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PACKER INTEGRATION INTO HOG PRODUCTION: CURRENT STATUS AND LIKELY IMPACTS OF INCREASED VERTICAL CONTROL ON HOG PRICES AND QUANTITIES

EXECUTIVE SUMMARY

INTRODUCTION:

In a survey conducted three years ago by the staff of Pork '88, it was found that some of the major players in the pork industry, like Smithfield foods, for example, have either integrated into hog production or have all the requirements for vertical integration in place. The move toward internalizing the exchange process in the hog/pork sector through vertical integration has raised several questions ranging from its impact on prices and quantities to its impact on individual hog producers.

This report is a first step toward studying these issues. Its specific objectives are a) to provide some insights into the nature and determinants of vertical integration, b) to describe the current status of packer integration into hog production, and c) to provide a theoretical and empirical assessment of the likely impact of increased vertical control in the hog industry on hog prices and quantities.

As a background, Chapter I describes supply/demand characteristics as well as structural characteristics of the hog/pork sector. Among agricultural commodities, and particularly livestock, the pork sector is characterized by cyclical output response, unresponsive short run demand, and a trend toward large scale specialization into hog production and slaughter.

INCENTIVES FOR VERTICAL INTEGRATION TRANSACTIONAL ECONOMIES:

The supply/demand characteristics as well as some aspects of the structural characteristics of the hog/pork industry make the hog sector a good candidate for vertical integration. The incentives for vertical integration are created by the existence of transactional economies.

In practical terms, transactional economies exist when the cost of open market exchange exceeds the costs of gaining control over quality, quantity, and price of the intermediate product either through direct ownership or contracting. If processors integrate to achieve the transactional economies and the market remains competitive, the cost savings from integration eventually will be passed on to the producer or consumer.

Under transactional economies there are three main sources for the incentive to integrate, namely risk and uncertainty, economic efficiency and assuring adequate supply inputs.

The more prone an industry is to uncertain supply of a material input, the more likely it will opt for vertical integration or contracts as a risk-reducing strategy. The economic rationale for this behavior is simple. Other inputs, such as labor, for example have to be combined with the material input to produce a final output. Thus, as the material input becomes more"uncertain", the ability to utilize the cost-minimizing levels of all inputs becomes more difficult.

While economies of scale may exist at all stages of production and/or marketing, it may happen that one stage is subject to substantially more scale economies that the next or previous stage. Data on the emerging structures in hog packing and hog production points to the divergent scales between the two stages. Consequently, a packer may opt for integration though ownership or contracts with several producers to match his scale of operation and, hence, improve economic efficiency.

Uncertainty about the quality of inputs also induces business to integrate in order to have a say about how the material input is produced. Obviously, vertical integration through ownership gives the processor complete management control. Contractual integration through market-specification contracts or resource providing contracts also gives the processor some control over production practices.

Assurance of adequate supply is perhaps the most often cited incentive for processors to integrate backward into agricultural production. However, the notion of "assuring supplies" is more than just avoidance of random fluctuations in input markets. It entails the inability to obtain the quantity and quality of inputs that the firm would like to purchase at the prevailing price. As such, it is a market imperfection and gives rise to transaction costs. The latter are different from production costs in that they arise from using the open market for transactions. Whether a business opts for market exchange or integration depends on cost conditions of the processing plant, variability of the raw material flows, and the

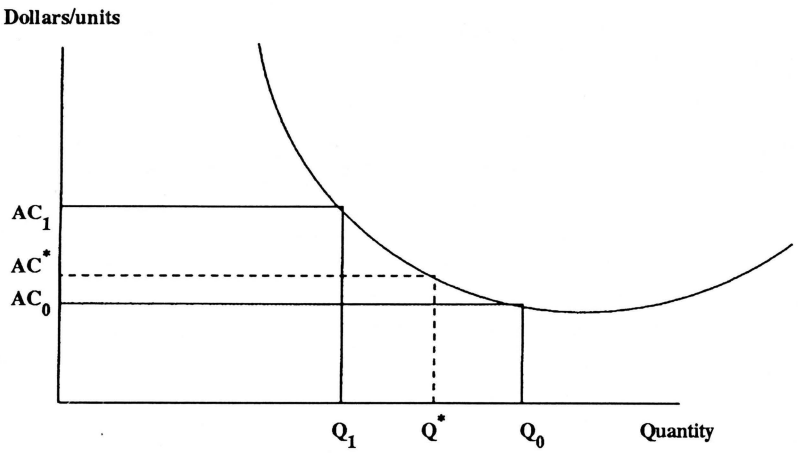

Figure 1.

