other industries has been on competitive relations on the selling side of the market (oligopoly).

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<sup>159</sup>This is known in the IO literature as the "trigger price" model developed by Edward J. Green and Robert H. Porter, "Non-Cooperative Collusion under Imperfect Price Information," *Econometrica*, vol. 87 (1984), pp. 100.

<sup>160</sup>The trigger price model was applied to beefpacking by Stephen R. Koontz, Philip Garcia, and Michael A. Hudson, "Meatpacker Conduct in Fed Cattle Pricing: An Investigation of Oligopsony Power," *American Journal of Agricultural Economics*, vol. 75 (1993), pp. 527-548.

As promising as the foregoing NEIO approaches may appear, they are not free from problems. To begin with, estimation of conduct using aggregate industry data, as is usually the practice, requires unrealistic assumptions about individual firm conduct. Besides, the functional forms of demand and cost functions used to identify market power are a maintained hypothesis. So, acceptance or rejection of price-taking behavior is not independent of the maintained hypothesis about the functional form. Approaches to testing market power not requiring such maintained hypotheses have been developed. Hall's<sup>161</sup> approach, for example, detects the absence or presence of market power by measuring the rate of growth in industry output relative to labor input. In its simplest form, Hall's approach asserts that, given a fixed capital stock, no technical change, and constant-returns-to-scale technology, the rate of growth in output is proportional to the rate of growth in the labor input. If the industry is competitive, the factor of proportionality should be equal to labor's share of total industry revenue. If the industry is an oligopoly, the gap between the factor of proportionality and labor's observed share is given by the ratio of price to marginal cost.<sup>162</sup> Unfortunately, results from nonparametric approaches are no better than the assumptions underlying their models. In Hall's case, the restrictive assumption of constant returns technology may be driving the test of market power.

Since the bulk of NEIO models identified so far are static, their relevance is open to question if (a) firms' strategies are guided by past behavior, (b) adjustments are costly, and (c) current demand depends on past demand.<sup>163</sup> So far, the enthusiasm for modelling dynamic behavior by game theorists has not been matched by many meaningful empirical applications.<sup>164</sup>

The link between conduct of incumbent firms and potential entry has yet to be established empirically. Tests confirming competitive conduct without a link to entry are not informative. It is plausible that such conduct is the outcome of strategic behavior of incumbents to deter entry.

In reflecting on the long trace of empirical examinations of market power, of which NEIO represents the latest strand, it would be a serious omission to fail to emphasize the importance of the contribution of both Chamberlin and Cournot to the foundations of empirical

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<sup>161</sup>Robert E. Hall, "The Relationship Between Price and Marginal Cost in U.S. Industry," *Journal of Political Economy*, vol. 24 (1988), pp. 921-947.

<sup>162</sup>Hall's approach has recently been used in an oligopsony setting by Charles Hyde and Jeffrey M. Perloff, "Can Monopsony Power be Estimated?" Presented paper at the Annual Meeting of the American Agricultural Economics Association, San Diego, CA, August 7-10, 1994.

<sup>163</sup>Perloff, *op. cit.* p. 16.

<sup>164</sup>There are some exceptions. See Larry S. Karp and Jeffrey M. Perloff, "Oligopoly in the Rice Export Market," *Review of Economics and Statistics*, vol. 71 (1989), pp. 462-470. The paper by Koontz, et al. on oligopsony in meatpacking is dynamic but not in the same sense as Karp and Perloff's. Meatpackers in the Koontz, et al. model engaged in what is essentially a repeated static game without adjustment.

IO research. As summarized by Hay and Morris, "Chamberlin provided a sophisticated classification of main and subsidiary forms of market structure and examined the theoretical relationships between, on the one hand, these different industrial structures and, on the other, the performance in terms of prices, profits, advertising, and efficiency that each generated. There is no doubt that Chamberlin provided the basis upon which economists, in particular Mason and Bain, could generate empirically-testable hypotheses about the structure-performance relationship that are at the heart of much current industrial economics."<sup>165</sup> However, it was Cournot's work, published almost a century before Chamberlin's, that provided a systematic treatment of oligopolistic interaction and a solution procedure for the resulting equilibrium. Cournot's work has, directly or indirectly, enriched empirical analyses by facilitating the development of conduct-based models on which much of the NEIO work is based.

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<sup>165</sup>Hay and Morris, *op. cit.*, p.12.

Chamberlin and Cournot also have enriched directly or indirectly the theory of oligopoly behavior. Chamberlin's treatment of "monopolistic competition," besides giving rise to empirical SCP, has been instrumental, along with later work by Lancaster,<sup>166</sup> in the development of theories of markets with differentiated products. Cournot's treatment of non-cooperative quantity-setting duopolists anticipated Bertrand's version assuming price rather than quantity as the strategic variable.<sup>167</sup>

Bertrand suggests that with price as the strategy variable, Cournot's oligopoly solution, in which price exceeds marginal cost, no longer applies. Bertrand predicts instead that firms will undercut one another until their prices are equal to each other and to marginal cost, thus defining a competitive industry equilibrium. This implies that where price is the strategic variable an industry with as few as two firms can be competitive. The result has been termed *Bertrand's paradox*.

The paradox set the stage for Edgeworth who recognized that although in theory a firm might lower price to the point where it can sell to the entire market, its production capacity may pose a constraint on its ability to do so. Firms with binding capacity constraints would have no incentive to cut prices to attract more consumers than they could serve. Edgeworth further contended that Bertrand's equilibrium is not an equilibrium at all; prices and profits will oscillate between Bertrand's equilibrium price and one which is more profitable. Edgeworth further reasoned that a firm could always raise prices in anticipation that its rivals will do the same, but that while its rivals follow the rise, they will not match it fully, setting off another round of price undercutting.

Hotelling,<sup>168</sup> in another attempt to resolve the *Bertrand paradox*, observed that the geographic distance between sellers and buyers invalidates the Bertrand equilibrium. For example, if firm 1 charges a price equal to marginal cost, its competitor (firm 2, located some distance away) can always charge a price above marginal cost as long as the difference is not

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<sup>166</sup>K. Lancaster, "A New Approach to Consumer Theory," *Journal of Political Economy*, vol. 74 (1966), pp. 132-157.

<sup>167</sup>J. Bertrand, "Revue de la Theorie Mathematique de la Richesse Sociale et des Recherches sur les Principes Mathematiques de la Theorie des Richesses," *Journal des Savant*, vol. 67 (1883), pp. 499-508.

<sup>168</sup>Hotelling, *op. cit.*

large enough to cause customers to travel to firm 1, thus giving firm 2 some market power. Hotelling's observation has been the impetus for much of the theoretical IO work on markets with spatially- differentiated products.<sup>169</sup>

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<sup>169</sup>The theory of imperfect competition in spatially-differentiated markets has yet to be exploited for testing market power in the meatpacking industry.

The Cournot and Bertrand oligopoly models formed the basis for Bowley's<sup>170</sup> theoretical work, which first introduced the concept of conjectural variation as a unifying index to parametrize alternative market structures. Years later, estimation of Bowley's conjectural variation was the purpose of Iwata's empirical work.<sup>171</sup> Cournot's oligopoly prototype is the basis for still other models of competition such as Stackelberg's leader-follower approach.

Game theory is another intellectual thrust, which was long ignored as were Cournot's ideas, and from which IO theory in general and Cournot-based oligopoly theory in particular have recently benefitted.<sup>172</sup> Developed in large part to study rational choice of a small number of players with unique but interdependent payoffs, it has proven well adapted to the study of oligopolistic markets. However, its contributions to IO are still largely theoretical.<sup>173</sup>

#### 4. Summary

Attempts to examine business conduct grew out of the case-study tradition rooted in the German Historical School. Mason and his students and followers built on this tradition and Chamberlin's pioneering work on oligopoly theory in initiating the SCP paradigm. Bain, Mason's prominent student, enriched the empirical content of the SCP approach with his pioneering inter-industry profit-concentration studies.

Demsetz exposed the Achilles heel of SCP studies when he observed that they may be detecting efficiency rather than market power. Stigler contended that an oligopoly theory which assumes conduct *a priori* as did SCP is not a satisfactory theory. Cowling and Cowling and Waterson built on Stigler's work, demonstrating the profit-concentration relationship can be derived from a conduct model in which firms take into consideration the reaction of rivals to their output decisions. Cowling and Cowling and Waterson modelled firm reactions or conduct by borrowing from the oligopoly model conceived by Cournot 100 years earlier. Clarke and

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<sup>170</sup>Arthur L. Bowley, *The Mathematical Groundwork of Economics* (Oxford: Oxford University Press, 1924).

<sup>171</sup>Iwata, *op. cit.*

<sup>172</sup>J. Von Neumann and O. Morgenstern, *Theory of Games and Economic Behavior* (Princeton, NJ: Princeton University Press, 1944). Credit for the link between game theory and the Cournot approach goes to Nash. J. Nash, "Non-cooperative Games," *Annals of Mathematics*, vol. 45 (1951), pp. 286-295.

<sup>173</sup>See Schmalensee, "Empirical Studies of Rivalrous Behavior," *loc. cit.*

Davies built on Cowling and Waterson's work by examining the joint determination of price-cost margins and concentration. Their theoretical results gave support to Demsetz's efficiency argument.

Iwata made the first attempt to quantify conduct by estimating the conjectural variation introduced by Bowley, who had built on the work of Cournot and Bertrand. Subsequent empirical attempts, structural and nonstructural, have evolved into what is now labelled as the New Empirical Industrial Organization. The essence of the structural models is to estimate a supply relation (often at the industry level) along with output demand and factor demand. Market conduct is estimated within the model rather than introduced as exogenous variables explaining performance as in the SCP work. Nonstructural models also search for market power but require less data and less *a priori* structure on functional forms of demand and cost. Structural or nonstructural, virtually all NEIO models are static and do not venture beyond the simple exercise of testing the presence or absence of market power.

## Mathematical Appendix

This appendix provides a brief algebraic summary of some of the theory and empirics of SCP and NEIO models of market power.

### Section A.1

The standard cross-section SCP regression looks something like this:

$$\Pi = \beta_0 + \beta_1 * H + \sum_{i=2}^k \beta_i z_i + \varepsilon, \quad (1)$$

where  $\Pi$  is some measure of profitability,  $H$  is a measure of concentration, the  $z_i$ 's are other control variables believed to affect the dependent variable,  $\beta$ 's are parameters to be estimated and  $\varepsilon$  is an error term. Observations correspond to different industries or temporally and/or spatially separated markets in the same industry. The center of attention in (1) is the estimate of the parameter  $\beta_1$ . A positive and significant  $\beta_1$  signals market power. The positive link between concentration and non-competitive conduct is a maintained hypothesis in (1).

### Section A.2

As shown by Cowling and Cowling and Waterson, relationship (1) is implied by the first-order condition for profit-maximizing firms who conjecture about the response of their rivals' outputs to the change in their own output. To demonstrate how, consider as Cowling and Waterson did, a homogeneous-product industry consisting of  $N$  firms facing a demand curve  $P(Q)$ , where  $Q$  is industry output. Firm  $j$ 's output is  $q_j$ . Total industry output is  $Q = \sum_{j=1}^N q_j$ . For simplicity, firms have identical cost functions  $C(q_j)$  and maximize profits

$$\pi_j = p(Q)q_j - C(q_j)$$

by choosing  $q_j$  according to the first order condition:

$$p \left\{ 1 - \frac{1}{\eta} \frac{q_j}{Q} (1 + \lambda) \right\} = c, \quad (2)$$

$$\eta = - \frac{dQ}{dp} \frac{p}{Q} > 0$$

where

is the market demand elasticity, and

$$\lambda_j = \frac{d(\sum_{i \neq j}^n q_i)}{dq_j}$$

is the  $j^{\text{th}}$  firm's "conjectural variation," or conjecture about the rate of response of the total output of its rivals to its own output, and  $c$  is marginal cost. The first-order condition (2) of the  $j^{\text{th}}$  firm may be rewritten as:

$$p \left\{ 1 - \frac{\beta_j}{\eta} \frac{q_j}{Q} \right\} = c. \quad (3)$$

where  $\beta_j = 1 + \lambda_j$ , and  $(q_j/Q)$  is the market share for firm  $j$ . From (3), the price-cost margin of the  $j^{\text{th}}$  firm is:

$$PCM_j = \frac{p - c}{p} = \frac{q_j}{Q} \frac{\beta_j}{\eta}. \quad (4)$$

In words, the price-cost margin of a firm is determined by its conjecture or conduct, its market share, and the market elasticity of demand. Multiplying (4) by  $(q_j/Q)$ , assuming identical conjectures  $\lambda_i = \lambda_j = \lambda$ , and summing over the  $N$  firms yields:

$$PCM = \frac{p - c}{p} = \frac{\beta H}{\eta}; \quad (5)$$

$$H = \sum_{j=1}^N \left( \frac{q_j}{Q} \right)^2$$

where

is the Herfindahl index of concentration. Hence, industry price-cost margin (performance) is determined by conduct  $\beta$ , concentration  $H$ , and elasticity of demand  $\eta$ . Equation 5 allows the description of alternative market structures. When  $\beta = 0$ , the market is perfectly competitive and price is equal to marginal cost a  $\beta = 1$  characterizes a Cournot-Nash solution, where the  $j^{\text{th}}$  firm believes the other firms' output will not change in response to a change to its own output, and the industry price-cost margin equals the ratio of the Herfindahl index to the elasticity of market demand. A value of  $\beta = Q/q_j$  implies collusive behavior or a monopoly solution, and the price-cost margin is equal to the inverse of the elasticity of market demand.

### Section A.3

Assuming a Cournot-Nash equilibrium and taking the log of (5) gives a logarithmic version (1):

$$\ln \Pi = \ln PCM = \beta_0 + \beta_1 * \ln H + \beta_2 \ln \eta + \varepsilon^* . \quad (6)$$

Lacking information on elasticities of demand across industries, one could assume them constant through time and estimate a version of (6) in difference form, thus eliminating  $\eta$ . Alternatively, one may estimate:

$$\ln \Pi = \ln PCM = \beta_0 + \beta_1 * \ln H + \varepsilon^* , \quad (7)$$

where  $\beta_1 = \beta/\eta$ . If  $\beta_0$  is not statistically different from zero, and  $\beta_1$  is positive and statistically significant, then, by SCP interpretation, higher concentration is responsible for higher price-cost margins.

#### Section A.4

Clarke and Davies point out, however, that the positive relationship suggested by (5) does not imply higher concentration **causes** higher price-cost margins. Their reasoning is that both concentration and profitability are jointly determined. To demonstrate how, Clarke and Davies assume differing marginal costs across firms, Cournot-Nash play, and solve for the  $j$ th firm's market share from the first-order condition shown in (3). This yields:

$$\frac{q_j}{Q} = \eta \left( 1 - \frac{c_j}{p} \right) . \quad (8)$$

Summing (8) across the  $N$  firms implies:

$$p = \frac{\eta \sum_{j=1}^N c_j}{1 - \eta N} . \quad (9)$$

Squaring (8) and again summing over the  $N$  firms gives an expression of the Herfindahl index:

$$H = \sum \eta^2 \left( 1 - \frac{c_j}{p} \right)^2 . \quad (10)$$

Substituting for  $p$  from (9) gives an expression for the Herfindahl index in terms of the number of firms,  $N$ , the market elasticity of demand,  $\eta$ , and the coefficient of variation of marginal costs across firms,  $\sigma_c^2$ :

$$H = \frac{1}{N} + \frac{(1 - \eta N)^2 \sigma_c^2}{N} . \quad (11)$$

Substituting the above expression into (5) and setting  $\beta = 1$  (Cournot-Nash), gives the price-cost margin also in terms of the number of firms, the elasticity of market demand, and the variation in marginal cost across firms:

$$PCM = \frac{1}{N\eta} + \left\{ \frac{(1-\eta N)^2}{N\eta} \right\} \sigma_c^2. \quad (12)$$

The significance of (11) and (12) is that, assuming Cournot-Nash play, both concentration and the price-cost margin are jointly determined by the same set of exogenous variables, making the SCP interpretation of one-way causality from H to PCM untenable. Interestingly, it is also consistent with Demsetz's efficiency argument that larger firms become more concentrated because of greater efficiency rather than non-competitive conduct. This is consistent with (11) and (12) since both concentration and PCM increase with the variations in the marginal cost of production.

Clarke and Davies also extended the structural models in (11) and (12) to Nash equilibria in other strategy variables by reparametrizing the conjectural variation in (2). They assumed the behavior of each firm is consistent with the expectation that its rivals' proportionate quantity responses will be a constant multiple  $\alpha$  of its own proportionate change. That is:

$$\frac{dq_i}{q_i} = \alpha \frac{dq_j}{q_j} \quad \text{for all } i \text{ NE } j. \quad (13)$$

Substituting this expression for the conjectural variation shown in (2) gives:

$$\lambda_j = \alpha \left( \frac{Q}{q_j} - 1 \right). \quad (14)$$

The term  $\alpha$  provides an index, between zero and one, of the degree of implicit collusion in the industry. A value of  $\alpha = 0$  implies Cournot conduct. A value of one implies a cartel solution. With this specification, the price-cost margin can be written as:

$$PCM = \frac{\alpha + (1-\alpha)H}{\eta}, \quad (15)$$

where the Herfindahl structural equation is now:

$$H = \frac{1}{N} + \frac{\{1 - N(\eta - \alpha)/(1 - \alpha)\}^2 \sigma_c^2}{N}. \quad (16)$$

Setting  $\alpha = 0$  gives the same expression as (5) with Cournot conduct. Also, as  $\alpha$  approaches unity a cartel solution is obtained in which case only the elasticity of demand drives monopoly power. So, a cartelized industry in a market with a high elasticity of demand has negligible market power.

## Section A.5

A major thrust of much of what has become known as the New Empirical Industrial Organization (NEIO) is the identification and estimation of conduct parameters such as  $\alpha$ , but on an individual industry level. This has proceeded in one of two ways. One way, known as calibration, is to infer the degree of collusion ( $\alpha$  in (15)), by plugging in data on market elasticity of demand, industry profitability, and concentration and solve for the value of  $\alpha$ . The other is to use observed industry data on prices, outputs, and costs, and econometrically estimate a structural model in which an estimate of conduct is obtained.

The empirical version of conduct in most structural econometric models is the conjectural elasticity rather than conjectural variation:

$$\theta_j = \frac{dQ}{dq_j} \frac{q_j}{Q}.$$

This allows (2) to be rewritten as:

$$p \left\{ 1 - \frac{\theta_j}{\eta} \right\} = c. \quad (17)$$

Multiplying this expression through by the firm's market share  $q_j/Q$  and summing across the  $N$  firms gives the estimating supply relation:

$$p = \frac{\theta}{\eta} p + c + e, \quad (18)$$

where  $\theta$  is a weighted average of the individual firms' conjectural elasticities,  $c$  is industry marginal cost, and  $e$  is an error term. If marginal cost is allowed to vary across firms then  $c$  could be considered also as a weighted average of individual firm marginal costs.

The ratio in the first term on the right-hand side of (18) is another expression for the price-cost margin, otherwise known as the index of market power or gap between price and marginal cost. By specifying a cost function (usually Leontief), an explicit expression for  $c$  is appended to (18). Share equations and a demand equation are usually added to construct a structural econometric model with cross-equation restrictions. The structural model gives empirical estimates of  $\theta$  and  $\eta$ . This provides an (average) indirect estimate of the price-cost margin, and bypasses the measurement problem of constructing a price-cost margin from published data on prices and costs as is done traditionally. Identifying market power by direct estimation of marginal cost in a relationship like (18) is only one of several ways used in the literature. the other identification techniques are discussed later in the chapter.



## CHAPTER IV

### EMPIRICAL TESTS OF MARKET POWER IN THE MEATPACKING INDUSTRY: A TAXONOMY OF SCP STUDIES AND THEIR FINDINGS

#### 1. Introduction

The studies of market power in the meatpacking industry reviewed in this chapter all employ the structure-conduct-performance paradigm (SCP) or Bainian approach discussed in Chapter III. The hallmark of this approach is the use of regression models relating various alternative measures of market performance to structural and other industry characteristics. Models are estimated using data from cross-sections of industries or markets. If the study addresses the issue of monopoly power, as most SCP analyses do, the dependent variable is often either price or the price-cost margin, while the key explanatory variable is industry concentration. A finding of a significantly positive concentration coefficient means concentration facilitates implicit or explicit coordination among firms, resulting in increasingly monopoly-like performance as industries become more concentrated.

SCP studies of the meatpacking industry typically differ in some respects from Bain's seminal work and that of most of its descendants. The papers reviewed here focused for the most part on monopsony power in livestock procurement markets. The regression models often used livestock price as their relevant performance index. They sometimes used variations of concentration such as the number of bidders in an auction market or number of bids received at a given feedlot as their explanatory variable. Most of the data were focused on geographically-segmented cattle markets within the same industry as opposed to the inter-industry analyses characteristic of Bain's original work. The basic approach of the studies, however, is faithful to the SCP tradition.<sup>174</sup>

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<sup>174</sup>A number of cross-industry structure-performance studies where meatpacking was but one of several food processing industries under study predate the single-industry meatpacking studies reviewed here. A classic example is the 1960 study by Lee F. Schrader and Norman R. Collins, "Relation of Profit Rates to Industry Structure in the Food Industries," *Journal of Farm Economics*, vol. 42 (1960), pp. 1526-1527.

Several previous surveys of the meatpacking SCP literature have been conducted in one form or another. Ward,<sup>175</sup> for example, summarized the specifications and findings of several studies, as have Roswell<sup>176</sup> and the authors of a GAO report.<sup>177</sup> Quail, et al.,<sup>178</sup> summarized and critiqued a number of studies preceding and relevant to their work. Though useful, these prior surveys emphasized differences in specification, estimation, conclusions, and implications of SCP studies alone. Generally lacking was a broader synthesis of their findings and those of NEIO studies.