cost associated with market exchange. Consider Figure 1 where the U-shape curve represent the average cost function for a typical processing plant. The minimum average cost of production occurs at point Q_0. If the firm is only able to purchase quantity Q_1, its average cost of processing rises from AC_0 and AC_1 or somewhere in between depends on the number of days (shifts) the firm is compelled to operate at less than full capacity. For example, if the processor operates at less than full capacity half of the time, then its annual production will be at Q^* at an average cost of AC^*. The potential cost saving due to integration are represented by the distance AC_0 to AC^*. Whether a business integrates backward to assure supplies, depends on whether the cost savings more than offset the costs of internally producing the material input or acquiring it through contracts.

IMPERFECT COMPETITION

Another less obvious phenomenon which gives rise to several incentives for processors to vertically integrate, aside from transactional economies, is imperfect competition. Imperfect competition may arise for example, when there is increased concentration in the slaughter industry.

Are there signs which indicate the slaughter industry may be characterized by imperfect competition? Well, the leading packers in the seventies have been replaced by companies that specialize in high volume, low cost plants. This has occurred only in those plants slaughtering more than one million head annually. The share of the latter plants in total hog slaughter increased by more than 100 percent between the year 1972 and 1988 and amounted to more than 75 percent of total U.S. hog slaughter (Figure 2). The consensus among those who follow

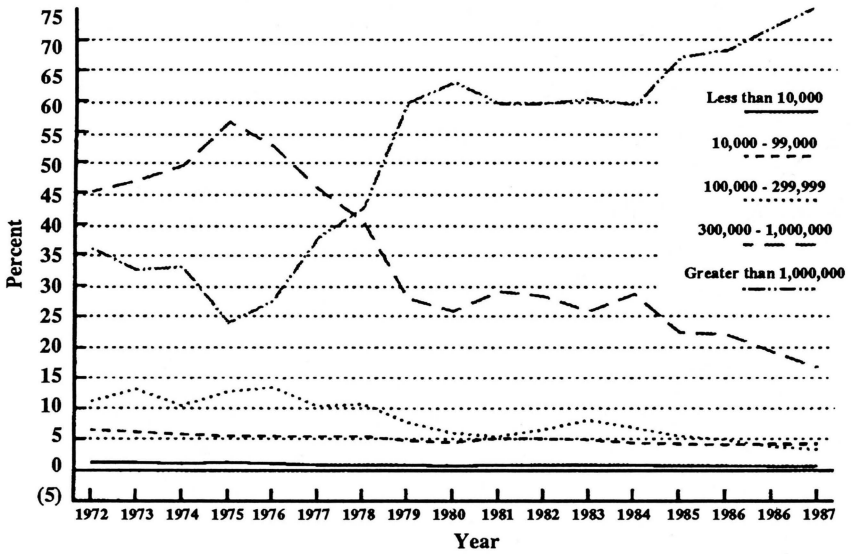

Figure 2. Source: Compiled from Rhodes (1990)

the industry closely is that of slaughtering concentration will increase over the next few years.

During this period of industry transformation, more than 600 plants have shut down across the United States, as have 217 auction yards, 372 dealer and order buyers and 3 terminal markets. A consequence of this decline is that fewer outlets are available for producers to sell their hogs. In a recent Farm Bureau Survey, it was found that 76 percent of those responding have access to only one or two markets.

Economic theory predicts that when a market for an intermediate input is imperfect, the price and quantity of the intermediate inputs would be less than what they would be had the market been perfectly competitive. The degree to which the quantity and price of the input diverge from the competitive level depends on the degree of market power exercised by the buyers of the intermediate inputs. The degree of market power is a function of three things: the number of firms, the nature of strategic behavior between the buyers, and the degree of supply response by the producers of the intermediate inputs.

The incentives under imperfect competition come from three sources: internalization of the efficiency losses from imperfect competition, 2) the ability to extract rents from the competitive producers, and 3) the ability to price discriminate among the competitive producers of the intermediate inputs. Economic theory also predicts that when the price of the intermediate inputs diverges from its competitive levels, an efficiency loss arises. In practical terms, the efficiency loss is the difference between the dollar loss to consumers and producers (engendered by market imperfections) and the extra profits made by the processor (also engendered by market imperfections). Interestingly, one way for the processor to convert the efficiency loss to profits is through backward integration. After we present some results of our survey, we will simulate the price and quantity impacts of increased vertical integration under the scenario of imperfect competition.