In that light, the present chapter and the one to follow have parallel objectives; they provide, respectively, a taxonomy of SCP and NEIO meatpacking literature and highlight the findings. The results provide the basis for a synthesis of SCP and NEIO findings in chapter V, including discussion of their theoretical and empirical strengths and weaknesses. Finally, chapter VI summarizes what has been learned from the entire body of literature and draws conclusions about the state of competition in the meatpacking industry.

The studies in the present chapter are organized in 10 sections. Sections 2 through 4 describe studies whose performance indices were, respectively, marketing margins, profits, and productivity. Section 5 discusses six subclasses of livestock price-concentration studies: aggregate price models, transaction price models, price and plant-exit models, plant ownership models, spatial price-linkage models, and price transmission asymmetry models. Section 6 reviews studies emphasizing relevant market definition. Section 7 reviews price-vertical integration models. Studies of meatpacking size economies are surveyed in section 8. A single analysis of firm growth is summarized in section 9. The final section (10) provides a summary. The reviews are ordered to correspond with entries in a final summary table at the end of the chapter.

## 2. Price Spreads and Concentration

In a multistage food marketing channel, a price spread or "marketing margin" for a specific food item is roughly the difference between price at one stage and price at some other, perhaps adjacent, stage. In the meat industry, the conventionally-represented tags are retail, wholesale, and farm. Concerns about imperfect competition within marketing channels are often

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<sup>175</sup>Clement E. Ward, *Meatpacking Competition and Pricing*, (Blacksburg, VA: The Research Institute on Livestock Pricing, 1988).

<sup>176</sup>John B. Roswell, "Annotated Bibliography," in Wayne Purcell, ed., *Pricing and Coordination in Consolidated Livestock Markets, Captive Supplies, Market Power, IRS Hedging Policy* (Blacksburg, VA: The Research Institute on Livestock Pricing, 1990) pp. 133-198.

<sup>177</sup>U.S. General Accounting Office, "Beef Industry: Packer Market Concentration and Cattle Prices," (Washington, D. C.: Government Printing Office, 1990).

<sup>178</sup>Gwen Quail, Bruce Marion, Frederick Geithman, and Jeffrey Marquardt, *The Impact of Packer Buyer Concentration on Live Cattle Prices*, NC 117 Working Paper No. 89 (Madison: University of Wisconsin, 1986).

prompted by widening margins between the different stages. In theory, a margin signals imperfect competition at a particular stage if it exceeds the marginal cost of the transformations occurring at that stage. The competitiveness of price spreads has been the subject of SCP work reported below as well as some NEIO studies summarized in Chapter V. Both wholesale-retail and farm-wholesale margins are represented in the three SCP margin studies below:

### **2.1. Wholesale-retail**

**2.1A.** Hall, et al. published the first SCP study of market power in the US Beef Retailing Industry in 1979.<sup>179</sup> An Error Component Model was used to estimate the relationship between wholesale-retail margins and concentration of the top four chain stores and retail store wage rates. Sample data spanned 19 standard metropolitan statistical areas over 7 years (1967-1973). The authors' margin model was based on that of Cowling and Waterson<sup>180</sup> which was reviewed in Chapter III. A 10-percent increase in concentration of the top four food chains was associated with a 4-percent increase in margins, a 10-percent increase in wage level with a 4-percent increase in margins.

**2.1B.** Concentration's impact on spreads was among several topics of a larger 1980 report written for the House Committee on Small Business by Multop and Helmuth (MH).<sup>181</sup> Beef carcass-retail margins were regressed on meatpacker rather than retailer concentration. Packer-buyer concentration was hypothesized to measure packer power over the retail value of beef. Using quarterly data from 1969 to 1978, the authors obtained Ordinary Least Squares (OLS) estimates of the influence on margins of concentration, wage rate, interest rate, and steer price. The interest rate alone had a weak link to margins. A positive and statistically significant relationship between concentration and margins was found.

### **2.2. Farm-wholesale**

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<sup>179</sup>Lana Hall, Andrew Schmitz, and James Cothorn, "Beef Wholesale-Retail Marketing Margins and Concentration," *Economica*, vol. 46 (1979), pp. 295-300.

<sup>180</sup>Keith Cowling and Michael Waterson, "Price-Cost Margins and Market Structure," *Economica*, vol. 43 (1976), pp.275-286.

<sup>181</sup>John R. Multop and John W. Helmuth, *Relationship Between Structure and Performance in the Steer and Heifer Slaughter Industry*, U.S. House of Representatives Committee on Small Business, (Washington, D. C.: Government Printing Office, 1980), pp. 32-36.

**2.2A.** Building on the Hall, et al. work, Ward<sup>182</sup> tested for the effect of beefpacker and porkpacker concentration on both beef and pork farm-carcass margins. Each equation included commercial production in addition to concentration and wages. Commercial production proxied for the cost of marketing services. Using annual observations (1972-1985), the author employed OLS to estimate the margin-concentration relationship. Results for beef failed to support the relationship. Concentration in beefpacking narrowed the farm-carcass margin, leading Ward to conclude his findings lend support to "the argument that larger firms tend to be more efficient, and thereby gain market share from smaller firms."<sup>183</sup> Increases in the wage rate widened the beef margin, but increases in marketing costs narrowed it. Ward suggested the latter result "may reflect lower costs per head as slaughter volume expands." Increases in wages and marketing costs affected the pork farm-carcass margin but concentration did not.

### 3. Profits and Concentration

**3.A.** Determining the effect of structure on profitability at the industry and firm level was the subject of Ward's 1988 meatpacking study.<sup>184</sup> Two indices of industry profitability for the 1974-1985 period were generated from data from the American Meat Institute (AMI) and *Forbes* magazine. An additional index, the price-cost margin, was created from the 1958-1982 Census of Manufacturers data. OLS estimates indicated no association between concentration and profits in total meatpacking. Results using AMI data by species also showed no relationship between concentration and profits in either beefpacking or porkpacking.

Returns to equity for individual meatpackers, as reported by *Forbes*, were pooled and regressed for each year, 1979-1986, on type of operation (beef, pork, or poultry) and the firm's sales rank. The results again showed weak association between firm size and profitability.

### 4. Productivity and Concentration

**4.A.** Focusing on the meatpacking industry in the only known such study, is Ward's 1987 report<sup>185</sup> of implications of concentration for productivity in meatpacking. This work, based on methods developed by Lustgarten<sup>186</sup> and Peltzman,<sup>187</sup> regressed total factor productivity against

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<sup>182</sup>Clement Ward, *op. cit.*, pp. 147-150.

<sup>183</sup>*Ibid.*, pp. 140-141.

<sup>184</sup>*Ibid.*, p. 193.

<sup>185</sup>Clement E. Ward, "Productivity-Concentration Relationship in the U.S. Meatpacking Industry," *Southern Journal of Agricultural Economics*, vol. 19 (1987), pp. 217-222.

<sup>186</sup>Steven H. Lustgarten, "Gains and Losses from Concentration: A Comment," *Journal of Law and Economics*, vol. 22 (1979), pp. 183-90.

<sup>187</sup>Sam Peltzman, "The Gains and Losses from Industrial Concentration," *Journal of Law and Economics*, vol. 20 (1977), pp. 229-264.

four-firm concentration (CR4) and dummy variables representing, respectively, periods of increasing and decreasing concentration. A series of equations were fitted using, alternatively, CR4, CR8, CR20, and CR50, and covered alternative time periods. The dummy variables were used for timing points keyed to concentration changes over the 25-year period, 1958-82 (decreasing -- 1958-77; increasing -- 1978-82). Both labor and total factor productivity were used as dependent variables in separate regressions.

Real output in meatpacking increased at an annual average rate of 1.5 percent, total factor productivity increased by 2.4 percent per year and labor productivity by 3.3 percent per year over the period of study. Ward had expected to find that larger firms were more efficient owing to size economies as theorized by the Chicago School. No significant association between productivity and concentration was found, none of the coefficients on the turning-point dummy variables being significant.

## 5. Livestock Prices and Concentration

The gridlock over the efficiency versus-market power interpretation of SCP profit-concentration studies led some researchers to substitute output price for profit as the dependent variable. A positive price-concentration relationship is consistent with oligopoly theory and seemingly immune from interpretation problems (see chapter III).

SCP studies of meatpacker concentration have most often employed price as the dependent variable. Since meatpacking studies have generally explored market power in factor markets (mostly live animals),<sup>188</sup> the dependent variable is livestock prices. These studies might well be called livestock cost-concentration studies since livestock is a factor cost to the packer.

Livestock price-concentration regressions have been estimated with a variety of variables, but buyer concentration has been the center of attention. Analysts invariably regard negative and statistically significant correlations between concentration and livestock prices as indication of an oligopsony markdown. The coefficient on concentration is often used to calculate welfare losses to livestock producers. This implies the estimate measures the gap between what livestock producers receive and what they should have received had the market been less concentrated.

Six types of livestock price-concentration models were identified in the literature: aggregate price models, transaction price models, price and plant-exit models, plant ownership models, spatial price-linkage models, and price transmission asymmetry models. Aggregate price models were estimated at national, regional, and state levels. Transaction price models use data

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<sup>188</sup>Market power issues involving other factors of production, such as labor, employed by packers, have sparked interest among some sociologists. See, for example, Lourdes Gouveia, "Global Strategies and Local Linkages: The Case of the U.S. Meatpacking Industry," University of Nebraska-Omaha, 1991 (mimeo), and Lourdes Gouveia, "Immigrant Labor in the Internationalization of Meat Processing," in Alessandro Bonnano, ed., *The Agricultural and Food Sector in the New Global Era* (New Delhi: Concept Publishers, forthcoming).

from auctions or sales of individual lots of livestock. Exit-price models calculate relative price changes in a local livestock market following exit of firms or plants from the market. Plant ownership models look at price impacts of ownership of multiple plants within the same region. Spatial price-linkage models search for concentration impacts on spatial and temporal co-movements of livestock prices across different markets. The price transmission asymmetry model's goal was measurement of concentration's impacts on co-movements of prices at different stages of the marketing channel within a market and through time.

### **5.1. Aggregate Price Models**

Industry-level average prices and aggregate quantity data were used. Concentration was measured in a variety of ways: CR4, Herfindahl index, or number of plants. The geographic scope varied from national to regional to state. One study used a 23-state, weighted-average, 4-firm concentration ratio as a structural measure.

#### **5.1.1. National Level**

**5.1.1.A.** Multop and Helmuth's beef margin-concentration study (section 2.1.B)<sup>189</sup> also examined steer price impacts of buyer concentration. Quarterly steer prices for 1969-78 were regressed against national packer CR4, 23-state CR4, the top firm's market share, the second ranking firm's market share, and a series of supply and demand variables. National packer concentration was associated with higher rather than lower prices. Large feeders received higher prices than did smaller ones. A major concern with the results has been the use of national concentration data.

#### **5.1.2. Regional Level**

**5.1.2.A.** Testing for oligopsony in beefpacking at the regional level was the aim of a 1986 study by Quail, et al.<sup>190</sup> Fed-cattle prices were regressed on CR4 (alternatively CR3 and Herfindahl Index), labor cost, market type (terminal or direct sale), distance from packing plant, feedlot size, plant size, deficit/surplus percent, presence of IBP, relative degree of instability of top four firms, Midwest carcass price and time dummies. The resulting cross-section, time-series regression was modeled in both OLS and Generalized Least Squares (GLS) forms. The data base extended over the period 1971-80 and across 14 geographic regions.

Cattle prices were negatively related to concentration. Regions with the lowest CR4 levels during 1976-80 tended to be regions with moderate slaughter volumes. Significantly higher prices were paid for cattle in the lower- than in the more-concentrated regions. Lower levels of concentration and higher cattle prices in the larger regions could apparently be achieved with little if any sacrifice in operational efficiency. Three small-volume regions appear to have both suboptimal-size plants and high market concentration. Concentration had a larger effect on live cattle prices in the major producing regions than in the fringe regions. Feedlot size was

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<sup>189</sup>Multop and Helmuth, *op. cit.*, pp. 16-26.

<sup>190</sup>Quail, et al. *op. cit.*

significant and positive in 10 of the 11 equations in which it was used, suggesting the presence of large-feedlot countervailing power. Remaining variables gave inconsistent results.

**5.1.2.B.** Marion and Geithman's<sup>191</sup> 1995 study was a refinement the work of Marion, et al.'s<sup>192</sup> 1990 work and a further extension of a 1986 beefpacking study by Quail, et al.<sup>193</sup> Major industry restructuring was occurring over the span of time covered by the study, including declining demand for beef, increasing prices, growing excess industry capacity, and ongoing rivalry among packers to obtain supplies sufficient to take advantage of expanding economies of scale.

National 4-firm concentration increased from 29 percent during the first years of the study to 67 percent at its conclusion in 1987. The average regional CR4 had reached 85 percent by 1986. Eight different regression models were run, using pooled cross-sectional (regional) time-series (1971-1986) data. Fed steer prices were regressed against concentration (variously CR4, 1/CR4, and Herfindahl Index), feedlot size (percent of cattle coming from feedlots of 1,000 head or more capacity), packer costs (wage rates, plant size binary, and distance to either Los Angeles or New York City), terminal dummy (to identify the four regions for which *Market News* prices were available and national supply/demand (annual average carcass price and yearly dummy variables). Data relate to the 13 regional markets identified by Williams;<sup>194</sup> 7 of the markets were the focus of most of the study. Beefpacking concentration was found to be negatively related to live cattle prices. Prices in the most concentrated region were about 3 percent less than those in the least concentrated one. Highest levels of concentration significance were found in models in which the annual dummies were included. All concentration measures were negative and highly significant in these models. The Herfindahl Index and inverse CR4 were somewhat more significant than CR4. Feedlot size was significant and positive, suggesting, once again, countervailing power. The cost variables were not significant, nor was the terminal market dummy. Plant economies were unexpectedly negative. CR4 coefficients were higher for 1979-86 than for the 1971-78 period, providing evidence of price effects from increasing concentration over time.

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<sup>191</sup>Bruce W. Marion and Frederick E. Geithman, "Concentration-Price Relations in Regional Fed Cattle Markets," *Review of Industrial Organization*, vol. 10 (1995), pp. 1-19.

<sup>192</sup>Bruce W. Marion, Frederick E. Geithman and Gwen Quail, *Monopsony Power in an Industry in Disequilibrium: Beef Packing, 1971-1986*, Working Paper No. 96 (Madison: University of Wisconsin, 1990).

<sup>193</sup>Quail, Marion, Geithman, and Marquart, *op. cit.*

<sup>194</sup>Willard F. Williams, "The Changing Structure of the Beef Packing Industry," in *Hearings Before the Committee on Small Business of the House of Representatives, Small Business Problems in the Marketing of Meat and Other Commodities*, Part 4 (Washington, D.C.: Government Printing Office, 1979).

Effects of alternative time periods (a major price break occurred between 1977 and 1979) were explored by splitting the data into shorter subsets. Change in CR4 was included as a short-term "rivalry variable" in one equation to test the hypothesis that firms may sacrifice short-term profits to increase their market shares. Higher prices were paid in years when market shares of leading firms were increasing, offering evidence that firms do forego short-term profits in efforts to build their market shares.

Further regressions were run, adding variables representing ranges of CR4, to test the question of whether there is a critical level of CR4 at which price effects begin to be felt. No significant price effects were identified until 60 to 65 percent concentration was reached, at which level cattle prices dropped abruptly.

Regressions using the ratio of live cattle prices to wholesale beef prices as the dependent variable yielded negative and significant CR4 and 1/CR4 results. Feedlot size in these models again was positive and significant. Annual dummies again improved the results.

**5.1.2.C.** Similarly, Heyneman<sup>195</sup> examined the price implications of changing concentration in hog slaughter in seven regional markets in the eastern U.S. over the period 1977 through 1989. The starting point was an oligopsony Lerner Index, where the output price-cost margin is replaced with the factor price-net marginal value product margin, the Herfindahl Index (H) of seller concentration with that of buyer concentration, demand elasticity with supply elasticity, and output quantity conjectures with factor quantity conjectures. From the Lerner Index, Heyneman derived a relation showing the equality of the factor price with a weighted (distorted) net marginal value product of the factor. The distortion decayed as either the supply became more elastic, H approached zero, or conduct, as measured by the conjectural variation, became more competitive.

Arguing that some of the variables suggested by theory "are difficult to obtain," Heyneman reverted to a reduced-form, price-concentration model similar to that used in the foregoing regional beef studies. The model regressed, alternatively, CR4 and H against annual prices for finished hogs. A series of control variables was employed, including packer operating costs (hourly packing wages), a surplus-deficit measure of regional hog supplies, the percent of slaughter capacity utilized, average Midwest wholesale price for pork, lagged slaughter hog price, marketing and distribution cost, and average size of hog-producing operations. Entry barriers were assumed to be "generally correlated with the level of concentration" and therefore not in need of explicit modeling. Regional hog supply is also a proxy for entry barriers since the size of the market is a measure of the scope for new entry. All but three of the control variables were significant, and the equation explained 96 percent of price variation. The authors concluded that there was a significant negative relationship between regional hog prices and hog slaughter concentration (measured as CR4). The price of hogs was expected to decline by 37 cents per hundred weight (cwt) for each 10-percent increase in concentration. Heyneman

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<sup>195</sup>Charles Matthew Heyneman, *Changing Buyer Structure and Its Impact on the Performance of the Market for Finished Hogs*, unpublished M.S. Thesis (Madison: University of Wisconsin, 1992).

acknowledged that some of the price differences may have been occasioned by differences in packer efficiency in small relative to large regions.

### 5.1.3. State Level

**5.1.3.A.** In 1981, Menkhaus, et al.<sup>196</sup> fitted a single-equation model using cross-section data covering 12 state-level areas for 1972, and 15 for 1977, in a test of implications of beefpacker buyer concentration for fed cattle prices. Market prices of fed cattle were regressed against packer concentration (state-level packer CR4), deflated average wage of packing plant workers, deflated annual average choice steer beef carcass price, and average size of feedlot. Two equations were fitted using OLS, one for 1972, and one for 1977. Each explained 79 percent of price variation, but the significance of the results was mixed. Packer concentration had a significant negative impact on fed cattle prices in each of the 2 years. The feedlot-size variable was positive and significant for 1977, perhaps an indication of countervailing power, according to the authors. The authors recognized that state-level data may not adequately conform to actual market boundaries. They also noted that formula pricing of beef and a growing shift to boxed beef production may have impaired the explanatory power of the beef price variable.

**5.1.3.B.** Miller and Harris<sup>197</sup> tested monopsony power in hog markets with a 1978 cross-section of state-level data. As in the previous model, the key variable was the state-level concentration ratio. Control variables included type of market (direct, terminal, auction), hog supplies, average wage rate as a proxy for packer cost, and density of hog marketings as proxy for packer procurements and assembly costs. The hog price-concentration coefficient was significant and robust under three different measures of concentration.

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<sup>196</sup>Dale J. Menkhaus, James S. St. Clair, and A. Zahedi Ahmaddaud, "The Effects of Industry Structure on Price: A Case in the Beef Industry," *Western Journal of Agricultural Economics*, vol. 6 (1981), pp. 147-53.

<sup>197</sup>Steve E. Miller and Hal M. Harris, "Monopsony Power in Livestock Procurement: The Case of Slaughter Hogs." Paper presented at SAEA Annual Meeting, Atlanta, Georgia, 1981.

**5.1.3.C.** Results of a study on the impacts of structural changes in the lamb slaughtering industry on lamb prices were reported by Menkhaus, et al. in 1990.<sup>198</sup> Deflated annual average lamb prices were regressed against number of head of lambs and sheep slaughtered, nominal East Coast (or Los Angeles) wholesale lamb prices divided by nominal plant wages, number of plants, and packer lamb feeding as a percent of lambs marketed. Wholesale carcass prices and plant wages were structured as a ratio variable to deal with collinearity problems. Plant numbers were used instead of concentration. State-level data from 1972 through 1985 were used in a series of five OLS regressions. Separate regressions compared prices over time within one state. Packer feeding had a positive effect on lamb prices in three of the four states under study, although the effect was relatively minor and the authors suggested that the true effects may have been short-period -- daily or weekly -- and therefore not picked up in their analysis. The findings may suggest that a smoothing of the flow of slaughter lambs rather than controlling market prices is the motivation for packer feeding. The plant numbers variable gave inconsistent results. In one state only, market prices were significantly higher (by \$5.03/cwt) when a few as opposed to only one buyer were present. The authors conclude there was "limited evidence" that one or a few buyers may have paid less than where there was a larger number of buyers.

## **5.2. Transaction Price Models**

In contrast to aggregate price models, prices here are examined at points of direct contact between individual sellers and buyers rather than at the industry level. Buyer concentration in most cases is measured by the number of bidders or bids received by the seller. Individual feedlots and auctions are the two principal sources of information used to obtain transaction prices. Since they also address the issue of monopsony power, the key coefficient is the one relating the number of bids or bidders to the transaction price. The idea behind the transaction price model specification is that the purchase price is directly related to the number of bids. The idea may be consistent with SCP models which relate performance to the number of buyers in the market, and with theoretical bidding models. In both types of models, the buyer's objective is to extract the maximum surplus from the seller. The degree of surplus extraction may then be a function of the number of buyers or bidders.<sup>199</sup>

### **5.2.1 Lot Level**

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<sup>198</sup>Dale J. Menkhaus, Glen D. Whipple, and Clement E. Ward, "Concentration in the Lamb Slaughtering Industry: Impact on Lamb Prices," *SID Sheep Research Journal*, vol. 6 (1990), pp. 25-29.

<sup>199</sup>See DeeVon Bailey, B. Wade Brorsen, and Chris Fawson, "Buyer Concentration at Feeder Cattle Auctions," *Review of Agricultural Economics*, vol. 15 (1993), pp. 103-119.

**5.2.1.A.** A 1981 paper by Ward<sup>200</sup> is the first SCP study of the industry using cattle prices at the transaction level. Short-term live cattle prices were regressed on *National Provisioner* carcass prices, near-term futures market price, variables describing cattle characteristics, variables reflecting "individualized supply conditions," and variables reflecting competitive conditions. The latter were measured by number of bids, bidders, and bid ranges. The number of both bidders and bids was on the decline in the early 1980s, according to a USDA survey. Producers marketed the majority of their livestock to a single buyer.<sup>201</sup> Three different OLS regression models were formulated from actual daily transactions data obtained from 26 commercial feedlot operators in Texas, Oklahoma, and Kansas, and from "three marketing agents representing cattle feeders" in Nebraska and Iowa during July 1979. Twelve separate equations were fitted for three variations in the model, and four area-sex combinations. Wholesale carcass price and futures price explained the greater part of the variation in live cattle prices. The number of packers bidding was significant and positive in one equation in each of three models; the number of bids per lot was significant in one equation. The negotiating range was negative and significant in one equation, suggesting that competitively-narrowed trading ranges may lead to higher prices.

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<sup>200</sup>Clement E. Ward, "Short-Period Pricing Models for Fed Cattle and Impacts of Wholesale Carcass Beef and Live Cattle Futures Market Prices," *Southern Journal of Agricultural Economics*, vol. 13 (1981), pp. 125-132.

<sup>201</sup>Julie A. Hogeland, *Market Access in an Era of Structural Change in the Livestock Industry*, Agricultural Cooperative Service (Washington, D.C.: USDA, 1988).

**5.2.1.B.** Using the same data set as in the foregoing study, Ward<sup>202</sup> switched focus to the impact of individual packer-buyers on cattle prices. Slaughter cattle price was regressed on buyer identification dummy variables, a trend variable, and controls for expected cattle grade, yield, and carcass size. The hypothesis was that larger buyers pay higher prices than their smaller competitors, although why this should be expected is not clear. While the larger buyers might be able to set the pace for the smaller buyers, both would seem in fact likely to pay about the same price for an undifferentiated product. Price differences were not associated with buyer size.

**5.2.1.C.** In a 1992 study, Ward reported findings on determinants of inter-firm differences in fed cattle prices in the Southern Plains.<sup>203</sup> Daily data for each lot sale were collected from 173 feedlot managers for the month of June 1989. The OLS regression framework again had fed cattle transaction prices as the dependent variable. Independent variables included boxed beef cutout value (lagged one day), live cattle futures price, sex, estimated percent choice grade, day-of-week dummies (Monday base), number of head in the lot, number of buyers bidding, number of days between purchase and delivery, individual buyer identification dummy, and a "Big-Three" buyer identification variable. Most of the variables were significant and had the expected signs. Lot size was not significant. Number of buyers was significant as were the "firm" variables, although their interpretation is not clear. Different firms did pay different prices, although why this is the case is not self evident. Prices were highest when the number of buyers was also greatest. The largest three buyers (Big Three) as a group had 83 percent of the market and paid significantly lower prices than did their competitors (between 17 and 26 cents/cwt less). There were, however, significant price differences within the Big Three. Ward concluded that "the relevant geographic market within which to study impacts of structural change in the cattle-beef subsector remains unclear." He noted, however, that sub-regional markets do have relevant detail that is masked in more aggregated definitions of spatial markets, detail which may reveal important market differences.

## **5.2.2. Auctions**

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<sup>202</sup>Clement E. Ward, "Relationship Between Fed Cattle Market Shares and Prices Paid by Beefpackers in Localized Market," *Western Journal of Agricultural Economics*, vol. 7 (1982), pp. 79-86.

<sup>203</sup>Clement E. Ward, "Inter-Firm Differences in Fed Cattle Prices in the Southern Plains," *American Journal of Agricultural Economics*, vol. 74 (May 1992), pp. 480-485.

**5.2.2.A.** A lambpacking study using transaction-level prices was published by Ward<sup>204</sup> in 1984. It addressed the implication of lambpacking market structure for gross margins and lamb prices. Price data were individual transactions from a tele-auction which operated in Oklahoma from March 1979 through February 1982. OLS price regressions, lamb prices against packer firm market shares, and other control variables were used in attempting to better understand what drives prices. Independent variables included a time trend, seasonal dummy, New York carcass price, pelt price, number of packers bidding on each lot, and a large/small buyer dummy.

A second model regressed packer gross margins against time trend, seasonal dummy, size dummy, and number of buyers. Margins were calculated by subtracting the sum of lamb price and freight costs from the sum of carcass and pelt values.

A third model regressed price differentials between tele-auction and San Angelo, Texas, markets against trucking costs between the markets and the number of tele-auction buyers.

Major findings were that price but not gross margins increased with number of buyers. Transportation costs appear to be the only element of cost variation in the model. Margins would therefore seem to be essentially the same variable as price after accounting for transportation. Price differences between the tele-auctions at San Angelo widened in favor of the tele-auction as tele-auction competition increased. The largest buyer paid significantly higher prices than did the smallest buyer. Why this should be so is not clear. Ward recognized that some packers may simply have more skilled buyers and concluded that absolute rather than relative buyer size may have been the source of the effect.

### **5.3. Price and Plant-Exit Models**

Price and plant-exit models are to some degree an exercise in equilibrium comparative statics in which the dependent variable is livestock price and the exogenous shock is exit of plants or firms. However, applications of the model go a step further and, because of changes in market shares, infer imperfect competition from price behavior changes accompanying the shock. Price declines following exit are taken to imply noncompetitive conduct.

**5.3.A.** The earliest effort was Love and Shuffett's<sup>205</sup> 1965 analysis of price implications of the withdrawal of one of two major hog buyers from the Louisville, Kentucky, terminal

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<sup>204</sup>Clement E. Ward, "An Empirical Study of Competition in the Price Discovery Process for Slaughter Lambs," *Western Journal of Agricultural Economics*, vol. 9 (1984), pp. 135-144.

<sup>205</sup>Harold G. Love and D. Milton Shuffett, "Short-Run Price Effects of a Structural Change in a Terminal Market for Hogs," *Journal of Farm Economics*, vol. 47 (1965), pp. 803-812.

market. This left the remaining firm in a clearly dominant position. The authors compared price differences between Louisville and two control markets (Indianapolis and Chicago) before and after the structural change. Hog prices declined relative to those in the control markets after the "power position in the terminal shifted to that of dominant firm." The price decline was attributed to noncompetitive conduct by the remaining dominant firm.

**5.3.B.** Dobbins<sup>206</sup> explored in 1973 the effects of exit and entry of plants on hog prices in St. Louis. Data covered the period 1969-1972. Relative weekly hog prices during the opening and the closing of the plants were compared to those in a control period. The hypothesis was that hog prices would decline following the exit of an existing plant and rise after entry of a new one. Results did not support the hypothesis.

**5.3.C.** The effects of plant closings on producer hog prices were also explored by Hayenga, Deiter, and Montoya<sup>207</sup> in 1986. Hog prices were compared before and after the closures in both local and control areas. OLS regressions with binary indicator variables were used in testing for price effects over a series of bi-weekly intervals following plant closures. Results showed generally no ongoing effects of plant closings (or reopenings) on hog prices. The authors noted that there have been further closings since the study was made, and that multiple closings might yield different effects.

**5.3.D.** In 1983, Ward<sup>208</sup> explored the effects of the closing of a porkpacking plant on hog prices in Oklahoma. The largest packer in the state closed its only plant in August 1981. Weekly price differences were measured between the Oklahoma terminal market and three comparison markets in Kansas City, Omaha, and interior Iowa-Southern Minnesota. Data were from the year prior to and following the plant's closure. Price differences were regressed against saleable hog receipts, a time trend variable, a seasonal dummy, and a zero-one/before-after plant-closure dummy. The Oklahoma City market benefitted relatively less from a rising market following the plant's closure than did the comparison markets; the increase was \$5.09 to \$5.51 per cwt. at comparison markets, only \$4.46 at Oklahoma City.

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<sup>206</sup>Kenneth Dobbins, *Short-Run Price Effects of a Change in the Buying Structure for Hogs at a Terminal Market*, unpublished M.S. Thesis (Columbia: University of Missouri, 1973).

<sup>207</sup>Marvin L. Hayenga, Ronald Deiter and Cristobal Montoya, "Price Impacts Associated with the Closing of Hog Slaughtering Plants," *North Central Journal of Agricultural Economics*, vol 8 (1986), pp. 237-242.

<sup>208</sup>Clement E. Ward, "Price Impacts of a Structural Change in Pork Processing: A Case Study in Oklahoma," *Current Farm Economics*, vol. 56 (1983), pp. 3-9.

#### **5.4. Plant-Ownership Models (POM)**

This research addresses the price impacts of structure as measured by the number of plant owners as opposed to the number of plants. The hypothesis is that plants under one ownership within a region are expected to limit competition in cattle procurement.

**5.4.A.** Hayenga and O'Brien<sup>209</sup> examined, among other things, the competitive implications of plant ownership using data from five states (Colorado, Kansas, Nebraska, Iowa, and Texas). The reference setting was Colorado, with other states as comparisons, following the loss of six out of the state's eight slaughter plants. In initial tests, Colorado fed cattle prices relative to those in the average of eight nearby states were regressed against annual plant ownership and seller concentration variables. Specific independent variables included: number of plant owners in each state and proportions of cattle marketed from feedlots of 1,000-or-fewer-head capacity in each state. Separate equations were fitted for Colorado relative to each comparison state. Declining numbers of plant owners had little if any effect; the variable was significant only in the Colorado/Texas equation. The feedlot size variable had mixed results.

In a second model, fed cattle prices were regressed against supply of beef, supply of competing products, income, population, number of plant owners, percent of small feedlot marketings, and percent of large feedlot marketings. Seemingly Unrelated Regressions (SUR) were used in the latter test to estimate a system of five equations, one for each of the five states. Change in the number of owners of larger packing plants was not a significant variable.

#### **5.5. Spatial Price-Linkage Models**

Quantifying the degree and determinants of price linkages between spatially separated markets is another approach to assessing cattle market performance. Net prices in these markets tend to converge to a unique equilibrium because of arbitrage or oligopsonistic interdependence among cattle processors across markets.

**5.5.A.** Spatial price analysis was the point of departure of a 1991 study by Goodwin and Schroeder.<sup>210</sup> Weekly prices from January 1980 through September 1987 for 10 markets were stratified into four sub-periods and analyzed using cointegration techniques.<sup>211</sup> Markets were

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<sup>209</sup>Marvin Hayenga and Dan O'Brien, "Packer Competition, Forward Contracting Price Impacts, and the Relevant Market for Fed Cattle," in Wayne Purcell, ed., *Pricing and Coordination in Consolidated Livestock Markets, Captive Supplies, Market Power, IRS Hedging Policy* (Blacksburg, VA: The Research Institute on Livestock Pricing, 1992), pp. 45-64.

<sup>210</sup>Barry K. Goodwin and Ted C. Schroeder, "Cointegration Tests and Spatial Price Linkages in Regional Cattle Markets," *American Journal of Agricultural Economics*, vol. 73 (1991), pp. 452-464.

<sup>211</sup>The terminology describing these types of studies can be confusing to the uninitiated. Intuitively, two or more price series are said to be *cointegrated* if they stay in line with each other, even though individually they may follow a random walk. When prices across regions are cointegrated, it means the markets in those regions are

found to be less than fully integrated but the degree of cointegration increased during a time when concentration in beef packing was also increasing. To explore why, a bootstrapping technique was used to estimate the influence of specific factors on the cointegration test statistics between markets. The factors were market type, packer CR4 at the national level, relative slaughter volume, and distance between markets. The most consistent results across the regions were that (a) the degree of inter-regional integration becomes smaller with distance, and (b) increasing concentration in beefpacking enhanced spatial integration.

### *5.6. Price Transmission Asymmetry Models*

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economically integrated in the long run.

Researchers here seek to determine if the speed of price transmission between farm, wholesale, and retail prices is different when prices rise versus when they fall.<sup>212</sup> Conclusions from the studies varied depending on whether the data were monthly, quarterly, or yearly. Reasons given for asymmetry range from differences in the assimilation of market information to lack of information on precise leads and lags to possible market power by processors and/or retailers.

**5.6.A.** Market structure and price transmission asymmetry in the beef and pork industries was the subject of an M.S. thesis by Balimwacha.<sup>213</sup> Using quarterly farm, wholesale, and retail price data from 1970 to 1990, the author estimated a Cobb-Douglas price transmission model in which the elasticities were expressed as a function of concentration in beefpacking and porkpacking, respectively. The hypothesis of no relationship between concentration and price transmission asymmetry was not rejected. However, the author noted that her findings do not establish cause and effect.

## 6. Relevant Markets

Assessing price impacts of concentration in meatpacking, or any industry, should involve, as a first step, the delineation of the relevant market in which firms compete. In the foregoing price-concentration studies, markets have spanned areas as large as the nation and as small as local terminal markets. Although there is general agreement that cattle markets are regional rather than national or state in scope, there is no agreement on exactly what constitutes a regional market. The three regional studies reviewed in section 5.1.2. relied on cattle shipment data for geographic market delineation. Studies have not been made in which cattle markets are demarcated by other criteria such as price interdependence. Attempts have been made, however, to determine the extent of "economic" cattle markets.

**6.A.** One attempt appeared in a 1988 dissertation by Schultz.<sup>214</sup> Two data sets on prices and four "increasingly sophisticated techniques" using data in space and time aimed at defining

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<sup>212</sup>See, for example, Milton S. Boyd and B. W. Brorsen, "Price Asymmetry in the U.S. Pork Marketing Channel," *North Central Journal of Agricultural Economics*, vol. 10 (1988), pp. 103-110.

<sup>213</sup>Zaina Balimwacha, *Price Transmission Asymmetry and Market Structure in the Beef and Pork Industry*, unpublished M.S. Thesis (Lincoln: University of Nebraska, 1994).

<sup>214</sup>Margaret M. Schultz, *The Relevant Geographic Market Area for Fed Cattle and the Changing Structure of the Beef Packing Industry*, unpublished Ph.D. Dissertation (Ames: Iowa State University, 1988).

market areas for fed cattle. States in the Central and Pacific Northwest U.S. constituted one relevant market. Coastal areas fell outside the relevant market. Examination of the organization of the beef industry within the relevant markets revealed no "hard and fast case of undue monopsony power."

**6.B.** Demarcating relevant cattle market boundaries was also part of a larger study by Hayenga and O'Brien.<sup>215</sup> Tests for spatial integration were conducted using weekly state average prices during 1973 to 1989, and daily state prices from 1987 through 1989 in absolute levels and differenced form. Alternative statistical methods, including simple price correlations between states, Vector Autoregressive Analysis of lagged prices, and tests of cointegration were used to assess the degree of spatial integration. Results suggested markets are much larger than single states and much larger than the trade areas of individual firms.

## 7. Livestock Prices and Vertical Integration

Concern over recent increases in backward packer integration have prompted questions regarding its impact on livestock prices. The reasoning is that "as packers procure an increased percentage of slaughter in the form of contracts, demand for cash market cattle decreases, [and] to the degree that this decrease in demand differs from the decrease in supply, the price in cash markets may be affected."<sup>216</sup>

**7.A.** Though most of the work is recent, the earliest integration effort was in 1966 by Aspelin and Engelman<sup>217</sup> who studied the effects of packer integration into cattle feeding on fed cattle prices. Fed cattle price differences between a terminal market and the average of prices at several other markets were regressed against (1) volume of cattle at the terminal market, and (2) volume of cattle owned and slaughtered by the feeder-packer. Observations were weekly and covered a 1-year span. The packer-feeder volume variable was significant and negative. Every 100-head increase in packer-fed cattle slaughtered by the subject packer led to a 6-cents/cwt. decline in terminal market cattle prices.

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<sup>215</sup>Hayenga and O'Brien, *op. cit.*

<sup>216</sup>Ted C. Schroeder, Rodney Jones, James Mintert and Andrew Barkley, "The Impacts of Forward Contracting on Fed Cattle Transaction Prices," *Review of Agricultural Economics*, vol. 15 (1993), p. 325.

<sup>217</sup>Arnold L. Aspelin and Gerald Engelman, *Packer Feeding of Cattle: Its Volume and Significance*, Consumer and Marketing Services MRR 776 (Washington, D.C.: USDA, 1966).

**7.B.** Schroeder, et al. focused attention on implications of vertical integration (or captive cattle supplies) on fed cattle selling price in a 1991 study.<sup>218</sup> Transaction level data were collected from 1,407 pens of cattle from May 1990 through November 1990. Using an OLS model, lot-level selling price was regressed against a series of quality variables, market conditions (nearby live futures month, number of head of Kansas marketings during week of sale, day of week, number of bids on the lot of cattle, and lag between sale and delivery date), and a dummy variable identifying the largest buying firms. The effect of captive supplies on price variability was tested by regressing the squared residuals from the first regression against captive supplies using a t-test of the statistical significance of the intercept (whether it is equal to zero). Two measures of captive supplies were employed: (1) USDA formula and contract shipments from Kansas feedyards during the week of delivery and (2) each packer's percent share of captive supplies relative to total Kansas slaughter. Captive supplies had a statistically significant negative effect on price. Price variability, however, was not related to captive supplies.

**7.C.** Impacts of captive supplies on cattle prices were among several issues in a 1991 study by Hayenga and O'Brien.<sup>219</sup> Weekly fed cattle prices (from October 1988 through December 1989) for each of four states (Colorado, Kansas, Nebraska, and Texas) were regressed on weekly boxed beef prices. The objective was to capture the effect of wholesale price and state-level forward contract deliveries during the current week as a proportion of total inspected federal slaughter in the state. SUR analysis was used to capture the contemporaneous correlation across the state equations. The coefficient on boxed beef prices was restricted to be the same across the four states. Captive supplies showed an effect on fed cattle prices in Kansas only. The boxed beef price was highly correlated with the fed cattle price. Similar regressions were run to test the effect of supplies on within-week price variability. No significant effect of captive supplies on price variability was found.

## 8. Economies of Size

The bulk of studies on meatpacking size economies were conducted before the surge of concentration in the industry in the 1980s.<sup>220</sup>

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<sup>218</sup>Schroeder, Jones, Mintert and Barkley, *op. cit.*

<sup>219</sup>Hayenga and O'Brien, *op. cit.*

<sup>220</sup>A number of economic-engineering studies of meatpacking plant size and utilization cost relationships were completed during the 1960s and 1970s. Many of the newer plants at that time were small compared with those of both previous and subsequent periods and their technologies relatively simple. See, for example, Samuel H. Logan and Gordon A. King, *Economies of Scale in Beef Slaughter Plants*, Giannini Foundation Research Report 260 (Davis: University of California, 1965); James H. Cothorn, R. Mark Peard, and John L. Weeks, *Economies of Scale in Beef Processing and Portion Control Operations: Northern California*, Extension Leaflet (Davis: University of California, 1978); G.R. Cassell and D.A. West, *Assembly and Slaughtering Costs for Hogs in North Carolina*, Economic Research Report 3 (Raleigh: North Carolina State University, 1967); J.R. Franzmann and B.T. Kuntz, *Economies of Size in Southwestern Beef Slaughter-Plants*, Agricultural Experiment Station Bulletin B-648 (Stillwater: Oklahoma State University, 1966); and L.D. Schnake, J.R. Franzmann, and D.R. Hammons, *Economies*

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*of Size in Nonslaughtering Meat Processing Plants*, Agricultural Experiment Station Technical Bulletin T-125  
(Stillwater: Oklahoma State University, 1968).

**8.A.** Ball and Chambers<sup>221</sup> explored scale relationships and technological change in the industry during the period 1972-76. Using data on aggregate meat products, the authors estimated a nonhomothetic cost function allowing for variable elasticities of scale and both neutral and factor-using technical change. Results indicated increasing returns to scale. Factor price and output level changes strongly affected the rate of technological progress. Rising labor costs were apparently important in setting the stage for technological change featuring a more capital-intensive industry and associated economies of scale. Labor cost reductions resulted from the substitution of relatively unskilled workers for a more skilled work force in the less-automated plants. But there were also increases in output per worker, suggesting an improvement in the quality of the work force. The potential is there, the authors concluded, based on their findings and those reported by Parker and Connor,<sup>222</sup> for monopoly pricing behavior.

**8.B.** Sersland,<sup>223</sup> estimated economies of size and plant utilization in beef packing. In comparison to the earlier study by Ball and Chambers,<sup>224</sup> the data were less aggregated both at the commodity and plant levels. Data were from interviews of plant managers and covered 6 plant sizes and seven levels of utilization representing combinations of hourly rates, number of daily shifts, and number of days per week. The data were obtained from manager recall and insight, and not accounting records. Slaughter costs per head varied from \$40.71 per head for a 52,000-head-per-year plant to \$22.20 for one capable of slaughtering 676,000 head per year, both operating a single shift per day, eight hours per day. Adding a second shift lowered costs by \$3.36 per head. Lengthening the shift to 10 hours reduced costs by \$1.37 per head. Operating six rather than five days per week saved \$1.36 per head. The foregoing were averages, actual benefits in every case were greater for larger plants than for smaller ones. Operating short of capacity penalized large plants more than smaller ones. The average penalty for plants at 90 percent of capacity was \$2.96 per head, \$4.77 at 80 percent capacity.

Sersland's cost relationships for fabricating plants were similar to those for slaughter; economies of size again were significant. A 426,000-head-per-year plant had costs per head of \$50.27, while those for a 676,000-head plant were \$46.80. Double-shifting and increasing hours per day or week had no effect on fabricating costs.

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<sup>221</sup>V. Eldon Ball and Robert G. Chambers, "An Economic Analysis of Technology in the Meat Products Industry," *American Journal of Agricultural Economics*, vol. 64 (1982), pp. 699-709.

<sup>222</sup>Russel C. Parker and John M. Connor, "Estimates of Consumer Loss Due to Monopoly in the U.S. Food Manufacturing Industries," *American Journal of Agricultural Economics*, vol. 61 (1979), pp. 626-639.