Contractual and Ownership Integration — Survey Results

Our survey results indicate that, on a national level, (Figure 3) hog packers who slaughter 10,000 head or less annually acquired about 38.56 percent of their

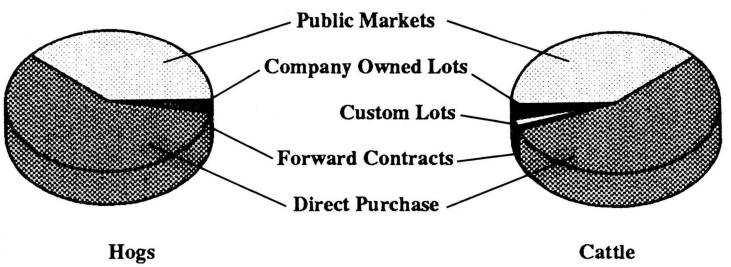

Figure 3. Slaughter Hogs/Cattle by Source Packer size < 10,000 head

hogs from public markets, 58.64 percent by direct purchase, and 2.67 percent through forward cash contacts. The percentage of hogs actually owned and fed by the hog packer in company owned facilities represented only 0.13 percent. The seventy two hog packers who responded to the survey represent more than half the actual packer population in the < 1,000 category reported in 1988. Assuming the response to our survey is representative of this category, and knowing that close to 500,000 hogs were slaughtered by packers in the 10,000 head and less category, roughly 70,000 hogs were owned and fed in packer-owned facilities. Figure 3 also shows the same breakdown for beef packers in the same size category. It is worth noting that while acquiring cattle through contracts represents only 1 percent in this size category, compared to 3 percent in hogs, about 5 percent of the cattle is actually owned in this category. About two percent is owned and fed in custom lots and 3 percent is owned and fed in company-owned lots.

Packer ownership of hogs in company-owned facilities is a little bit higher in the 10,000 to 100,000 head category. It represented about 1.07 percent of all hogs in this category and range from 10 to 20 percent. The rest was acquired from either public markets or direct purchase (Figure 4). Figure 4 also shows how the distribution of hogs by source compares with cattle. Again, cattle owned and fed in company facilities in this category is more than three times that of hogs. One beef packer in this category reported owning 100 percent of his slaughter cattle.

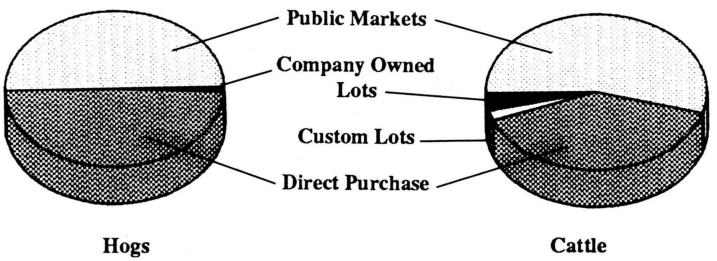

Figure 4. Slaughter Hogs/Cattle by Source Packer size 10,000 - 99,999 head

Figures 5 and 6 show the distribution of hogs by source for the two size categories 100,000 - 299,999 head and > 300,000 head, respectively. In the 100,000 - 299,999 head category, none of the hogs were contracted or owned. On the other hand, 1.43 percent of cattle in the same category were forward contracted and close to 3 percent were owned and fed in custom lot facilities.

In higher category, > 300,000 head (Figure 6), close to 8 percent of hogs fall in the captive category, of which 3.64 percent is forward contracted, 2 percent is owned and fed in custom facilities, and 1.86 percent in company-owned facilities. Assuming the proportion of the captive hog supplies are representative