<sup>223</sup>Claudia J. Sersland, *Cost Analysis of the Steer and Heifer Processing Industry and Implications on Long-Run Industry Structure*, unpublished Ph.D. Dissertation (Stillwater: Oklahoma State University, 1985). Sersland's findings are also summarized in Ward, *Meatpacking Competition and Pricing*, *op. cit.*

<sup>224</sup>Ball and Chambers, *op. cit.*

Minimum efficient scale for an integrated plant was estimated to be 1,520,000 head per year for a two-shift operation. Although no hard evidence of multiple-plant (firm) economies of size was available, possible sources of economies cited included the larger geographic scope of buyer operations and opportunities for favoring least-cost plants in times of short supplies.

**8.C.** Ward<sup>225</sup> surveyed 108 U.S. meatpacking firms in 1988 seeking information about plant sizes and utilization. The study found large differences in plant capacity, the bottleneck generally being cooler space to hold a day's output. There were also big differences in utilization of capacity, with larger firms generally operating more hours per week than small firms. Thus, Ward concluded larger packers were capable of paying higher prices than were smaller ones. He also acknowledged that they may not have competition-disciplined incentives to pay such higher prices.

## 9. Growth

**9.A.** In an early (1969) study, Anthony and Egertson explored the determinants of firm growth in the industry.<sup>226</sup> The authors regressed the ratio of size (log of pounds of meat output) of firm in 1962 to the size of firm in 1950 against the size of firm in 1950, ratio of processing to slaughter in 1961 (vertical integration index), number of species slaughtered in 1950 (horizontal integration index), and number of plants operated in 1950. The model's conclusions about the determinants of growth are minimal. The authors did find that small firms had grown faster than larger ones. This latter finding, coupled with other evidence of low profit rates in the industry, low advertising expenditure, and a considerable influx of new technology suggest performance "is favorable in at least some important dimensions."

## 10. Summary

This chapter has provided a taxonomy of existing SCP work. Of the several dozen SCP meatpacking studies surveyed, 35 examples have been highlighted here.

Of the 35 studies, 1 focused on beef retailing, 20 on beefpacking, 8 on porkpacking, 2 on lambpacking, and 4 on total meatpacking. Fourteen of the 21 beef studies tested oligopsony power measured in one form or another, 2 studies explored relevant markets, 3 treated price-vertical integration relationships, and 2 estimated size economies. Testing packer buyer power was the subject of all the porkpacking and lambpacking studies. Of the four meatpacking

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<sup>225</sup>Clement E. Ward, "Meatpacking Plant Capacity and Utilization: Implications for Competition and Pricing," *Agribusiness, An International Journal*, vol. 6 (1990), pp. 65-73.

<sup>226</sup>Willis Anthony and Kenneth Egertson, *Size, Growth, and Structural Change in the Meat Packing Industry*, Staff Paper P69-2 (St. Paul: University of Minnesota, 1969).

studies, 2 addressed the issue of profit and productivity impacts of buyer concentration, respectively; one estimated size economies (including processing), the last also looked at effects of concentration on technological change.

Table 4.1 highlights the studies whose key issue was the effects of concentration on performance. Of the 14 beef studies in table 4.1, 3 focused on price spreads, 1 on profits, 4 on aggregate prices, 3 on transaction prices, 1 on plant ownership, and 1 on spatial price behavior. Units of observation ranged from feedlot to national levels. The popular estimating method was OLS. Daily, weekly, monthly, quarterly, and annual observations were variously used. The earliest sample data stretched from 1959 to 1961, the latest dated from 1990. Beefpacker concentration was the key variable in all but one of the studies, the exception being a beef retailing study (2.1A) in which beef retailer concentration was the key variable. Half of the 14 studies found significant correlation between concentration and cattle prices.

Half of the eight porkpacking studies treated price impacts of plant closings, two considered aggregate price impacts of concentration, one addressed the profit-concentration relationship, and one looked at farm-carcass margins.

The price-concentration hypothesis was strongly supported when regional or state data were used. Results from plant closing studies, margins, and profits were either inconsistent or inconclusive.

Only two lambpacking studies addressed price impacts of concentration, one at the state level and one at the auction level. The former found no evidence of buyer power, the latter was inconclusive.

Table 4.1. Summary Results of SCP Concentration-Performance Studies of U.S. Meatpacking, by Study Characteristics and Livestock Species.

Type of Study	Study	Data Frequency	Data Type	Observation Unit	Estimation Method	Sample Period	Findings For:		
							Beef	Pork	Lamb
Price Spreads									
Wholesale-Retail	2.1A	A	CT	Regional	ECM	1967-1973	+		
Wholesale-Retail	2.1B	Q	T	National	OLS	1967-1978	+		
Farm-Wholesale	2.2A	A	T	National	OLS	1972-1985	—	0	
Profits	3A	A	T	National	OLS	1974-1985	0	0	
Prices									
Aggregate Prices	5.11A	A	T	National	OLS	1969-1978	—		
	5.12A	A	CT	Regional	OLS,GLS	1971-1980	+		
	5.12B	A	CT	Regional	OLS,GLS	1971-1986	+		
	5.12C	A	CT	Regional	OLS,GLS	1977-1989		+	
	5.13A	A	C	State	OLS	1972,1977	+		
	5.13B	A	CT	State	OLS	1972-1985			0
Transaction Price	5.21A	D	CT	Feedlot	OLS	July '79	+0		
	5.21B	D	CT	Feedlot	OLS	July '79	+		
	5.21C	D	CT	Feedlot	OLS	June '89	+		
	5.22A	E	T	Auction	OLS	1979-1982			+0
Entry/Exit	5.3A	W	T	Local Market	OLS,TD	1959-1961		+	
	5.3B	W	T	Local Market	TD	1969-1972		—	
	5.3C	W	T	Local Market	OLS	1972-1983		—	
	5.3D	W	T	Local Market	OLS	1981		+	
Plant Ownership	5.4A	A	C	State	OLS,SUR	1973-1987	—		

Spatial Prices	5.5A	W	CT	Direct Market	COINT, BOOT	Jan. '80-Sep. '87	+		
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Table 4.1 (Continued)

Data Frequency

A = Annual  
Q = Quarterly  
M = Monthly  
W = Weekly  
D = Daily  
E = Occurrence of Sale

Data

C = Cross-section  
T = Time series  
CT = Cross-section time series

Type Estimation

COINT = Cointegration  
BOOT = Bootstrapping  
ECM = Error Component Model  
OLS = Ordinary Least Squares  
TD = Difference Test  
GLS = Generalized Least Square  
SUR = Seemingly Unrelated Regression

Method Finding

+ = Evidence of market power  
— = No evidence of market power  
0 = Inconclusive evidence of market power

In the two meatpacking studies where concentration was the key variable, no significant impact on profits or productivity was found. Increasing returns were found in meatpacking and processing, suggesting a potential for monopoly power.

The inventory of the main SCP findings regarding competition in beefpacking, porkpacking, and lambpacking is summarized as follows:

### ***10.1. Beefpacking***

**Study 2.1.B.** National wholesale-retail margins widened with increasing national beef packer buyer-concentration. Quarterly time-series data for the 1967-1978 period were used. The share of the top 4 cattle slaughtering firms increased during the period from 28 to 30 percent.

**Study 2.2.A.** Increases in national beefpacking concentration were negatively correlated with farm-wholesale margins but had no association with profits. Yearly time-series data for 1972-1985 were used. Concentration increased from 29 percent to 50 percent during the estimation period.

**Studies 5.1.2.A, B.** Cattle-price-depressing effects of beefpacker buyer concentration were strongly supported by regional concentration data. Recognizing that concentration levels are 20 to 25 points higher in regional markets, results from studies covering the 1971-1986 period (during which national concentration levels increased from 28 to 55 percent), using time series-cross-regional concentration data, showed a strong negative relationship between increased regional concentration and regional cattle prices.

**Studies 5.2.1.A, B, C.** Cattle prices at the transaction level were negatively correlated with concentration as measured alternatively by number of packers bidding, number of bids per lot and identification specific packer buyers. Results were based on daily lot-level data during 2 months, one in 1979 the other in 1989. Cross-section time series data were used.

**Study 5.1.2.B.** Presence of larger size feedlots was positively correlated with cattle prices, suggesting countervailing power. The result was more significant when state and regional data were substituted for transaction-level data.

**Study 5.4.A.** Presence of multiple plants under one ownership within a state did not necessarily result in less competition. Among five states (Colorado, Kansas, Nebraska, Iowa, and Texas), Colorado and Texas were the exceptions. Annual cross-section data were used.

**Study 5.5.A.** Increases in geographical spatial integration were highly correlated with increasing packer-buyer concentration. Data came from 1980-1987, a period of accelerating beefpacker buyer concentration. Weekly cross-section time series were used.

**Study 5.6.A.** Price transmission asymmetry was positively correlated with beefpacker concentration. Beefpacking concentration increased during the sample period (1970-1990) from 28 to 72 percent. Database consisted of monthly time series.

**Study 6.A, B.** Relevant cattle markets are much larger than single states and much larger than the trade areas of individual firms. Weekly and daily state average prices were used. Sample period extended from 1973 to 1989.

**Study 7.B.** Captive supplies and lot-level cattle prices were negatively correlated. Transaction cross-section time series data were used covering May to November 1990.

**Study 7.C.** Captive supplies were negatively correlated with cattle prices in some states but not others. Weekly time series data were used from 4 states (Colorado, Kansas, Nebraska, and Texas) for the period between October 1988 through December 1989). Only in Kansas were captive supplies negatively correlated with fed cattle prices.

## ***10.2. Porkpacking***

**Study 2.2.A.** Concentration in porkpacking had no impact on farm-wholesale margins or profits in the industry. Time-series data for the 1972-1985 period were used. No dramatic increases in porkpacking concentration occurred during the period.

**Study 5.1.2.C.** Concentration in regional hog procurement markets was negatively correlated with hog prices. Results were for a seven-region model for the 1979-1989 period, using cross-section time-series data.

**Study 5.3.C. D.** Results on effects of more recent plant closing on hog prices were inconclusive.

## ***10.3. Lambpacking***

**Study 5.1.3.B.** Limited evidence that declining numbers of plants adversely affected lamb prices.

**Study 5.1.3.B.** Packer feeding of lambs had a positive, although minor, price effect. Results from state-level data from 1972 through 1985.

**Study 5.2.2.A.** Lamb prices increased with number of bidders, and the largest buyers paid significantly higher prices than the smallest buyers. Individual transaction price data from a tele-auction from 1979 through 1982.

The following generalization transpires from the foregoing findings:

Study findings indicate a strong negative correlation between beefpacking concentration and cattle prices, especially in studies using more recent data and from cattle supply areas or units that do not correspond to political boundaries. Structural impacts were either weak or inconclusive where national data were used, but negative and statistically strong between regional beefpacker concentration and average regional fed cattle prices. The estimated concentration effects were about 14 cents/cwt for a 10-percent increase in concentration. Effects in one study were not significant until a 60-65 percent concentration level was reached. Price-concentration correlation also was significant at the transaction level. The largest 3 buyers paid between 17 and 26 cents/cwt less than the fringe buyers. Geographical fed-cattle price interdependence seems to have increased with increased national beefpacker concentration.

Effects of structure on market performance, in studies using national data, were inconclusive in porkpacking. However, the relation between regional porkpacker concentration and average regional hog prices was negative and statistically strong. Each 10-percent increase in concentration lowered prices about 14 cents/cwt. No definite relation between plant closings and hog prices was found.

Lambpacking has received relatively limited coverage. Evidence of market power in lambpacking remains inconclusive.

An appraisal of the findings is provided in the final chapter.

## CHAPTER V

### EMPIRICAL TESTS OF MARKET POWER IN MEATPACKING: A TAXONOMY OF NEIO STUDIES AND THEIR FINDINGS

#### 1. Introduction

This chapter reviews analyses of market power in the meatpacking industry that fall within the broad category of NEIO. All are relatively recent, the earliest published in 1988 and the latest as yet unpublished. Although they differ widely in their methods and in the specific issues they address, all apply a clearly-specified theoretical model of firm optimization that yields testable implications of market power.

This chapter is organized according to the side or sides of the market being tested for market power, buyer versus seller. Section 2 reviews oligopoly/oligopsony studies. Section 3 discusses four subclasses of oligopsony studies. One study dealing with oligopoly alone is discussed in Section 4, and one with bilateral oligopoly is discussed in Section 5.

#### 2. Oligopoly/Oligopsony Models

Competitive theory establishes the profit-maximizing requirement that each packer equates the margin between its beef selling price and live cattle buying price to its marginal cost of processing cattle (MC). The presence of market power is signalled by a gap between the margin and MC, composed of oligopoly and oligopsony components. The empirical task is to test the null hypothesis that the components are not different from zero.

**2.A.** One of the first papers to apply NEIO techniques to the analysis of market power in meatpacking was Schroeter's<sup>227</sup> adaptation of Appelbaum's<sup>228</sup> approach to the measurement of

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<sup>227</sup> John R. Schroeter, "Estimating the Degree of Market Power in the Beef Packing Industry," *Review of Economics and Statistics*, vol. 70 (1988), pp. 158-62. Schroeter's paper and a closely related paper by Azzam, Pagoulatos, and Yanagida were written independently at about the same time.

<sup>228</sup> Elie Appelbaum, "Testing Price Taking Behavior," *Journal of Econometrics*, vol. 9 (1979), pp. 283-94; and Elie Appelbaum, "The Estimation of the Degree of Oligopoly Power," *Journal of Econometrics*, vol. 19 (1982), pp. 287-299.

monopsony as well as monopoly power. Applied to beefpacking, Schroeter's technique highlighted the two main features of NEIO. First, market power is taken to be an object of statistical inference rather than something directly measurable. Second, market power is estimated within the context of a consistent model of firm optimization. Schroeter's paper employed the conjectural variation, a device frequently used by NEIO analysts as a means of quantifying firm conduct.

Schroeter assumed a fixed-proportions technology and derived the following necessary condition from the assumption of static, period-by-period profit maximization on the part of packing firms:

$$p(1 + \theta/\eta) = w_M(1 + \theta/\varepsilon) + \partial C/\partial Q, \quad (1)$$

where  $p$  is the price of output (dressed beef carcasses),  $w_M$  is the price of the raw product input (live cattle),  $\partial C/\partial Q$  is the representative firm's marginal processing cost,  $\eta$  is the elasticity of market demand for beef,  $\varepsilon$  is the elasticity of market supply of cattle, and  $\theta = (\partial Q/\partial Q^j)Q^j/Q$  is the representative firm's "conjectural elasticity." One interpretation of  $\theta$  is that it is the representative firm's perceived rate of response of market-wide output ( $Q$ ) with respect to a change in its own output ( $Q^j$ ), expressed as an elasticity.<sup>229</sup> Price-taking firms are assumed to behave as if they expect that changes in their own output levels will leave market price, and therefore market quantity, unchanged. For this case,  $\theta = 0$ . For the contrasting monopoly case,  $Q \equiv Q^j$  and  $\theta = 1$ . Thus, the value of  $\theta$  serves as an index of market conduct, with polar cases of competitive and purely monopolistic behavior associated with values of 0 and 1, respectively.

The real significance of the conjectural elasticity is its role in measuring the degree of monopolistic or monopsonistic market performance. Equation (1) asserts equality between the representative firm's perceived marginal revenue and perceived marginal cost. Lerner's index,  $L$ , the price-marginal cost gap expressed as a proportion of price, is a conventional measure of monopoly power. Manipulation of equation (1) leads to

$$L = -\theta/\eta. \quad (2)$$

Rearranging equation (1), one obtains

$$w_M(1 + \theta/\varepsilon) = p(1 + \theta/\eta) - \partial C/\partial Q. \quad (3)$$

Equation (3) expresses equality between the firm's marginal cattle cost and the marginal revenue product of cattle net of processing costs. In a competitive cattle market, marginal net revenue product equals factor price, so the gap between the two, expressed as a proportion of  $w_M$ , serves as a monopsony index analogous to Lerner's index of monopoly power:

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<sup>229</sup> Alternatively, conjectural variation terms can be regarded as parameters that simply serve to index the model's oligopoly solution concept within the spectrum bounded by perfect competition and pure monopoly. As noted in Chapter III, it is not appropriate within an inherently static model to interpret a conjectural variation as a measurement of an anticipated reaction on the part of a firm's rivals.

$$M = \theta/\varepsilon. \quad (4)$$

A system of equations consisting of an industry-wide counterpart to equation (1), market beef demand and cattle supply equations, and an industry-wide beefpacking labor demand equation was estimated using full-information maximum-likelihood.<sup>230</sup> The sample period consisted of annual data from the beefpacking industry for the period 1951 through 1983. The results led to rejection of the hypothesis of price-taking conduct on the part of beefpacking firms: estimates of  $\theta$  for most of the sample's 33 years were significantly greater than zero at conventional levels. Estimates of  $L$  and  $M$ , defined in equations (2) and (4), suggested, however, that the degree of market power was relatively limited. At least for the latter years of the sample, output and input market price distortions (values of  $L$  and  $M$ ) averaged about 3 percent and 1 percent, respectively. One feature of the results is surprising in light of recent structural changes in the industry. Consolidation through plant acquisition and small-plant closing markedly increased beef packing concentration starting in about 1977. Yet the model's results indicated no corresponding increase in the size of pricing distortions.

**2.B.** Azzam, et al.<sup>231</sup> extended the method in 2.A. to the analysis of farm-wholesale pork margins. Prior models of margin determination had relied on the assumption of perfect competition within the marketing channel. This paper explicitly allowed for non-competitive conduct in input and output markets on the part of food processors. The empirical method used decomposed observed margins into components reflecting the marginal cost of the processing industry and oligopoly/oligopsony pricing distortions.

The theoretical model starts with  $N$  profit-maximizing firms. Each firm produces a homogeneous food product from a single agricultural input (in fixed proportions) and competitively-purchased non-agricultural inputs (in variable proportions). Conduct in agricultural input and output markets is potentially non-competitive; possibilities ranging from price taking to pure monopoly/monopsony are parametrized by a conjectural elasticity term,  $\theta$ . Solution of the profit-maximization problem leads to a necessary condition essentially equivalent to equation (1) which the authors wrote in the form:

$$M \equiv P_p - P_h = -P_p\theta/\mu + P_h\theta/\varepsilon + C(w), \quad (5)$$

where  $M$  is the marketing margin and  $P_p$  is the price of output. In this specific application,  $P_p$  corresponds to the wholesale (carcass) price of pork,  $P_h$  is the price of the input (live hogs),  $\mu$  is the elasticity of output (pork) demand,  $\varepsilon$  is the elasticity of input (hog) supply,  $C(w)$  is the marginal processing cost, and, again,  $\theta$  is the conjectural elasticity. Under competitive

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<sup>230</sup>The labor demand equation was derived from the cost function via Shephard's Lemma. Estimation subject to the implied cross-equation cost parameter restrictions improved the credibility of the results and the statistical efficiency of the estimates.

<sup>231</sup>Azzeddine M. Azzam, Emilio Pagoulatos, and John R. Schroeter, "Price Spreads and Market Power in Food Processing Industries," NE-165 Working Paper No. 8 (1989).

conditions,  $\theta = 0$  and the price spread is simply equal to marginal processing cost. If processors exercise market power,  $\theta > 0$  and the price spread exceeds marginal cost by two positive terms: a monopoly distortion,  $-P_p\theta/\mu$  and a monopsony distortion,  $P_h\theta/\varepsilon$ .

Functional forms were specified for the pork demand and hog supply equations, and for marginal cost.<sup>232</sup> Estimation of the system of equations was carried out by iterative three-stage least-squares, using quarterly data for the period 1972.IV through 1986.IV (where I = first, II = second, III = third, and IV = fourth quarters). The empirical results were used to test the hypothesis of price-taking behavior ( $\theta = 0$ ), and to estimate the value of each of the three margin components appearing on the right-hand-side of equation (5) for each of the quarters in the sample period. The major findings: Oligopoly/oligopsony behavior apparently prevailed for the 27 quarters between 1972.IV and 1979.II with the result that price spreads were inflated by significant market power pricing distortions. On the other hand, the hypothesis of price-taking conduct cannot be rejected for the 29 quarters between 1979.IV and 1986.IV and, consequently, price spreads appeared to reflect marginal costs quite closely.

The authors noted that evidence of lessening market power over the sample period is not discernable through casual inspection of the farm/wholesale price spread: the early sample period contains some of the lowest as well as some of the highest values of nominal spreads. Again, the findings belie the *a priori* expectation of growing market power based on the fact of growing packer concentration throughout the sample period. Noting the growth of very large-scale hog production facilities over this period, the authors speculated that the countervailing power of large hog producers may have held in check the market power of a highly concentrated hog-packing industry.

**2.C.** Azzam and Pagoulatos<sup>233</sup> abandoned the assumption of fixed proportions, using instead, a variable proportion production function relating livestock and non-livestock inputs to meat output. First-order conditions for the livestock input were derived which, for each input, equate the representative firm's perceived marginal revenue product to its perceived marginal factor cost. Conditions for the livestock input were:

$$w_1(1 + \Phi/\varepsilon) = (1 - \Theta/\eta) P f_{x_1}, \quad (6)$$

and for each of the non-livestock inputs:

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<sup>232</sup>As in Schroeter, *op. cit.*, the system was augmented with an aggregate labor demand equation derived from the cost function via Shephard's Lemma.

<sup>233</sup>Azzeddine M. Azzam and Emilio Pagoulatos, "Testing Oligopolistic and Oligopsonistic Behavior: An Application to the U.S. Meat-Packing Industry," *Journal of Agricultural Economics*, vol. 41 (1990), pp. 362-70.

$$w_k = (1 - \Theta/\eta) P f_{x_k}, \quad \text{for } k = 2, 3, \dots, M, \quad (7)$$

where  $w_1$  is the price of the livestock input and, for  $k = 2, 3, \dots, M$ ;  $w_k$  is the price of the  $k^{\text{th}}$  non-livestock input;  $P$  is output price;  $f_{x_k}$  is the marginal product of the  $k^{\text{th}}$  input;  $\varepsilon$  is the elasticity of livestock supply;  $\eta$  is the absolute value of the elasticity of meat demand; and  $\Theta$  and  $\Phi$  are output and input market conjectural elasticities, respectively. The translog specification adopted for the production function implied parametric forms for the marginal product terms appearing in equations (6) and (7). These conditions were reexpressed in cost-share form and, together with the production function itself, were estimated by iterative three-stage least-squares using annual (1959-82) data from U.S. meatpacking (beef, pork, sheep, and lamb).<sup>234</sup>

The hypotheses of zero conjectural elasticities (price taking behavior) in the input and output markets were individually and jointly rejected at conventional significance levels. The hypothesis of equal conjectural elasticities across markets could not however be rejected.<sup>235</sup> Their estimated elasticity of livestock supply was much smaller (in absolute value) than that of meat demand, however. Consequently, roughly equal input and output market conjectural elasticities yielded a monopsony distortion estimate significantly larger than the estimate of the monopoly distortion.

**2.D.** A 1991 paper by Schroeter and Azzam<sup>236</sup> was an extension of work by Brorsen, et al.,<sup>237</sup> who investigated the relationship between output price risk and marketing margins under perfect competition. Here as in Azzam, et al.,<sup>238</sup> the application was to hogpacking. Whether output price risk is an important factor in this industry is unclear, *a priori*. The production lag between slaughter and sale of final product is 2 or 3 days for fresh carcass pork, and up to a week for cured products. The ratio of net earnings to total sales is very low, however, so even a 1- or 2- percent change in output price might have a significant impact on profit.<sup>239</sup> Whether firms' optimal reactions to price risk play a role in margin determination is an empirical question.

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<sup>234</sup>In the estimation of conjectural elasticities and technology parameters, the supply and demand elasticities were fixed at values estimated by a separate procedure.

<sup>235</sup>This conflicts with the prior expectation that conduct in input markets might be less competitive than output market conduct. It may also offer *ex post* support for the assumption of equal conjectural variations used in Schroeter, *op. cit.*, and Azzam, Pagoulatos, and Schroeter, *op. cit.*

<sup>236</sup>John R. Schroeter and Azzeddine Azzam, "Marketing Margins, Market Power, and Price Uncertainty," *American Journal of Agricultural Economics*, vol. 73 (1991), pp. 990-999.

<sup>237</sup>B. W. Brorsen, J. P. Chavas, W. Grant and L. D. Schnake, "Marketing Margins and Price Uncertainty: The Case of the U.S. Wheat Market," *American Journal of Agricultural Economics*, vol. 67 (1985), pp. 521-528.

<sup>238</sup>Azzam, *et al.*, *op. cit.*

<sup>239</sup>The model's assumption that hog packers do not use forward contracting to reduce output price risk is consistent with standard industry practice.

The key relationship emerging from the study's theoretical model is:

$$M = C - Q\theta_1/\eta + Q\theta_2/\varepsilon + Q\delta\sigma_p^2, \quad (8)$$

where  $M$  is the expected farm-to-wholesale hog/pork margin;  $C$  is marginal processing cost;  $\eta$  and  $\varepsilon$  are the slopes of the wholesale pork demand and hog supply curves, respectively;  $Q$  is industry output;  $\theta_1$  and  $\theta_2$  are output and input market conjectural elasticities;<sup>240</sup>  $\sigma_p^2$  is the conditional forecast variance of output price about its mean; and  $\delta \geq 0$  is a parameter that proxies the firm's degree of risk aversion. The first three terms on the right-hand side of equation (8) are familiar from Azzam, et al.<sup>241</sup> They correspond, respectively, to marginal cost, and the oligopoly and oligopsony pricing distortion components of the marketing margin. Competitive conduct is associated with zero values for  $\theta_1$  and  $\theta_2$  and yields zero distortions, while market power in either the hog or wholesale pork markets ( $\theta_1$  and/or  $\theta_2 > 0$ ) contributes positive terms to the price spread. The fourth term in the decomposition represents this paper's innovation; its form implies a positive relationship between the degree of output price risk and the margin as long as firms are risk-averse ( $\delta > 0$ ).

The empirical decomposition of observed margins was guided by theoretical characteristics of each of the components of equation (8). Marginal cost is linearly homogeneous in non-livestock factor prices, the oligopoly and oligopsony components are inversely proportional to the demand and supply slopes,<sup>242</sup> and the price risk component is proportional to the conditional forecast variance of output price. Data describing the  $\sigma_p^2$  variable were generated using a weekly wholesale pork price forecasting equation with an autoregressive-conditional-heteroscedasticity (ARCH) model for the error term. The ARCH specification highlighted the variance of rational, one-week-ahead forecasts of packers' output price over the sample period. However, data limitations forced estimation of equation (8) from quarterly data.

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<sup>240</sup>Although the model assumed a fixed proportional relationship between hog input and pork output, conjectural elasticities were permitted to differ between input and output markets because of differences in geographic scope. Because they use only national data, however, the authors were forced to compromise in the empirical implementation of the model by assuming that regional market and national market supply slopes were equal. They acknowledged the potential problems with this assumption in their note 5.

<sup>241</sup>Azzam, *et al.*, *op. cit.*

<sup>242</sup>Econometric identification of these two components therefore requires time-variability in these slopes.

A given quarter's value of  $\sigma_p^2$  became the quarter's average value for the conditional variance of weekly forecasts estimated from the separate ARCH model for wholesale pork prices.

Full information maximum likelihood was used to estimate equation (8), simultaneously with hog supply and pork demand equations, for the period 1972.II through 1988.IV. Estimated oligopoly distortions were small and insignificant throughout the sample period; oligopsony distortions tended to be statistically significant early in the sample period but insignificant thereafter;<sup>243</sup> and price risk components were statistically significant throughout the period and generally exceeded the sum of the two market power components. Importantly, recognition of the role of output risk had a significant impact on the empirical findings: A re-estimated model with  $\delta$  forced to be zero -- in effect, a deliberate omission of the effect of output price risk -- resulted in oligopoly pricing distortions becoming statistically significant throughout the sample period.<sup>244</sup>

**2.E.** Azzam<sup>245</sup> developed and applied a simpler procedure for testing whether farm-wholesale beef margin data were consistent with competitive conduct on the part of beefpackers. The advantage of the approach over alternatives discussed so far, is that it imposes minimal structure upon the empirical model and, consequently, is relatively invulnerable to the possibility that results may simply be artifacts of choices of functional form. The procedure does not involve the estimation of conjectural variation terms.

The general conceptual framework starts with a processing industry that operates between an upstream industry (feed lots) producing an agricultural input (live animals) and a downstream industry (wholesalers and retail grocery stores) that purchases the processors' output (carcass or boxed beef) and transforms it into a final consumer good.<sup>246</sup> Assuming a fixed proportional relationship between live animal input and beef output, aggregate profit for the processing industry is given by

$$\pi^w = (p^w - p^f)x^f - C^w(x^f, p), \quad (9)$$

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<sup>243</sup>Here, too, the market power results were contrary to what might have been casually inferred on the basis of the significant trend toward higher concentration over the sample period.

<sup>244</sup>Work by Holt was closely connected to the Schroeter and Azzam paper. Holt also examined the impact of output price uncertainty in the meat packing industry, but under the assumption of perfectly competitive conduct. While Holt's paper did not address the issue of market power, *per se*, it was a significant methodological advance in that it treated the process generating output price variability as endogenous. See Matthew T. Holt, "Risk Response in the Beef Marketing Channel: A Multivariate Generalized ARCH-M Approach," *American Journal of Agricultural Economics*, vol. 75 (1993), pp. 527-548.

<sup>245</sup>Azzeddine Azzam, "Testing the Competitiveness of Food Price Spreads," *Journal of Agricultural Economics*, vol. 43 (1992), pp. 248-256.

<sup>246</sup>Azzam's theoretical model assumes perfectly competitive conduct in the upstream and downstream industries, although the empirical methods appear to remain valid when this assumption is relaxed.

where  $p^w$  is the wholesale price of the processors' product,  $p^f$  is the price of the agricultural input,  $x^f$  is the processors' agricultural input/output quantity,  $C^w(\cdot)$  is a processing industry cost function, and  $p$  is a vector of non-agricultural input prices. Differentiating (10) with respect to  $x^f$  and setting the result to zero yields:

$$p^w - p^f = -x^f(\partial p^w / \partial x^f) + x^f(\partial p^f / \partial x^f) + \partial C^w / \partial x^f. \quad (10)$$

The left-hand side of the equation is the farm-to-wholesale margin. The right-hand side includes processor marginal cost,  $\partial C^w / \partial x^f$ , and two additional non-negative terms,  $-x^f(\partial p^w / \partial x^f)$  and  $x^f(\partial p^f / \partial x^f)$ . These terms are reflections of the input and output market conduct on the part of processors that is necessary to reconcile observed margins with the assumption of industry profit maximization. Formally,  $\partial p^w / \partial x^f (\leq 0)$  is the perceived slope of the derived demand curve at the wholesale level and  $\partial p^f / \partial x^f (\geq 0)$  is the perceived slope of the agricultural input supply curve. If processors behave as price takers in both markets, these terms are zero and equation (10) yields the competitive result that the price spread equals processor marginal cost. If, however, processors exercise some degree of monopoly and/or monopsony power, they will perceive a relationship between input and output prices, on the one hand, and industry output, on the other, and the margin will exceed marginal cost by positive pricing distortions given by  $-x^f(\partial p^w / \partial x^f)$  and  $x^f(\partial p^f / \partial x^f)$ . To test whether monopoly and monopsony distortions are zero, one simply regresses price spreads on a parametric functional form for processor marginal cost and additional variables that are thought to affect the derived demand for output or the supply of input (and therefore will enter  $-x^f(\partial p^w / \partial x^f)$  or  $x^f(\partial p^f / \partial x^f)$ ) without affecting processor marginal cost. A finding that any such variables are significant is evidence against competitive processor conduct.

The author argues that industry-specific factor prices for the upstream and downstream industries are natural candidates for these test variables. Prices of feeder cattle and feed were determinants of the supply of slaughter cattle and prices of grocery store labor and intermediate inputs became determinants of the derived wholesale demand for beef. The data sample consisted of monthly observations for the period January 1988 through March 1991. The hypothesis that the coefficients of the feed lot cost variables were jointly zero was confidently rejected. This is evidence that beef price spreads contained a monopsony power distortion during the sample period. The hypothesis of competitive conduct in beefpackers' output market could not be rejected, however.

**2.F.** Schroeter and Azzam<sup>247</sup> extended the market power measurement method to accommodate a significant stylized fact about the meatpacking industry: joint production of demand-related (substitute) goods. The importance of this feature is evident in the industry's makeup. In 1985, for example, 6 of the top 10 U.S. meat packers, including the 2 largest (IBP and Swift Independent) operated both cattle and hog plants.

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<sup>247</sup>John R. Schroeter and Azzeddine M. Azzam, "Measuring Market Power in Multi-Product Oligopolies: The U.S. Meat Industry," *Applied Economics*, vol. 22 (1990), pp. 1365-76.

A static, profit-maximizing, quantity-setting firm is said to possess market power if it behaves as if it expects price to change with changes in its output. For example, in a single-homogeneous-product environment, a firm with Cournot conjectures perceives a negative relationship between its own output and the market clearing price. An increase in own output will not prompt a quantity response by rivals, so market quantity will be expected to increase and price to fall. Suppose now that the firm produces two substitute goods, beef and pork. With Cournot conjectures still assumed, the firm anticipates a fall in beef price in response to an increase in its beef output; but now, because beef and pork are substitutes, a fall in the market-clearing price of pork is expected as well. The advisability of the firm's increasing beef output will depend on both the anticipated "same-market" (beef) *and* "cross-market" (pork) profit impacts.

More generally, industries engaged in joint production of demand-related goods may display conduct more complicated than Cournot. Because two related markets are involved, the characterization of conduct, and of the resulting oligopoly solution concept, will require a richer parametrization of the model than in the single-product case. Now, cross-market as well as same-market conjectural variations are needed: For  $i$  and  $k = 1$  (beef) and  $2$  (pork),

$$\theta_{ik} \equiv (\partial Q_i / \partial Q_k^j)(Q_k^j / Q_i)$$

is the representative firm's conjectural elasticity of market quantity of good  $i$  ( $Q_i$ ) with respect to own quantity of good  $k$  ( $Q_k^j$ ). Adapting a model developed by Gelfand and Spiller,<sup>248</sup> the authors derived equilibrium conditions for the oligopoly in terms of the  $\theta_{ik}$ s, own- and cross-price elasticities of beef and pork demand and cattle and hog supply, and technology parameters. From these, price-equals-marginal-cost equilibria emerge only where  $\theta_{11} = \theta_{12} = \theta_{21} = \theta_{22} = 0$ .

Using quarterly data from 1976 through 1986, the equilibrium conditions were estimated by iterated three-stage least squares.<sup>249</sup> Estimates of the  $\theta$ s provide a basis for statistical inferences about conduct in the industry. The results were consistent with evidence from the previously-discussed studies in their support of the rejection of price-taking behavior.

### 3. Oligopsony Models

The focus of the studies in this section is market power in live cattle markets. Price-taking behavior in the beef market is a maintained hypothesis. Four types of NEIO meatpacking

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<sup>248</sup>M. D. Gelfand and P. T. Spiller, "Entry Barriers and Multiproduct Oligopolies: Do They Forbear of Spoil?" *International Journal of Industrial Organization*, vol. 5 (1987), pp. 101-113.

<sup>249</sup>As in some of the other papers reviewed, industry demands for certain non-livestock factors of production (meatpacking labor and meat-processing labor, in this case) were estimated jointly with the equilibrium conditions to improve efficiency.

oligopsony studies were identified: (1) calibration/simulation, (2) switching conduct, (3) trigger price and (4) average-cost pricing.

### **3.1. Calibration/Simulation**

**3.1.1.** Concerns about market power in the meatpacking industry generally reflect fears that high concentration and/or non-competitive conduct in regional livestock markets will lead to lower livestock prices. Azzam and Schroeter<sup>250</sup> used a simple calibration/simulation model to project cattle market price and quantity effects associated with various hypothetical changes in concentration and conduct. Their model explicitly recognized the regional nature of cattle procurement markets and attempted to account for heterogeneity among regions. The authors assumed firms to be price takers in the national output market while potentially exercising oligopsony power in regional cattle markets. Profit maximization implies:

$$(p - c - w)/w = [\alpha - H(\alpha - 1)]/\varepsilon, \quad (11)$$

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<sup>250</sup>Azzeddine Azzam and John R. Schroeter, "Implications of Increased Regional Concentration and Oligopsonistic Coordination in the Beef Packing Industry," *Western Journal of Agricultural Economics*, vol. 16 (1991), pp. 374-381.

where  $p$  is packer's output price,  $w$  is cattle price,  $c$  is marginal processing cost,  $H$  is the Herfindahl index of packer concentration in the representative region,  $\varepsilon$  is regional cattle supply elasticity,<sup>251</sup> and  $\alpha$  is a parameter indexing packer conduct in the cattle market. Formally,  $\alpha$  is the conjectural elasticity of each individual rival's quantity with respect to changes in a given firm's quantity. A value of zero for  $\alpha$  coincides with Cournot conduct, this paper's bench mark for non-cooperative behavior.<sup>252</sup> Pure monopsony (perfectly collusive) conduct is implied when  $\alpha = 1$ . The expression on the left-hand-side of equation (11), which the authors denote by  $D$ , is the counterpart to Schroeter's monopsony distortion of equation (4).  $D = 0$  corresponds to competitive cattle market conduct.  $D > 0$  signals the exercise of some degree of oligopsony power. Equation (11) predicts that the distortion increases as  $\alpha$  increases (for given  $H$  and  $\varepsilon$ ) and as  $H$  increases (for given  $\alpha$  and  $\varepsilon$ ), and decreases as  $\varepsilon$  increases (for given  $\alpha$  and  $H$ ).

Assuming that  $\varepsilon$  were known,<sup>253</sup> equation (11) can be used to determine how the distortion would change if conduct and concentration parameter values characteristic of a "baseline" case were replaced by "test case" values describing greater concentration and/or more collusive conduct. How a given change in the distortion translates into price and quantity effects depends upon the elasticities of national market cattle supply and derived demand for packer output (see figure 5.1). Baseline case values for cattle price and quantity are denoted  $\hat{w}$  and  $Q$ , respectively. The baseline distortion is denoted  $D$ . An increase in the distortion to  $D^*$ , engendered by either heightened concentration or more collusive conduct, leads to a fall in cattle price, from  $\hat{w}$  to  $w^*$ , and a fall in market quantity from  $Q$  to  $Q^*$ . The comparative magnitudes of these price and quantity changes obviously depend on the steepness of the supply and demand curves.

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<sup>251</sup>It is important to distinguish between the regional supply elasticity,  $\varepsilon$ , and the national supply elasticity, denoted  $e$  in the study. Regional supply responses included not only production responses but potentially inter-regional shipments as well. Hence regional supply will be much more elastic than national supply.

<sup>252</sup>The parametrization of conduct here was slightly different from that in the previous papers. In the present study  $\alpha = 0$  corresponds to Cournot, not price-taking, behavior. See the Mathematical Appendix in chapter III for more detail.

<sup>253</sup>Lacking an adequate database for directly estimating  $\varepsilon$ , the authors fix its value by a calibration approach. Using measured values of regional concentration,  $H$ , and under the assumption that current conduct is perfectly non-cooperative ( $\alpha = 0$ ),  $\varepsilon$  is fixed at the value that makes equation (11) consistent with a distortion estimate inferred from beef packing industry financial data.

Assuming constant elasticity forms for the national market demand and supply relations, and using estimates of these elasticities obtained from secondary sources, the authors developed expressions for changes in cattle price and quantity terms resulting from alternative baseline and test case distortion values. Simulation exercises then involved pairing various characterizations of the baseline case with a variety of characterizations of test cases to project the resulting price and quantity effects. Overall, the results provided a somewhat less alarmist view of the potential

**FIGURE 1**

dangers of increased concentration and attendant oligopolistic coordination than have the findings of conventional econometric studies of pricing and concentration in regional

markets.<sup>254</sup> The authors estimated that even perfect collusion in regional cattle markets would depress price by only about 1 percent and reduce transaction volume by only about 1.5 percent. The small size of these effects is a reflection of the high estimate of regional supply elasticity that is consistent with the model's calibrated estimate of the current distortion. (A high supply elasticity severely limits packers' ability to benefit from increased concentration or coordination.) The paper also included sensitivity analyses to help assess the impact of some of the method's quantitative assumptions.

**3.1.2.** Azzam and Schroeter<sup>255</sup> extended the foregoing model to analysis of a problem first addressed by Williamson:<sup>256</sup> the market power/cost efficiency tradeoff in horizontal consolidation. Plant closings and acquisitions in beef packing may occur because of the potential improvement in plant utilization or cost efficiencies due to multi-plant operation. Unfortunately, consolidation of production in larger, more efficient plants, or a reorganization bringing existing plants under more unified control increases the concentration of the ownership structure and may lead to greater market power. The economic issue is, in part, whether cost reductions achieved through economies of plant size or multi-plant operation offset allocative inefficiency resulting from the decline of competitiveness.

Figure 5.2 illustrates the tradeoff. The national market consumer demand curve for beef is labeled  $D$  and  $S$  is the national market cattle supply curve. Assuming constant marginal processing costs, packers' derived demand for cattle is  $DD$ . With an initial (pre-consolidation) distortion of  $D$ , initial cattle/beef quantity and cattle price are  $Q$  and  $\hat{w}$  and initial beef price is  $\hat{p}$ . Now suppose that (perhaps over a period of several years) the industry undergoes a drastic reconfiguration involving consolidation of production in fewer, more efficient plants and heightened market power. The improvement in cost efficiency shifts the derived demand to  $DD^*$ . Marginal processing cost is now lower so the vertical distance between consumer demand

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<sup>254</sup>"Conventional" comparison studies include Ward; Menkhaus et al.; and Quail et al., all reviewed in chapter IV.

<sup>255</sup>Azzeddine M. Azzam and John R. Schroeter, "Oligopsony Power-Cost Efficiency Tradeoffs in Horizontal Consolidation: An Application to Beef Packing," *American Journal of Agricultural Economics* (forthcoming).

<sup>256</sup>Oliver Williamson, "Economies as an Antitrust Defense: The Welfare Tradeoff," *American Economic Review*, vol.58 (1968), pp. 18-36.

for beef and packers' derived demand for cattle is now smaller. Greater market power is reflected in a larger distortion:  $D^*$  as opposed to  $D$ . Post-consolidation quantity, cattle price, and beef price are now  $Q^*$ ,  $w^*$ , and  $p^*$ , respectively.

The welfare effects are also represented in the diagram. The loss in consumer surplus is area "abcd", loss in cattle producer surplus is "mnp", and gain in packers' variable profit is area "fgpo" minus area "jknm". Adding these components gives the total welfare effect: area "fghi"

FIGURE 2

minus the additional deadweight loss associated with the further oligopsony curtailment of output, area "iknp".

Calibration of the model requires an initial estimate of  $D$ . For this, Azzam and Schroeter relied heavily on the cost analysis of beef packing plants conducted by Duewer and Nelson.<sup>257</sup> Once calibrated, the simple regional oligopsony model, summarized by equation (11), was used to project the effects of changes in concentration (measured by  $H$ ) or conduct (reflected in  $\alpha$ ). For a variety of such hypothetical changes, the authors solved for the proportionate reduction in marginal processing cost that would be consistent with no net change in overall welfare; that is, the cost reduction that would render the sizes of areas "fgih" and "iknp" equal.