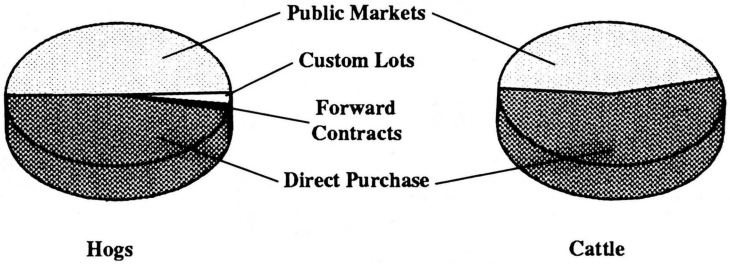

Figure 5. Slaughter Hogs/Cattle by Source Packer size 100,000 - 299,999 head

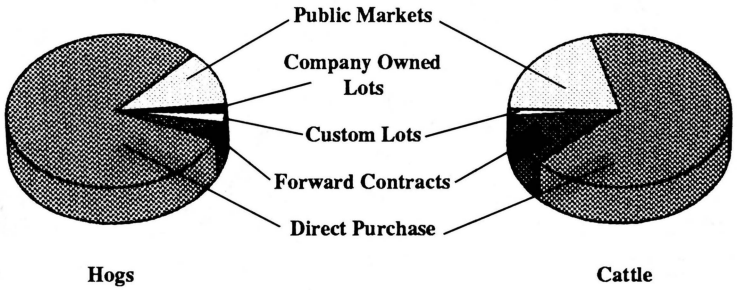

Figure 6. Slaughter Hogs/Cattle by Source Packer size > 300,000 head

of the population (57 plants), the total number of hogs in >300,000 category is roughly 5.8 million head. Beef packers in this category, on the other hand, acquired about 11 percent of their supply through contracts and 1.4 percent through ownership and feeding in custom lots.

Figure 7 summarizes the above information across sizes. It is worth noting that while contracting and ownership of cattle seems to take place across all sizes

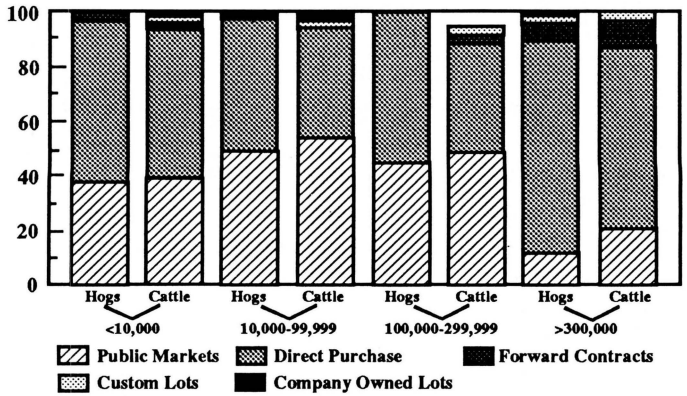

Figure 7. Slaughter Hogs/Cattle By Source and Category

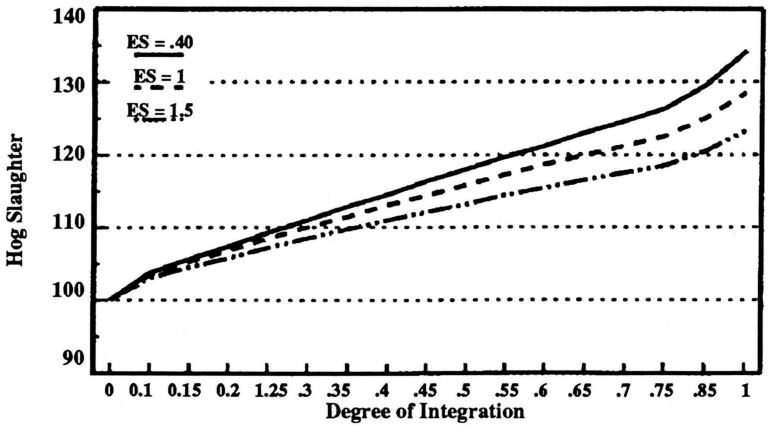

Figure 8. Degree of Integration and Hog Slaughter for Different ES

in beef packing, it is mostly prevalent among the large sizes in hog packing. Information on the regional breakdown is in the text.

SIMULATING THE IMPACT OF INCREASED VERTICAL CONTROL.