For example, one hypothetical scenario had concentration ( $H$ ) and average plant size increasing by 50-percent while conduct shifted to pure monopsony ( $\alpha = 1$ ). For this case, the marginal cost reduction needed to offset the deadweight loss was a relatively modest 2.4 percent. The Duewer and Nelson cost estimates suggest that the marginal cost reduction that would actually be achieved through a 50-percent increase in average plant size is more on the order of 4 percent. This calculation suggests that the recent trend toward consolidation in beef packing, even assuming that it has been accompanied by heightened market power, may well have been welfare-enhancing on balance.<sup>258</sup>

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<sup>257</sup>Using a detailed breakdown of slaughter and processing plant activities and a set of corresponding item cost estimates for 1988, Duewer and Nelson (DN) project annual total cost and output for slaughter and processing plants of a variety of plant sizes operated at several hypothetical rates. Combined with information about the industry's distribution of plant sizes, the DN results can be used to estimate an industry quantity-weighted average marginal cost, the "c" in equation (11). This, combined with data on average revenue per head ( $p$ ) and average livestock cost ( $w$ ), gives a baseline estimate of the monopsony distortion. The DN data were not available when the 1991 Azzam and Schroeter paper was written. Footnote 10 of the 1994 study summarizes a replication of the 1991 analysis using the more reliable DN data for calibration purposes. Results are qualitatively similar to those reported in the 1991 paper. L. A. Duewer, and K. Nelson, "Beefpacking and Processing Plants: Computer-Assisted Cost Analysis," CED, ERS Staff Report No. AGES 9115 (Washington, D.C.: USDA, April 1991).

<sup>258</sup>Although arguably welfare-enhancing on balance, the effects of course do not represent Pareto improvements. Processing firms gain rents while consumers and cattle producers sustain loss of surplus.

### 3.2. *Switching Conduct*

In all NEIO studies to this point, the conjectural elasticity parameter reflecting market conduct,  $\theta$ , was either assumed constant or taken to be an *ad hoc* function of continuously and smoothly varying exogenous variables of the model. This kind of specification restricts the values of  $\theta$ , likewise, to vary continuously and relatively smoothly over time. But another plausible scenario for industry conduct is that price might remain relatively stable at one level for an extended period until perturbed by a significant institutional or structural event whereupon it might assume a different (either more or less competitive) level, perhaps after a brief period of transition.

The foregoing pattern was modeled in Azzam and Park's 1993 "switching study."<sup>259</sup> The authors began by adapting Bresnahan's<sup>260</sup> model to the case of monopsony rather than monopoly power. The model's key equation is:

$$NVMP = (1 - \theta)w + \theta ME, \quad (12)$$

where NVMP is beef packers' net value of the marginal product of cattle,<sup>261</sup>  $w$  is the price of cattle, and ME is the industry's marginal expenditure on cattle. Although not presented as such in their paper, the  $\theta$  parameter in fact played exactly the same role as Schroeter's " $\theta$ ," the conjectural elasticity of market output with respect to a representative firm's output. Here again, a zero value for  $\theta$  corresponds to competitive conduct while a value of 1 is consistent with pure monopsony.

An empirical technique developed by Ohtani et al.,<sup>262</sup> permitted a specification for  $\theta$  that fixed its value at one level,  $\theta_1$ , for sample periods prior to a particular date,  $t_1$ , and at another level,  $\theta_2$ , for periods after a later date,  $t_2 > t_1$ . Between  $t_1$  and  $t_2$ , the transition between the original level of conduct ( $\theta_1$ ) and the final level ( $\theta_2$ ) is modelled as a smooth polynomial function of time. This technique permits simultaneous estimation of not only  $\theta_1$  and  $\theta_2$ , but also the  $t_1$  and  $t_2$  dates that delineate the first and second regimes from the transition phase. Thus, the data themselves are allowed to identify, not only the nature, but also the timing of the change in conduct. Other studies, including Lopez and Dorsainvil,<sup>263</sup> and Buschena and Perloff,<sup>264</sup> have

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<sup>259</sup>Azzeddine Azzam and Timothy Park, "Testing for Switching Market Conduct," *Applied Economics*, vol. 25 (1993), pp. 795-800.

<sup>260</sup>Timothy F. Bresnahan, "The Oligopoly Solution Concept is Identified," *Economic Letters*, vol. 10 (1982), pp. 87-92.

<sup>261</sup>In the case of a fixed proportional relationship between cattle input and beef output, and of competitive conduct in the beef market, NVMP would simply equal output price less marginal processing cost. Neither assumption is essential for the analysis, however.

<sup>262</sup>K. Ohtani, S. Kakimoto and K. Abe, "A Gradual Switching Regression Model with Flexible Transition Path," *Economic Letters*, vol. 32 (1990), pp. 43-8.

<sup>263</sup>R. A. Lopez and D. Dorsainvil, "An Analysis of Pricing in the Haitian Coffee Market," *Journal of Developing*

investigated whether specific institutional or structural changes have affected conduct. In those studies, however, the effects of changes in the environment were simply modelled using dummy variables that "switched on" abruptly at dates that were treated as known.

Azzam and Park implemented the foregoing technique using annual data from beef packing for the period 1960 - 1987 . A cattle supply function was estimated as a basis for construction of the ME term in equation (12). After specification of a parametric form for NVMP, equation (12) was estimated using the Ohtani, et al. technique. The results identified a first regime, extending from the beginning of the sample period until 1977, for which the estimate of  $\theta$  was small and statistically not significantly different from zero. A transition phase followed the first regime and extended until 1982. The second regime, from 1982 until the end of the sample period, was associated with a  $\theta$  estimate which, while still small, was larger than that associated with the first regime and significantly different from zero. Thus, beginning in 1977, industry conduct underwent a transition from essentially competitive to at least modestly monopsonistic. Significantly, the date of the beginning of the transition phase, 1977, correlates with actual industry events. Most industry analysts identify 1977 as the year in which concentration began to be markedly greater.

### ***3.3. Trigger Price***

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*Areas*, vol. 34 (1990), pp. 93-106.

<sup>264</sup>D. E. Buschena and J. M. Perloff, "The Creation of Dominant Firm Market Power in the Coconut Oil Export Market," *American Journal of Agricultural Economics*, vol. 73 (1992), pp. 1000-1008.

Several NEIO studies of meatpacking have attempted to infer market conduct and power from the information contained in the co-movements of prices, quantities, and exogenous variables sampled annually or, at most, quarterly. Koontz, et al.<sup>265</sup> assessed the degree of monopsony power exercised by beef packers through examination of day-to-day movements in regional beef margins. The vehicle for their analysis is the well-known trigger price model of "non-cooperative collusion" developed by Green and Porter.<sup>266</sup>

The intuition of the model is as follows. Beefpackers engage in a repeated pricing game within their procurement regions. Collectively, their interest is in holding the price of fed cattle below competitive levels. Once an oligopsony price is established, however, each firm faces incentives to bid prices up somewhat in order to secure greater cattle volume and greater profit. To reconcile individual with collective incentives, the regional oligopsony/buyer cartel issues a threat of punishment: if departures from the cooperative price are detected, the group will revert to non-cooperative pricing for a specified length of time. This threat of punishment might be adequate to deter all maverick departures from the cooperative price.

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<sup>265</sup>Stephen R. Koontz, Philip Garcia, and Michael A. Hudson, "Meatpacker Conduct in Fed Cattle Pricing: An Investigation of Oligopsony Power," *American Journal of Agricultural Economics*, vol. 75 (1993), pp. 527-48.

<sup>266</sup>Edward J. Green and Robert H. Porter, "Non-Cooperative Collusion under Imperfect Price Information," *Economica*, vol. 52 (1984), pp. 87-100.

The cartel faces the problem that cheating on the cooperative agreement cannot be observed directly because packers typically do not know the bids of specific rivals. An imperfect inference of cheating can be drawn, however, from the regional average beef margin which typically would be available to firms with a lag of a few days. Unusually low realized margins might be evidence of cheating on the part of one or more regional rivals.<sup>267</sup> Green and Porter's contribution is the insight that, facing such a situation, firms may coordinate their activities with a "trigger-price" (or, in this case, a "trigger-margin") strategy. Margins falling below a specified critical level trigger a punishment phase consisting of a reversion to non-cooperative pricing conduct. In theory, the height of the trigger threshold and the length of the punishment phase would be selected such that a potential maverick, weighing the expected short-term gains of cheating against the possibility of triggering a reversion and incurring the associated long-term loss of collusive profits would be deterred from departing from the cooperative price in the first place.

Another problem for the cartel is that a margin low enough to trigger a reversion might also be a result of perfectly innocent, unobservable, random shifts in daily fed cattle supply. The peculiar irony of this model is that, even though all players know that cheating is effectively deterred and that any significant drop in the margin must be due, instead, to supply shifts, such a drop, nonetheless must be met with a reversion to non-cooperative pricing if the credibility of the deterrent is to be preserved. So, in equilibrium, the oligopsony alternates between periods of cooperative and non-cooperative pricing conduct even though no one ever cheats.

Koontz, et al. couched the implications of the trigger price theory within the following reduced-form model for the margin:

$$\begin{aligned} m_t &= W_t\alpha + \varepsilon_{1t}, & \text{if } t \text{ is a cooperative period, and} \\ m_t &= W_t\alpha\phi + \varepsilon_{2t}, & \text{if } t \text{ is a non-cooperative period,} \end{aligned} \quad (13)$$

where  $m_t$  is the regional average boxed beef/fed cattle margin on day  $t$ ;  $W_t$  is a vector of exogenous factors that affect fed cattle supply in the region on day  $t$ ;  $\varepsilon_{1t}$  and  $\varepsilon_{2t}$  are zero mean random disturbance terms with variances  $\sigma^2$  and  $\sigma^2\phi^2$ , respectively; and  $\alpha$ ,  $\phi$ , and  $\sigma^2$  are parameters to be estimated. Equation (13) indicates that during non-cooperative periods the margin is simply scaled downward from its cooperative level by a factor  $\phi < 1$ . In the econometric model, the classification of days in the sample as "cooperative" or "non-cooperative" is assumed to be the realization of a series of independent Bernoulli trials with probability of a cooperative regime  $\lambda$  and probability of a non-cooperative regime  $1 - \lambda$ . Given appropriate data, the parameters of the model, including  $\lambda$ , can then be jointly estimated by maximum likelihood.

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<sup>267</sup>Koontz, et al. assumed that boxed beef prices are determined in competitive markets beyond the control of packers in any one region. The trigger mechanism thus focuses equivalently on either fed cattle prices or the margin.

The approach yields estimates of several meaningful indices of market power. The first is  $\phi$ , the ratio of the margin under cooperative conditions to the margin under non-cooperative conditions. A greater value of  $\phi$  means greater market power because it implies that, through cooperation, oligopsony firms are able to achieve a greater proportionate increase in margin relative to the non-cooperative level. The second is  $\lambda$ , the long-run proportion of days that are characterized by cooperative conduct. A larger value of  $\lambda$  means greater market power because it implies that the cartel sustains cooperation a greater proportion of the time. A third statistic, packers' expected gain from cooperation, effectively combines the first two into a single, overall index of market power. Cooperation offers packers a lottery that returns the "high" cooperative margin with probability  $\lambda$  and the "low" non-cooperative margin with probability  $1 - \lambda$ . The expected gain from cooperation is simply the mean value of this outcome minus the non-cooperative margin.

Koontz, et al. applied the technique to daily beef margin data from each of four supply regions -- Iowa, Eastern Nebraska, Western Kansas, and Texas-New Mexico -- for each of 2 time periods -- May 1980 through September 1982, and July 1984 through July 1986. The hypothesis of no switches in the margin equation (13) ( $\phi = 1$ ) was soundly rejected for each of the regions for both time periods. Generally speaking, market power as measured by  $\phi$  was higher during the 1984-86 period than during the 1980-82 period but market power as measured by  $\lambda$  was lower during the second period. When the expected gain from cooperation was adopted as the appropriate index, market power was lower, on balance, during 1984-86 than during 1980-82. In the early period gains from cooperation varied between \$5 and \$19/head across regions. In the later period gains were between \$2 and \$5/head. The authors speculated that increased incidence of packer-buyer contractual arrangements and the greater volatility of short-run fed cattle supplies during the second period may have contributed to packers' diminished success at sustaining effective cooperation.

### ***3.4. Average-Cost Pricing***

The papers reviewed to this point adopted period-by-period profit maximization within the context of a quantity-setting model as their basic firm-behavior objective.

**3.4.1.** Stiegert, et al.<sup>268</sup> explored the possibility that beefpacker conduct may, instead, be consistent with actual slaughter volumes being dictated primarily by supply conditions and cattle pricing being determined by adherence to an average-cost-based rule.

The authors used a flexible-form profit function approach to derive a system of equations that provided a context for the estimation of the markdown of cattle prices relative to their marginal revenue product. This approach, most often applied to competitive input and output

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<sup>268</sup>Kyle W. Stiegert, Azzeddine Azzam, and B. Wade Brorsen, "Markdown Pricing and Cattle Supply in the Beef Packing Industry," *American Journal of Agricultural Economics*, vol. 75 (1993), pp. 549-58.

markets, can be extended, as Diewert has shown, to the case of imperfect competition in one or more markets.<sup>269</sup> Specifically, the authors began with an industry profit function defined as

$$\begin{aligned} \Pi(p, w_0, w_1, \dots, w_m) \equiv \max \{pq - w_0x_0 - w_1x_1 - \dots - w_mx_m \\ \text{s.t. } q = q(x_0, x_1, \dots, x_m)\}, \end{aligned} \quad (14)$$

where  $p$  is the price of the beef output;  $w_0$  is the price of cattle;  $w_1, w_2, \dots, w_m$  are the prices of other inputs;  $q$  and the  $x_i$ s are output and input quantities, respectively; and  $q(\cdot)$  is the production function. If the cattle market is oligopsonistic, replacing  $w_0$  with the shadow price

$$w_0^* = w_0(1 + \theta/\eta), \quad (15)$$

where  $\eta$  is the elasticity of cattle supply and  $\theta$  is the conjectural elasticity identifying the industry's degree of oligopsony power, yields a profit function which is dual to the packers' production function. The term  $w_0^*$ , defined in this way, is simply the representative firm's marginal outlay for cattle. In a profit-maximizing equilibrium, the latter would be equated to the marginal revenue product of cattle. Rewriting equation (15) as

$$w_0^* = w_0(1 + M)$$

introduces  $M$ , the proportionate markdown of cattle prices below their marginal revenue product to packers. Stiegert, et al. specified a generalized Leontief form for  $\Pi(\cdot)$ , and applied Hotelling's lemma to derive a system of output supply and input demand relations consistent with profit-maximizing behavior. Thus, the authors used results from duality theory for a profit-maximizing firm to establish a bench mark with respect to which  $M$  was defined.

Attention was focused on the nature of packers' cattle pricing strategy and how it manifests itself in the relationship between  $M$  and cattle supply movements. One possibility is that packers employ an "average-processing-cost" (APC) approach in which cattle bid prices are set at a level insuring that processing costs are covered given the prevailing price received for carcass or boxed beef. Under this scenario, when supplies are either expectedly or unexpectedly "inadequate" and plants must operate at an inefficiently low weekly slaughter volume, packers would reduce bids (thereby increasing the cattle/beef margin and the markdown,  $M$ ) so as to cover the higher average processing cost. Another possibility is that packers might respond to expectedly or unexpectedly meager supplies by expanding their normal procurement areas in an effort to secure larger cattle volume needed for efficient operation. This would increase the

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<sup>269</sup>For an earlier example of the application of the technique to an imperfectly competitive market, see M. Roberts, "Testing Oligopolistic Behavior: An Application of the Variable Profit Function," *International Journal of Industrial Organization*, vol. 4 (1988), pp. 367-384.

average number of bidders in any one market and so would tend to increase cattle prices (reducing the margin and M). Stiegert, et al. characterize this as "SCP" pricing because of its assumed direct relationship between the number of buyers and the level of prices.

As suggested above, the response to supply fluctuations could conceivably be governed by different pricing rules depending on whether the fluctuations are expected or unexpected. The authors developed an econometric model of total fed cattle supply that was capable of identifying these "anticipated" and "unanticipated" components. The components were then separately entered as explanatory variables in their specification for M. Using quarterly data for the period 1972.I through 1986.IV, the supply and demand system derived from the profit function was estimated and the relationship between M and both anticipated and unanticipated cattle supply movements was revealed.

The results provided robust evidence of APC pricing in the face of anticipated supply movements. Foreseeable supply shortfalls induced packers to increase their markdowns to insure a margin adequate to cover processing costs at the resultant lower, less efficient weekly slaughter volumes. The pricing response to unanticipated supply shocks appeared to be more complex. As might be expected, the response to "small" supply shocks was comparable to the response to predictable supply movements, APC pricing thus prevailing. For larger shocks, though, APC pricing discipline appeared to deteriorate into an SCP pricing free-for-all. When supplies were unexpectedly and significantly inadequate, packers did compete aggressively to secure an adequate flow of slaughter cattle. Markdowns decreased as a result.

Expecting the finding of SCP pricing for the case of "large" supply shocks, the authors found behavior consistent with APC pricing, contending this discovery has valuable policy implications. One implicit assumption of SCP analyses of the beefpacking industry is that reducing packer concentration and, consequently, increasing the average number of buyers in a typical cattle procurement area, would lead to more aggressive bidding and commensurately higher cattle prices. The fact that the authors found no evidence of this pricing mechanism, finding instead that cattle prices appear to be determined mainly by the level of average processing cost, casts some doubt on the assumed linkage between concentration and more competitive pricing.

#### **4. Oligopoly Models**

The studies of imperfect competition in the meatpacking industry reviewed to this point have all been "short-run" in that they treat the number and size of firms as either fixed or exogenously determined.

**4.A.** Holloway<sup>270</sup> developed an endogenous-entry, conjectural variations model of an oligopolistic marketing sector. The model, which is a generalization of Gardner's<sup>271</sup> model of

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<sup>270</sup>Garth J. Holloway, "The Farm-Retail Price Spread in an Imperfectly Competitive Food Industry," *American Journal of Agricultural Economics*, vol. 73 (1991), pp. 979-989.

price spreads under perfect competition, yields implications about retail food and farm commodity price responses that can be used to distinguish empirically between perfectly and imperfectly competitive conduct on the part of firms in the industry.

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<sup>271</sup>B. L. Gardner, "The Farm-Retail Price Spread in a Competitive Food Industry," *American Journal of Agricultural Economics*, vol. 57 (1975), pp. 399-409.

Holloway assumed that profit-maximizing marketing firms face constant marginal cost and exercise some degree of market power as indexed, in the usual way, by a conjectural elasticity parameter,  $\theta$ . Firms were symmetric so equilibria required equal market shares. The equilibrium number of firms was determined by a zero profit condition reflecting the effects of assumed free entry. Supply of non-farm processing inputs was assumed perfectly elastic and the supply of the farm commodity was treated as exogenous. In support of these assumptions, Holloway cited Wohlgenant's<sup>272</sup> finding that farm commodity supplies are econometrically predetermined.

The paper used the following notation:

$P_x$  = retail food price,  
 $P_a$  = farm commodity price,  
 $P_b$  = non-farm processing input price,  
 $N$  = demand shift variable, and  
 $a$  = supply quantity of the farm commodity.

$E(z, w)$  was defined as the elasticity of the equilibrium value of the endogenous variable  $z$  with respect to the exogenous variable  $w$ . Holloway obtained the following result for perfect competition but only for that case:

$$E(P_a, N) = -E(P_a, a) \text{ and } E(P_x, N) = -E(P_x, a). \quad (16)$$

Thus, if and only if the marketing industry is perfectly competitive, equal proportionate shifts in retail demand and farm commodity supply will have effects on farm commodity (retail food) price that are equal in absolute magnitude but opposite in sign.

The mathematics of the model are complex and not particularly revealing, but some intuition about the result can be obtained from a graphic exposition that incorporates simplifying assumptions (Figure 5.3). Assume that marginal processing cost is zero and that there is a fixed proportional quantity relationship between the farm product and the retail food product, with one unit of farm commodity needed to make one unit of food. With  $a$ , the level of farm commodity supply, being given exogenously,  $P_a$  is determined as the marketing firms' perceived marginal revenue evaluated at  $a$ , or  $(1 - \theta)P_x + \theta MR_x$ , where  $MR_x$  is marginal revenue computed with respect to the industry demand curve. In general, the price of the farm commodity was determined, in Holloway's model, as the representative marketing firm's perceived marginal revenue product of the commodity net of marginal processing cost. In this case, with fixed proportions and zero marginal cost in food processing,  $P_a$  is simply perceived marginal revenue.

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<sup>272</sup>Michael K. Wohlgenant, "Demand for Farm Output in a Complete System of Demand Equations," *American Journal of Agricultural Economics*, vol. 71 (1989), pp. 241-252.

Panels i and ii of figure 5.3 illustrate farm commodity price responses in the perfectly competitive ( $\theta = 0$ ) case. Equal rightward shifts in farm commodity supply (panel i) and retail demand (panel ii) have effects on  $P_a$  that are of equal absolute magnitude but opposite sign. Panels iii and iv illustrate the perfect monopoly ( $\theta = 1$ ) case. Here, equal rightward shifts in farm

FIGURE 3

commodity supply (panel iii) and retail demand (panel iv) result in changes in  $P_a$  that are of different absolute magnitudes. The reason for this result is that the shift in marginal revenue in panel iv is smaller than the shift in demand, which in turn equals the shift in farm commodity supply in panel iii. Thus marginal revenue evaluated at the farm commodity supply quantity, and hence farm commodity price, increases less in panel iv than it fell in panel iii. Qualitatively similar results are obtained whenever  $\theta > 0$ .

A test of the equalities in (16) amounts to a test of perfect competition in the marketing industry. Holloway carried out such tests within the context of two regression models of the following form:

$$\begin{aligned} P_{xt}^* &= \beta_{xx}N_t^* + \beta_{xa}a_t^* + \beta_{xb}P_{bt}^* + \varepsilon_{xt}, \\ P_{at}^* &= \beta_{ax}N_t^* + \beta_{aa}a_t^* + \beta_{ab}P_{bt}^* + \varepsilon_{at}, \end{aligned}$$

where \* superscripts indicate proportionate changes, t subscripts have been added to index observations, the  $\beta$ s are parameters to be estimated, and the  $\varepsilon$ s are random disturbance terms. The hypothesis of interest is

$$H_0: \beta_{xx} = -\beta_{xa} \text{ and } \beta_{ax} = -\beta_{aa}.$$

Holloway used annual data for 1955-83 in testing this hypothesis for several commodities, including beef/veal and pork.<sup>273</sup> For these meat cases, as well as for the other food cases tested, he failed to reject the hypothesis of perfect competition. Thus the findings as well as the methodology of Holloway's study were quite different from those of most other NEIO analyses of meatpacking.

## 5. Bilateral Oligopoly Models

The NEIO analyses of packer market power surveyed to this point all assume price-taking behavior on the part of the retail distributors that packers confront in their output market, and that retailers are price-takers in selling beef to consumers. Not much is known about the sensitivity of market power tests to simplifications that omit a stage or stages of the marketing channel from the analysis. The following is a first effort in testing market power at alternative stages.

**5.A.** Azzam and Zhang<sup>274</sup> developed a framework for testing the validity of a price-taking assumption for players at various vertically-related stages of a marketing channel. They applied

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<sup>273</sup>Quantity data and retail- and farm-level price data are readily available for a variety of commodities. In the construction of  $N^*$ , the demand shift index, Holloway followed the procedure used by Wohlgenant, *op. cit.*

<sup>274</sup>Azzeddine Azzam and Mingxia Zhang, "Testing Successive Market Power in Vertically Related Markets," unpublished manuscript, 1992.

the technique to quarterly data on beef for the period between 1970.I and 1990.IV. Results suggested that retailer monopoly power may be more of a problem than beefpacker monopsony power.

Three alternative scenarios characterized the state of competition among and between stages of the beef marketing channel. In each of the three, cattle feeders were assumed to be price takers in the cattle market. In the packer dominance (PD) model, an additional maintained hypothesis was that retailers were price-takers in the wholesale beef market. Packer conduct in the cattle and wholesale beef markets and retailer conduct in the retail beef market were tested within this context. In the retailer dominance (RD) model, packers were assumed to behave as price-takers in their dealings with retailers. Retailer conduct in both input and output markets and packer conduct in the cattle market could then be tested. In the bargaining (BM) model, the maintained hypotheses included pure monopsony on the part of packers in the cattle market and pure monopoly on the part of retailers in their output market. The solution in the wholesale beef market was assumed to obtain through bargaining between packers and retailers as bilateral monopolists.

The economic "fundamentals" of the problem were parametric specifications for retail beef demand and for costs at each of the three marketing stages. The PD and RD models yielded distinct expressions for the equilibrium wholesale price of beef in terms of these fundamentals. The PD solution for wholesale price was a logical upper bound on the level of price that would be achieved through bargaining while the RD prices served as a lower bound. So, not surprisingly, the equilibrium wholesale price under the BM scenario turned out to be roughly a weighted average of the PD and RD solutions, with the weights reflecting the degrees of bargaining power possessed by the two sides.

The hypothesis of price-taking behavior on the part of packers in the cattle market amounts to a parametric restriction on the parameters of the expressions for equilibrium wholesale price emerging from both the PD and RD models. In neither case could these restrictions be rejected. In other words, the results did not provide evidence supporting non-competitive cattle market conduct on the part of packers. On the other hand, the hypothesis of competitive retailer conduct in their output market was rejected for both the PD and RD models.

Within the context of the PD model, which assumes that retailers respond passively to packers' setting of wholesale price, the hypothesis of packer monopoly power was not rejected. Likewise, the hypothesis of retailer monopsony power was not rejected within the context of the RD model, which assumed that packers are price-takers in the wholesale market. These results suggest that bilateral monopoly may be the most accurate characterization of the wholesale beef market. Non-nested hypothesis tests used to execute pair-wise comparisons of the three models confirm this conclusion. The BM model emerged as the most defensible of the three models, with parameter estimates suggesting roughly equal degrees of participant market power.

As the authors point out, bilateral monopoly in the wholesale market is plausible in view

of the high levels of concentration on both sides of the market.<sup>275</sup> The finding of competitive packer conduct in cattle markets is more surprising and runs counter to the conclusions of many of the papers reviewed above. Azzam and Zhang's methodology merits replication in the assessment of market power in vertical chains of industries, but it does suffer a shortcoming -- the models estimated are single-equation, reduced-form, models of wholesale prices only. They had no auxiliary equations embodying cross-equation restrictions that would help in validating the models' parameter estimates. The method's results may therefore be sensitive to changes in the parametric forms utilized in structuring their demand and cost functions.

## 6. Summary

This chapter has provided a taxonomy of 11 NEIO market power studies of meatpacking, highlighting their respective hypotheses, period of analysis, periodicity of data, empirical method, and main findings. As summarized in table 5.1, there were six oligopsony/oligopoly studies, four oligopsony studies, one oligopoly study, and one bilateral oligopoly study. The common objective of these studies was to determine the presence or absence of market power.

Two of the six oligopsony/oligopoly studies appraised beefpacker competition in live cattle and wholesale beef markets, and two examined porkpacker competition in live hog and wholesale pork markets. One studied joint beefpacking and porkpacking competition in their respective live markets, and competition in beef and pork at retail. The sixth study tested for oligopoly and oligopsony market power in meatpacking (beef, pork, and lamb).

Six of the seven studies testing competition in cattle markets found support for monopsony power, either singly or jointly with wholesale or retail beef markets. However, the switching study (3B) failed to reject competition in cattle markets during the 1955-1977 period. Only in the bilateral oligopoly study were cattle markets found to be competitive. One study (2A), which tested beefpacker competition in live cattle as well as wholesale beef markets, found evidence of market power in both markets. However, the parameter measuring market power was constrained to be the same for both markets. In the other study (2B), where market power was not constrained to be the same in both markets, beefpackers were found to exert market power in live cattle markets but not in wholesale markets. Market power at retail was not rejected when the test was conducted jointly with a test of buyer power in live cattle markets (studies 2F and 5A). The bilateral oligopoly study tested jointly for beefpacker monopsony power in live cattle markets, beefpacker/retailer bilateral monopoly market power, and retailer

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<sup>275</sup>The four largest national grocery store chains purchase 55 to 60 percent of the beef sold directly to integrated retailers/wholesalers. See John M. Connor, "Concentration Issues in the U.S. Beef Sector, Can Beef Compete in the 1990s" in *Competitive Issues in the Beef Sector*, Report No. 1 (Humphrey Institute: University of Minnesota, 1989).

oligopoly market power. Beefpackers were found to be competitive in buying cattle, but exercised bilateral market power with retailers, who also later exerted monopoly power at retail.

Table 5.1. Summary Results of NEIO Studies of U.S. Meatpacking, by Study Characteristics and Livestock Species.

Type of Study	Study	Data Frequency	Data Type	Observation Unit	Estimation Method	Sample Period	Findings For:		
							Cattle/Beef	Hogs/Pork	Total Meat
Oligopsony/Oligopoly	2A	A	T	N	FIML	1951-1983	+L,+W		
	2B	Q	T	N	I3SLS	1972-1986		+L,+W(72-78)	
	2C	A	T	N	I3SLS	1959-1982			+L,+W
	2D	Q	T	N	FIML	1972-1988		-L,-W	
	2E	M	T	N	OLS	1988-1991	+L,-W		
	2F	Q	T	N	I3SLS	1976-1986	+L,+R	+L,+R	
Oligopsony									
Simulation	3A.1 3A.2	A	T	N	SIM	NA	+L		
Switching	3B	A	T	N	ML	1955-1987	-L(55-77)+L(78-87)		
Trigger Price	3C	M	T	R	ML	80-82, 84-86	+L		
APC Pricing	3D	Q	T	N	I3SLS	1972-1986	+L		
Oligopoly	4A	A	T	N	ML	1955-1983	-R	-R	
Bilateral Oligopoly	5A	Q	T	N	NLS	1970-1990	-L,+BO,+R		

Data Frequency

A = Annual  
 Q = Quarterly  
 M = Monthly  
 W = Weekly  
 D = Daily  
 E = Occurrence of Sale

Data Type

C = Cross-section  
 CT = Cross-section time  
 T = Time series

Observation Unit

N = National  
 R = Regional

Estimation Method

FIML = Full Information Maximum  
 I3SLS = Iterative Three Stage Least  
 ML = Maximum Likelihood  
 NLS = Nonlinear Least Squares  
 SIM = Deterministic

Finding

+ = Evidence of market power  
 — = No evidence of market power  
 L = Livestock market  
 W = Wholesale market  
 R = Retail market  
 B = Bilateral market power

Hog/pork studies were not numerous. Evidence from the first two oligopsony/oligopoly studies of porkpacking points to absence of market power, especially when pork demand uncertainly is taken into account (2D). The multiproduct case, however, did show some evidence of porkpacking oligopsony market power and pork retailing seller power. The last study (4A) dealing exclusively with retail-level markets found no evidence of market power in pork retailing.

Only one study examined meatpacking competition by aggregating all meats (beef, pork, and lamb). The findings supported both oligopsony and oligopoly market power. A calibration/simulation oligopsony study measured beefpacker buyer power under alternative structure-conduct scenarios (3.1.1). Relatively small distortions in cattle markets were found even under the extreme case of pure monopsony. A second such study calculated the cost reduction required to offset the social welfare losses due to increased market power occasioned by horizontal consolidation in the industry. Cost savings of about 2.4 percent were needed to offset welfare losses from a 50-percent increase in the Herfindahl index of concentration or plant size of a representative firm,<sup>276</sup> well below the 4-percent economies-of-scale savings from an equivalent increase in plant size.

The main NEIO findings, by livestock species, are summarized below:

### **6.1. Beefpacking**

**Study 2.A.** Oligopsony and oligopoly market power distortions averaged about 3 percent and 1 percent, respectively. Size of pricing distortions did not increase with increasing concentration during the sample period. Estimates were based on annual data for the period 1951 through 1983. Identical market power in live cattle and beef-wholesale market was a maintained hypothesis.

**Study 2.B.** Oligopsony market power distortion averaged about 2.6 cents/pound of the beef farm-wholesale margin. No oligopoly distortions were found. Estimates were based on monthly data for the period 1988 through 1991. Oligopsony and oligopoly conduct were not assumed identical.

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<sup>276</sup>To relate the 50-percent increase in the Herfindahl index (H) of concentration to a 50-percent increase in average plant size, pre- and post-consolidation market structures were assumed to be comprised of equal-sized firms. Because the equivalent number of equal-sized firms for H is  $1/H$ , a 50-percent increase in HHI corresponds to a reduction in the number of firms by a factor of 1/1.5 which, assuming the industry output remains roughly the same post-consolidation, implies a 50-percent increase in the output of a representative firm.

**Study 2.F.** Oligopoly and oligopsony distortions in the beef farm-retail margin averaged about 13-percent and 14-percent, respectively. Estimates were based on quarterly data from 1976 through 1986. Cross-market effects with pork as a jointly demanded product were considered in this model.

**Study 3.A.2.** Even a transition to pure monopsony in regional cattle markets would not result in more than a 1-percent reduction in cattle prices. Regional market power was mitigated by high regional cattle-supply elasticity. Results were based on a regional calibration/simulation model.

**Study 3.A.2.** A reduction in marginal processing cost of 2.4 percent was capable of offsetting social welfare losses from market power stemming from a 50 percent increase in concentration and average plant size. The cost reduction actually achieved through a 50 percent increase in average plant size is about 4 percent. Results in this study were based on a regional calibration/simulation model. Estimates of cost reductions from increased plant size were obtained from an economic engineering study.

**Study 3.B.** There is an indication that, beginning in 1977, conduct in the industry underwent a transition from competitive to modestly monopsonistic. Results were based on annual data from 1960 to 1987. Transition in conduct was not specified *a priori*; it was identified by the data through the use of a switching regression model.

**Study 3.C.** Beefpacker oligopsony alternated between periods of cooperative and non-cooperative pricing conduct. Beefpackers were not successful in sustaining effective cooperation. Results were based on behavior of daily beef margin data from four supply regions for 2 periods (May 1980-September 1982, and July 1984-July 1986).

**Study 3.D.** Average processing-cost pricing of cattle was the rule during periods of expected shortfalls in cattle supply. Shortfalls induced packers to increase the markdowns, apparently to insure a margin adequate to cover processing costs resulting from inadequate cattle supply. Increases in markdowns were not correlated with increased in beefpacker concentration. Estimates were based on quarterly data for the period 1972 through 1986.

**Study 4.A.** Beef retailing was found to be competitive. Conclusions were based on annual data for 1955-1984. Competition in livestock markets was a maintained hypothesis.

**Study 5.A.** Evidence suggested bilateral market power between packers and retailers, monopoly power by retailers, and perfect competition by packers in procuring cattle. Results were obtained using a bilateral monopoly model and quarterly data from 1970 through 1990.

## ***6.2. Porkpacking***

**Study 2.B.** Farm-wholesale pork margins were competitive for much of the period, during which concentration was on the increase. Estimates were based quarterly data for the period 1972 through 1986. Identical market power in the live hog and pork wholesale markets was a maintained hypothesis.

**Study 2.D.** Output price risk was found to be a more important component of farm-wholesale pork margins than market power. Estimates were based on quarterly data for the period 1972 through 1988. Oligopsony and oligopoly conduct were allowed to be different.

**Study 2.F.** Oligopoly and oligopsony distortions in the pork farm-retail margin averaged about 5 percent and 34 percent, respectively. Estimates were based on quarterly data from 1976 through 1986. Cross market effects with beef as a jointly produced output were considered in the model.

**Study 4.A.** Pork retailing was found to be competitive. Conclusions were based on annual data for 1955-1984. Competition in hog markets was a maintained hypothesis.

The following generalization emerges from the foregoing NEIO findings:

The evidential balance from time series studies using national data appears to weigh in favor of the hypothesis that meatpacker conduct in live cattle markets is not competitive. However, the apparent degree of market power did not increase with increasing concentration.

Results from studies using regional data showed beefpackers were unable to sustain effective cooperation. Their cattle buying alternated between cooperative and non-cooperative pricing conduct. Cattle price impacts of increased concentration were found to be small. High regional cattle supply elasticities may have been the cause. The cost reductions required to offset the welfare losses from consolidation-induced concentration are half of what is actually achieved through such consolidation.

Porkpacking has received relatively less research coverage than beef, but the evidential balance appears to weigh in favor of price-taking behavior, especially when the output price risk is incorporated in the analysis.

An appraisal of the findings is provided in the final chapter.

## CHAPTER VI

### APPRAISAL, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

#### 1. Introduction

The two previous chapters have gathered assorted evidence from a succession of studies which applied various tests of market power in the meatpacking industry. The present chapter reviews that evidence and attempts to draw conclusions about the apparent state of competition in the industry.

Unfortunately, the pathway to straightforward and meaningful conclusions courses some awkward and poorly-marked terrain. Various paths might seem tentatively to lead in the right general direction. One might simply count the score of the studies finding evidence of market power relative to those that don't, ignoring perhaps those with the most ambivalent findings. Alternatively, and more heroically, one might take sides, depending on one's perception of the relative persuasiveness of the separate studies, and arrive thereby at some sort of weighted composite conclusion. Or one might attempt to lay out, in matrix form perhaps, the diversity of the findings and let the readers take their preference.

The third path is simply not very helpful and the first two fail to reach relevant conclusions. Recognize first, that the studies under review are highly varied in their method, data sources and coverage (temporal, spatial, etc.), variables analyzed, and methods of estimation and the like. Their findings are therefore not additive. Second, there is not a definitive analysis in the lot. Because the complexities of firm behavior are at the outer reach of analytical technology, every author has had to accept modelling compromises.

The present chapter takes an alternative approach which attempts to appraise whether the market power interpretation of the empirical findings is persuasive enough to warrant the conclusion that competition in the meatpacking industry is deficient. The approach is a middle course which backs away from most of the detail, assessing the broader analytical foundations of the studies, but examining detail as well where it is particularly relevant.

Appraisal of SCP and NEIO evidence is presented in sections 2 and 3, respectively. Section 4 reports conclusions and implications

#### 2. Appraisal of the SCP Evidence

Of the SCP studies reviewed in chapter IV, the four categories comprising the most recent and most credible work made the strongest case for market power in the industry. These are, in the order in which they are summarized below, regional price-concentration studies, transaction-level price studies, plant entry/exit studies, and spatial price-behavior studies.

##### *2.1 Regional Price-Concentration Studies*

By focusing on single industries across geographically-differentiated markets, and using prices rather than profits as the dependent variable, meatpacking price-concentration researchers have sought to shield their studies from measurement and interpretation problems apparent in earlier empirical estimates of structure-performance relationships (see chapter III).

SCP analyses of meatpacking have used livestock price as the performance index, seemingly bypassing the marginal-cost measurement dilemma. However, performance is not revealed by price, *per se*, but rather by the discrepancy between actual and competitive prices. The competitive price is given by packers' marginal revenue product of livestock net of marginal processing cost. So the marginal-cost measurement problem is merely obscured, not resolved.

SCP analyses of meatpacking interpret negative correlations between livestock prices and buyer concentration to imply oligopsonistic conduct. The causal link runs from higher concentration to increased oligopsonistic coordination to lower livestock prices. Results of such studies are open to alternative interpretations since, among other things, estimation of reduced-form price-concentration studies is not undertaken subject to the discipline imposed by microeconomic theory.

Consider, for example, figure 6.1 taken from Schroeter<sup>277</sup> which illustrates the basic model underlying most SCP studies of monopsony power in regional livestock procurement markets. Supply, S, and demand, D, combine to determine competitive livestock price, WC. If packers in the region exercise monopsony power, actual price will be lower than the competitive price. A conventional SCP approach would use data drawn from a cross-section of regional markets to estimate a regression equation, including demand and supply shifters, to capture cross-market differences in WC, and a concentration variable intended to capture the magnitude of the oligopsony distortion, the gap between WC and the actual price. But the oligopsony distortion is not determined solely by concentration; supply elasticity plays a role as well. This can be seen by imagining a hypothetical regional market with the given supply and demand curves and packer concentration sufficient to bring about pure monopsony pricing at the level WM.<sup>278</sup> Suppose that supply conditions undergo changes that have the effect of making the supply curve more elastic, rotating it clockwise about point C. The monopsony price would

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<sup>277</sup>This discussion draws heavily from John R. Schroeter, "Measuring Market Power in Food Processing Industries: Discussion," *American Journal of Agricultural Economics*, vol. 72 (1990), pp. 1227-1229.

<sup>278</sup>The monopsony quantity is determined by the intersection of the marginal livestock cost schedule, S1, and demand, D. The monopsony price WM is determined by intersection of the monopsony quantity with the live cattle supply schedule, S.

increase, and the distortion would correspondingly decrease even though WC and, more importantly, concentration remain unchanged. If this theoretical linkage between supply elasticity and the oligopsony distortion is not imposed in the estimation procedure, there is no guarantee that the concentration term will capture the whole distortion and nothing more. It might, for example, simply pick up the effects

FIGURE 6.1

of spurious cross-market correlations of concentration with factors that shift supply or demand and so affect WC, not WC-WM.

In all SCP regional meatpacking studies, prices (as the dependent variable) and costs (as one of the control variables) are averages for each region. Any information on the degree of heterogeneity of packer processing cost-efficiency within a region is lost. As argued by Bresnahan,<sup>279</sup> and Dunne and Roberts,<sup>280</sup> variation in within-region producer cost efficiency puts in doubt the market power interpretation given to the price-concentration relationship. Their argument was cast in terms of oligopoly, but it is equally valid for oligopsony. In the presence of differential packer processing-cost efficiency, livestock price is determined by the least efficient fringe, but distribution of slaughter is skewed toward the most efficient plants. The result is a lower regional livestock price and higher concentration than would be observed had all plants or firms been as efficient as the lowest-cost plant or firm. Hence, one alternative to the market power interpretation of negative and statistically significant correlations between regional packer-buyer concentration and livestock prices is processing-cost heterogeneity across regions.

Nor are price-concentration studies free of estimation problems. A particular problem derives from the assumption of mutual regional independence. As highlighted by Kmenta,<sup>281</sup> "when the cross-sectional units are geographic regions with arbitrarily drawn boundaries -- such as the states of the United States -- we would not expect this assumption to be well satisfied."<sup>282</sup> One may argue that regional livestock markets are not as arbitrary as states. Still, basing geographic market boundaries upon the predominant movement of cattle does not imply the regions are mutually independent.

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<sup>279</sup>Timothy Bresnahan, "Empirical Studies of Industries with Market Power," in Richard Schmalensee and Robert Willig, eds., *Handbook of Industrial Organization* (Amsterdam: North Holland, 1989), p. 1044.

<sup>280</sup>Timothy Dunne and Mark J. Roberts, "Costs, Demand, and Imperfect Competition as Determinants of Plant-Level Output Prices," In D. B. Audretsch and J. J. Siegfried, eds., *Empirical Studies in Industrial Organization* (Dordrecht: Kluwer Academic Press, 1992), pp. 13-14.

<sup>281</sup>Jan Kmenta, *Elements of Econometrics* (New York: Macmillan Publishing Co., Inc., 1971), pp. 512-514.

<sup>282</sup>*Ibid.*, p. 512.

Accounting for mutual regional dependence requires econometric techniques different from those applied in cross-sectional, time-wise, autoregressive models. "This is primarily a result of the multidirectional nature of dependence in space, which, as opposed to a clear one-directional situation in time, precludes the application of many simplifying results," and spatial econometric methods are needed instead.<sup>283</sup> Methods have in fact been devised to account for cross-sectional spatial effects. Two types of such effects are distinguished in the literature: (1) spatial dependence and (2) spatial heterogeneity. In general, spatial dependence can be considered to be the existence of a functional relationship between what happens at one point in space and what happens elsewhere. Two broad classes of conditions would lead to this. The first is a by-product of measurement errors for observations in contiguous spatial units. The second is more fundamental to regional science and human geography, and follows from the existence of a variety of spatial interaction phenomena.<sup>284</sup>

Spatial heterogeneity, on the other hand, is related to the lack of stability over space of the behavioral or other relationships under study. More precisely, this implies that functional forms and parameters vary with location and are not homogenous throughout the data set. For instance, this is likely to occur in econometric models estimated on a cross-sectional data set of dissimilar spatial units.<sup>285</sup>

The phenomenon of spatial interaction is central to spatial, as opposed to spaceless, economic analysis of imperfect competition. To illustrate, consider the model of a packer oligopsony with spatially separate plants and procurement options in figure 6.2. Delivered livestock prices at locations 1, 2, and 3 are denoted by  $W_1$ ,  $W_2$ , and  $W_3$ , respectively. Net livestock prices are equal to the delivered price net of transportation cost ( $td$ ), where  $t$  is the average transportation cost per mile, and  $d$  is distance. Product flow regions are designated as 3-A for packers at location 3, A-2-B for packers at location 2, and B-1 for packers at location 1. Now, suppose demand and/or cost conditions result in a higher delivered price,  $W_1'$ . To preserve their supply area, packers at location 2 must match the price rise at location 1. This may involve strategic interaction at location 2 as well as spillovers to location 3 and so on, generating spatially correlated errors.

## ***2.2 Transaction-Level Price Studies***

Packer-buyer market power assessments at the transaction level use price received for each individual sales lot as the dependent variable. Explanatory variables generally fall into one of three categories: (1) variables capturing movements in derived demand, (2) variables indicating individual lot characteristics and (3) variables representing competition for cattle. The latter are proxied by number of bids received by each seller and/or identification of the specific

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<sup>283</sup>Luc Anselin, *Spatial Econometrics: Methods and Models* (Dordrecht: Kluwer Academic Press, 1988), p. 9.

<sup>284</sup>*Ibid.*, p. 11.

<sup>285</sup>*Ibid.*, p. 9.

buyers of the lot. A negative relationship between price and, say, the indicator variable identifying the largest buyers either as a group or as individuals is taken to suggest oligopsonistic market power, as is a positive relationship between price and the number of bidders.

Specification of the reduced-form price model and support for *a priori* expectations about the signs of the estimates of market power coefficients are based on observed packer bidding behavior and previous empirical research, respectively. Since no behaviorally-based bidding model relating conduct to competitive outcome is spelled out, *a priori*, it is not clear what hypotheses are being maintained and what interpretation should be given to the results.

FIGURE 6.2

For example, the positive relationship between price and the number of bidders could be generated in one of two ways. Assuming packers have identical net marginal value products (NMVP), and the NMVP represents an upper bound on packers' bids, one would expect the winning bid to approach the NMVP (a smaller oligopsony distortion) as the number of bidders increases. However, dropping the assumption of identical NMVPs among packers introduces heterogeneity in packer costs and hence in bids. The larger the number of bidders, the higher the chances of the presence of a low-cost packer who will offer a relatively high bid. This result also may impart a positive relationship between number of bidders and livestock prices.

### **2.3 Price Plant-Exit Studies**

Price Plant-Exit Studies models test for market power by comparing prices at a test location relative to another control location, before and after the entry or exit of a plant or plants. A lower relative price following an exit of plant, for example, may indicate market power (figure 6.3). Assume the market was competitive before exit with the NMVP curve intersecting the competitive supply curve *S*. Increased market power subsequent to exit implies movement of the perceived marginal factor cost from *S* toward *S*<sub>1</sub> and perhaps to *S*<sub>2</sub>, resulting in relatively lower livestock prices, *WO* and *WM*, respectively. Whether the latter represent markdowns from *WC* hinges on whether the lower prices are actually the result of intersections between the competitive supply curve, *S*, and lower derived demand curves. This is the classic problem of trying to identify market power from observed data in the absence of additional restrictions on the model.<sup>286</sup> More importantly, since prices and quantities also change in control markets over the course of the study, events in those markets may also affect the result.

### **2.4 Spatial Price-Linkage Models**

Tests for market power in meatpacking, using a spatial price linkage model, take their theoretical guidance from the spatial microeconomics of imperfect competition. Here, packers and livestock producers are spatially distributed and the cost of transporting cattle from producers to packing houses is significant. Though this gives rise to geographic segmentation of regional cattle markets, it does not imply absence of spatial integration among those markets. Spatial integration can be occasioned by competitive profit-seeking activities, such as commodity arbitrage, or by noncompetitive spatial pricing conduct (a basing-point pricing system, for example) of a spatially-linked oligopsony.

The empirical challenge is to deduce noncompetitive conduct from the dynamic price adjustments across the regional cattle markets. One approach is to formulate hypotheses about pricing conduct consistent with particular price reactions and feedbacks. The other is structural, where the degree of cointegration between markets is correlated with concentration. The latter

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<sup>286</sup>Timothy Bresnahan, "The Oligopoly Solution is Identified," *Economic Letters*, vol. 10 (1987), pp. 87-92.

approach was adopted by the only meatpacking study in this category, as profiled in chapter IV. Markets were found to be not fully integrated, but the degree of integration increased with

FIGURE 6.3

increased concentration. The significant relationship between increased concentration and increased cointegration was attributed to either informational economies due to multiplant operations across regions, or increased coordination among packers because of increased concentration.

Unfortunately, two features of the study limit its contribution to understanding conduct in a spatially linked oligopsony such as meatpacking. First, its concentration variable was national and, hence, out of correspondence with concentration in the pairs of markets assessed for cointegration. Second, separate bivariate analysis as was used to test for cointegration between regional markets is a source of misspecification. Dynamic price adjustments involve all spatially separated markets, whether contiguous or not.<sup>287</sup>

### 3. Appraisal of the NEIO Evidence

Reducing measurement and interpretational problems is among the most cogent arguments for embracing NEIO over SCP methodology (see chapter III). Performance indices are not treated as data to be measured, but as parameters to be estimated. Equations comprising NEIO econometric models are not merely *ad hoc* reduced-form relationships, but structural equations derived from a clearly-specified, consistent optimization model of firm behavior. NEIO models therefore have a benchmark by which the reasonableness of their empirical assessment of market power can be judged. Furthermore, model parameters interpretable as supply and demand elasticities can be checked for consistency against findings of other studies; cost or production function parameter estimates can be judged in terms of their compatibility with theoretical restrictions on slope, curvature, and the like.

A particularly promising feature of NEIO models is their applicability to a variety of structure and conduct settings. However, empirical testing of the models reviewed here was less rigorous; reasons include modeling compromises specific to the NEIO meatpacking studies and empirical compromises specific to all NEIO models, as indicated in chapter III. Study-specific modeling compromises were necessitated by lack of appropriate data, scarcity of degrees of freedom, the need for mathematical tractability, or a combination thereof. These issues are explored in turn for each of the studies in which testing for market power in livestock markets was at least one of the objectives in the analysis.

#### 3.1 *Oligopoly/Oligopsony Studies*

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<sup>287</sup>Bruce L. Benson, Merle D. Faminow, Milton H. Marquis, and Douglas G. Sauer, "The Impact of Provincial Marketing Boards on Price Relations and Pricing Dynamics in the North American Slaughter Hog Market," *Applied Economics*, vol. 26 (1994), pp. 677-688.

The first of the studies in this group constrained the degrees of market power to be equal in both input and output markets. The model could not formally accommodate differing degrees of market power in input and output markets owing to two of its assumptions. First, both markets were assumed to be national in scope and, second, a fixed proportional relationship was assumed between the livestock (cattle) input and the meat (beef) output. The result was that the market quantities that determine the respective prices faced by a representative firm in input and output markets were essentially the same.<sup>288</sup> Therefore the firm's perceived degree of influence upon these respective prices, that is the firm's input and output market conjectural variations must also be the same.

The assumption of fixed proportions was abandoned in a subsequent study, using a variable production function and aggregate meat data to implement the oligopoly/oligopsony test. The study avoided the implications of equal input and output market conjectural elasticities by allowing some degree of independent variability in input and output market quantities. It is not certain how the results were affected by the use of aggregate meatpacking rather than beefpacking data.

A later study used beefpacking data alone and allowed unequal output and factor market power, but failed to include auxiliary equations embodying cross-equation restrictions that might help to validate the models' parameter estimates. The results might therefore be sensitive to changes in the parametric forms utilized for the processing cost function.

The empirical findings of the only multiproduct study should also be qualified somewhat owing to unavoidable shortcomings of the estimation procedure. Scarcity of degrees of freedom led to some compromises. The conjectural elasticities were assumed constant throughout the sample period, and the demand and supply elasticities were simply fixed at values estimated by independent means. Data limitations also prevented the authors from incorporating a full set of factor demand functions in the econometric model. One questionable feature of the results is the estimated 50 percent of the farm-to-retail spreads for beef and pork attributable to market power distortions. The result does not square with the widespread view that packing is a relatively thin-profit-margin industry.

Some of the foregoing studies assumed the conduct parameter to be constant. Later work which found switching oligopsony conduct, and more importantly, switching oligopsony conduct coinciding with the upsurge of concentration, makes that constancy assumption questionable. Also, in view of switching conduct work, it appears likely that specification of conduct may have been too inflexible, even in those studies allowing it to change through time. Consequently,

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<sup>288</sup>Prices might differ by a constant input/output conversion factor; with appropriate definition of units, such a conversion factor can be re-scaled to equal 1.

findings of smaller distortions during periods of increased concentration may stem from inflexibility.

In the only trigger-price meatpacking model, the stochastic specification for the classification of periods did not do justice to the theoretical implication of alternating cooperative and non-cooperative regimes, each typically lasting several periods. As the authors acknowledged, more realistic specifications were econometrically intractable.

In the only test of meatpacking average-cost pricing, duality results based on the profit maximization hypothesis were used to study average-cost-pricing conduct. Specifically, the supply and demand system derived from the profit function via Hotelling's lemma was used merely to identify the markdown (M) of cattle prices relative to their marginal revenue product. Once identified, M parametrizes the set of oligopsony solution concepts, ranging from competitive to pure monopsony, just as the conjectural elasticity parameter did in several other treatments. Each solution concept, that is each value of M, is reconcilable with profit maximization for a specific perception, on the part of a firm in the industry, of its degree of influence on cattle prices. The realized M values are not maintained to come about through profit maximization, however. Rather, the strategy is to examine how the competitiveness of the market outcome, as measured by M, varies over time, and to compare the findings with the predictions of theories of pricing conduct other than profit maximization.

The welfare comparisons in the study of cost-efficiency/market-power tradeoffs owing to horizontal consolidation assumed negligible differences in fixed costs between the pre- and post-consolidation configurations of the industry. This is likely to be a reasonable assumption if, driven by multi-plant operating economies, consolidation involves primarily the acquisition and continued operation of existing plants. The assumption becomes more dubious if, instead, consolidation involves mainly replacement of old plants with new ones of larger scale and improved technologies.

### ***3.2 Bilateral Monopoly***

The only bilateral monopoly study tried to be all encompassing, and in the process suffered a major shortcoming. All of the models estimated were single-equation, reduced-form models for wholesale beef price only. There were no auxiliary equations embodying cross-equation restrictions that might help to validate the models' parameter estimates. Hence, there is reason to believe that results are sensitive to changes in the parametric forms utilized for demand and cost functions.

Two additional meatpacking-specific aspects that affect the results of all the above efforts, even those as wide-ranging as the foregoing model, are risk and market relevance. Although firms exert influence over price in all the foregoing NEIO models, the relevant price-quantity menus from which they choose (for example, the output demand schedule) were assumed in practically all studies to be known with certainty at the time decisions are made. An additional complication is introduced if the production cycle involves a significant time lag so

that when inputs are purchased and an irrevocable commitment to output quantity is made, the demand schedule is still subject to uncertainty. In such a case, maximization of the expected utility of profit rather than maximization of profits would have been the conventional behavioral assertion. In the only NEIO meatpacking study where uncertainty was considered, the hypothesis of price-taking behavior could not be rejected.

Market relevance is another contentious issue where studies used national rather than regional data in assessing market power. It has often been pointed out that slaughter cattle and hogs are seldom shipped more than 200 or 300 miles from feedlot or producer to packing plant, making meat packers' livestock markets regional. Dressed carcasses and boxed primal sections, on the other hand, are often shipped long distances from plant to wholesale distributors, making these markets more nearly national in scope. Packing plants with relatively few regional competitors for livestock purchases may thus exert monopsony power, while behaving essentially as price-takers in national output markets in which competitors abound.

For an NEIO model to capture such detail, an input supply relation is needed for each region, along with an over-arching national demand schedule. Livestock supply regions would have to be defined and regionally disaggregated data collected before the grand, multi-equation system could be estimated. Modeling challenges of such an approach are daunting.

However, as was alluded to earlier, the economic relevance of livestock markets is not synonymous with geographic relevance. The economically relevant livestock market is that area encompassing the forces that influence the price-setting ability of packers, and not just the physical movement of cattle. Although the available empirical evidence on relevant cattle markets did not deal directly with pricing conduct in space, findings lend support to the idea that cattle markets are considerably wider than those based on movement of cattle.

Problems arise in NEIO studies of meatpacking, and of other industries for that matter, because industry time series analyses put greater demands on the underlying models and the data needed to estimate them. Although NEIO parameters do have clearer economic interpretations because estimation is carried out subject to the discipline imposed by economic theory, the full versions of structural meatpacking oligopoly/oligopsony models have rarely been estimated because of data limitations. As a compromise, researchers have been compelled to carry out their estimations without auxiliary equations embodying cross-equation restrictions, and to use aggregate industry price and quantity data. The former affects efficiency of the estimates, while the latter clouds the interpretation of the findings because the variation in packer processing costs is suppressed. By Bresnahan's<sup>289</sup> reasoning, there is an interpretation problem under the null hypothesis of perfect competition since, in equilibrium, livestock price is equal to the value of the marginal product of livestock net of industry marginal processing costs. Under imperfect competition, however, there is no guarantee packers will have identical marginal processing

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<sup>289</sup>Timothy Bresnahan, "Empirical Studies of Industries of Market Power," In Richard Schmalensee and Robert W. Willig, eds., *Handbook of Industrial Organization* (Amsterdam: North Holland, 1989), p. 1030.

costs in equilibrium. As a consequence, the estimated gap between the livestock price and its net marginal value product may have been an artifact of the maintained aggregate processing cost function. To salvage the results, analysts have often given the industry supply relation the interpretation of a market-share-weighted average of individual firm supply relations. The index of market power also becomes an average for the industry.

Matters are complicated by the possibility of a gap between the price of livestock and its net marginal value product, even in the absence of strategic interdependence among packers. If a substantial share of livestock slaughter occurs in plants operating below capacity, then the price of livestock will necessarily be below the net marginal value product of cattle to cover the average processing cost of high-cost packers. Matters are also complicated by absence of a link between conduct of incumbent packers and potential entry. Even findings of competitive conduct in the industry would not be comforting as they might be the result of coordinated behavior aimed at deterring entry.

Interpretational problems aside, the other notorious problem is bias from model misspecification. The point estimates of the key conduct parameter are sensitive to the forms and shapes of cost curves and of demand and supply functions. Add to that the lack of data, and measurement problems of key variables such as capital, for example, and the SCP problems are dwarfed by comparison.

Using Monte Carlo simulation to examine the power of a typical NEIO model in estimating monopsony power, Hyde and Perloff<sup>290</sup> found there is "no way of knowing if the model was correctly specified." They also discovered the estimate of monopsony power is sensitive to returns to scale of the production function. A recently suggested alternative is use of a nonparametric test of market power which is not conditional on the functional forms of the auxiliary equations in the structural model.<sup>291</sup> Unfortunately, nonparametric tests of market power also are conditional on the type and number of constraints appended to the model.

#### **4. Conclusions, Implications, and Recommendations**

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<sup>290</sup>Charles E. Hyde and Jeffrey M. Perloff, "Can Monopsony Power be Estimated?" Paper Presented at the annual meetings of the American Agricultural Economics Association, San Diego, CA, August 7-10, 1994.

<sup>291</sup>H. Alan Love and C. Richard Shumway. "Nonparametric Tests for Monopsonistic Market Power Exertion," Paper presented at the annual meetings of the American Agricultural Economics Association, San Diego, CA, August 7-10, 1994.

In summary, because of interpretational difficulties, stemming largely from using *ad hoc*, reduced-form models, SCP studies of the U.S. meatpacking industry offer no objective benchmark for judging the reasonableness of their empirical assessments of market power. Parameters lack clear, fundamental, economic interpretations to which the analyst can appeal in seeking to validate empirical results. Therefore, the validity of SCP methodology in the assessment of competition in the U.S. meatpacking industry is questionable.

That does not, by any means, imply that SCP research efforts must be interpreted as failures. The most significant contribution of the SCP literature was in producing an impressive body of robust empirical regularities, which consist, on balance, of statistically significant negative correlations between buyer concentration and prices of cattle and hogs, especially in studies using regional and more recent data. However, since estimation of SCP models has not been carried out subject to the discipline imposed by a formal conduct framework, an overall conclusion of noncompetitive conduct from the empirical results seems unwarranted.

The same is equally true of NEIO models. The key parameter estimates, from which market conduct (in the sense of price-taking behavior) is inferred, are extremely sensitive to the functional forms of the auxiliary demand and supply curves, and of cost or production functions. Even nonparametric tests of market power must contend with measurement error.

Just as SCP studies have produced an empirically regular price-concentration relationship, the NEIO studies' evidential balance weighs in favor of a persistent gap between the price of livestock and its net marginal value product, suggesting incompatibility with price-taking behavior. Ascertaining what type of behavior has actually generated the data requires more detailed information on firm-level demand and cost conditions. Accounting for such detail is not only daunting in terms of data requirements, but would also require more than just a static framework. Even if the requirements are met, the final test of market power would still be conditional on the *a priori* structure imposed on the model.

The returns from the considerable investment in SCP and NEIO studies may appear fairly meager; but, given measurement and interpretational problems, that is the most one should expect from such studies. We must, finally, reach the decision that the body of empirical evidence from both SCP and NEIO studies is not persuasive enough to conclude that the industry is not competitive.

It is important to emphasize that the foregoing conclusion is based strictly on the SCP and NEIO meatpacking literature reviewed in this study. It is equally important to emphasize that failure to show conclusively that the industry is not competitive is not, by any means, evidence that it is competitive in the sense of price-taking behavior.

It is also worth emphasizing that the measurement and interpretational problems encountered in testing performance or behavioral results in meatpacking (or other industries) are not exceptional but are, in fact, rather typical of the sorts of challenges economists face in most empirical analyses. Perspective may be served by also recognizing that the measurement and

interpretational problems of the empirical literature arise more from the type of information or data available to economists than the discipline of economics itself. True, some of the economic models reviewed do have stronger conceptual foundations than others and vary in levels of sophistication. Unfortunately, such sophistication generally outruns economists' ability to find matching data. There is no doubt that the type of data available to researchers affects the research agenda.

Having said that, and putting for the moment all their limitations aside and assuming that SCP and NEIO studies have the relevant data to test for market power, there is a further question of the usefulness of their findings to policy makers. Clearly, the surplus of both meat consumers and livestock producers could be increased by forcing packer behavior toward closer conformity with the perfectly competitive benchmark. This, however, presumes that the theoretical, static construct of perfect competition is the appropriate benchmark against which to compare dynamic, real-world markets. As chapter III suggests, the normative conclusions economists draw from the competitive model result from the meaning economists attach to the term "competition." It is not rivalry between particular firms in particular industries. It is a hypothetical market structure with unnamed firms making output and price decisions in such a manner that rivalry is ruled out by definition.

Alternatively, one could intervene surgically to maintain a large number of processing firms in the industry. This, however, entails the assumption that concentration is exogenous, rather than the result of a dynamically competitive (rivalrous) process in which firms with successful strategies respond to market and technological forces reap short term market power.

The trace of historical events that have brought commercial meatpacking from the obscurity of William Pynchon's modest seventeenth century enterprise to the industrial giants that dominate the industry today strongly suggests patterns of concentration that are driven by technological and market forces and by meatpacker strategies aimed at exploiting those forces in the processing and distribution of a highly perishable product. Enormous change has overtaken the production, slaughter, processing, and merchandising of meat and meat products and the tempo of change has increased dramatically late in the twentieth century. Perhaps the most significant lesson these changes teach is the prevalence and relevance of change itself. These changes have had striking implications over time for enterprise location, technological makeup, scale of enterprise, and concentration.

In that regard, the trade-off between static and dynamic efficiency becomes central to assessing the performance of the industry under alternative configurations. The magnitude of the trade-off is not exactly known. What is known, however, is that while oligopolistic and oligopsonistic industry configurations result in static resource misallocation, it is suspected they also result in intertemporal efficiency gains through growth and innovation. Accounts from the history of the industry are not unsupportive of a pattern of growth and innovation in the industry.

In such a setting, we believe a conduct policy in which firms are steered toward rivalrous behavior is preferable (in terms of social welfare) to a structural policy in which market structure

is the target. Although in instances where efficiencies may not be evident, such as in mergers, concentration could be nipped at its incipiency through merger controls.

The implication for future research of a conduct policy is to develop workable empirical pricing conduct models for short-term monitoring that are not as hampered by problems of market definition, auxiliary hypotheses, as are the SCP and NEIO models reviewed in this report. A good start is the extension of time-series-based spatial-price-linkage models, such as the one by Goodwin and Schroeter,<sup>292</sup> to testing spatial pricing conduct. Rather than relying on estimation of conduct parameters or measures of market concentration, inferences on coordination could be made from evaluating price changes between spatially-dispersed locations.

However, making further advances in our understanding of the meatpacking industry calls for, in addition to short-term monitoring, studying the dynamics of the competitive process in the industry. The brief business history of the industry reported in this study is one approach to studying such process, but is no substitute for data that capture aspects of intra-industry change and, hence, allow the empirical testing of its implications. Currently available data emphasizing summary measures, such as concentration, are too aggregative. What is needed are panel or longitudinal data describing how entry, exit, mergers, market shares, and other aspects of industry change at the firm and plant level over time.

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<sup>292</sup>Barry K. Goodwin and Ted C. Schroeder, "Cointegration Tests and Spatial Price Linkages in Regional Cattle Markets," *American Journal of Agricultural Economics*, vol. 73 (1991), pp. 452-64.

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