Figure 8 simulates the impact of increased vertical integration on the volume of hog slaughter under different elasticities of Supply (S). As the degree of integration increases, the volume of hog slaughter also increases. For example at an elasticity of supply of .40, a level of 10 percent integration will bring forth about 3.8 percent increase in the volume of hog slaughter. Figure 8 also shows that as hog supply becomes more responsive, the quantity of hogs forthcoming to the market is also higher. Figure 9 shows the relationship between the degree of vertical integration and hog slaughter under varying demand responses, holding the supply elasticity at a value of .40. The more responsive the demand

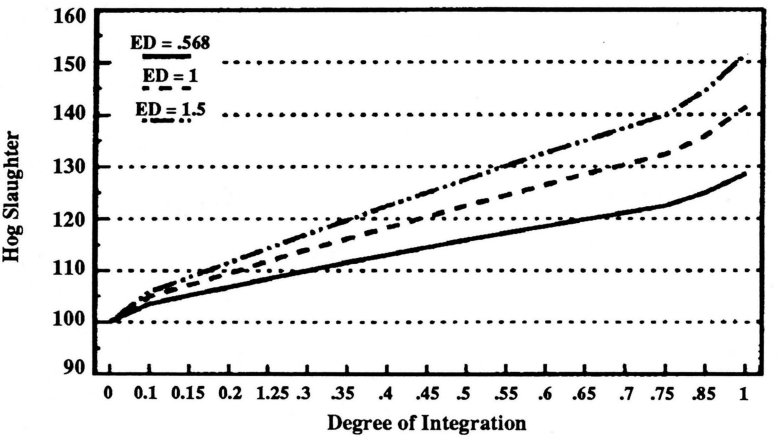

Figure 9. Degree of Integration and Hog Slaughter for Different ED

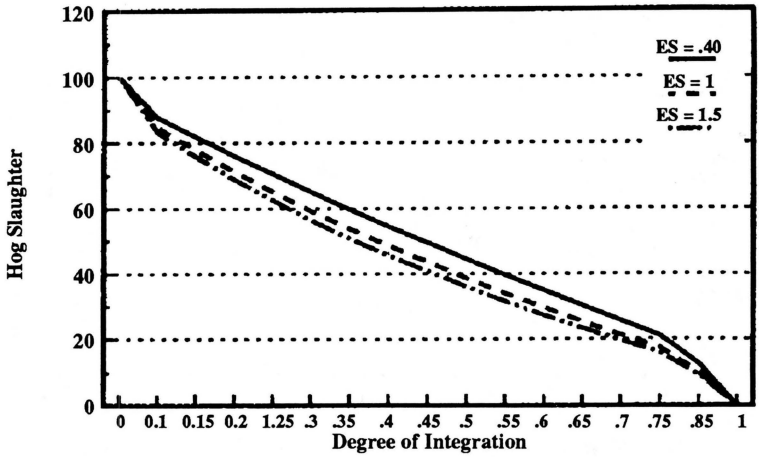

Figure 10. Degree of Integration and Quantities from Independents (ES)

curve is the more quantity of hogs forthcoming under increasing levels of vertical integration. This also implies that the consumer benefits from lower prices of pork as output expands.

Figure 10 demonstrates the relationship between the degree of integration and the quantities of hogs purchased from independents. Obviously, although the total quantity of hogs slaughtered increased, the quantity purchased from independent hog producers is predicted by the model to decrease by more than the increase slaughter. For example, at a ten percent level of integration, total slaughter goes up by 3.8 percent but the quantity purchased from independents declines by 13.3 percent. This means, given the magnitude of supply and demand elasticities, that 17 percent of the hogs are being captive by the processor. Figure 11 shows the same relationship between the degree of integration and purchases of independents under varying demand responses.

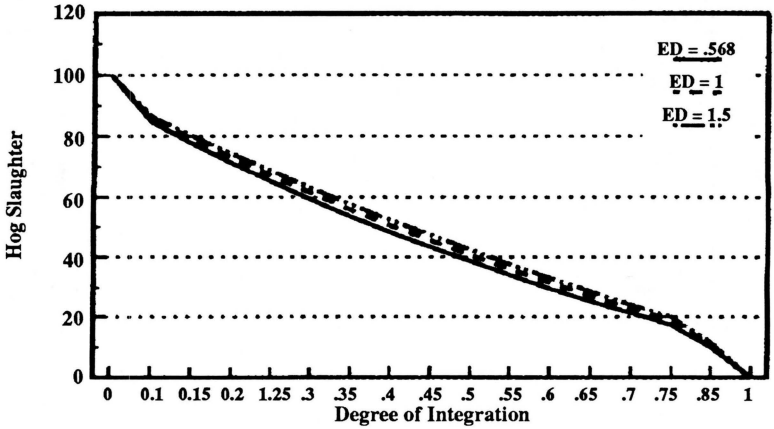

Figure 11. Degree of Integration and Quantities from Independents (ED)

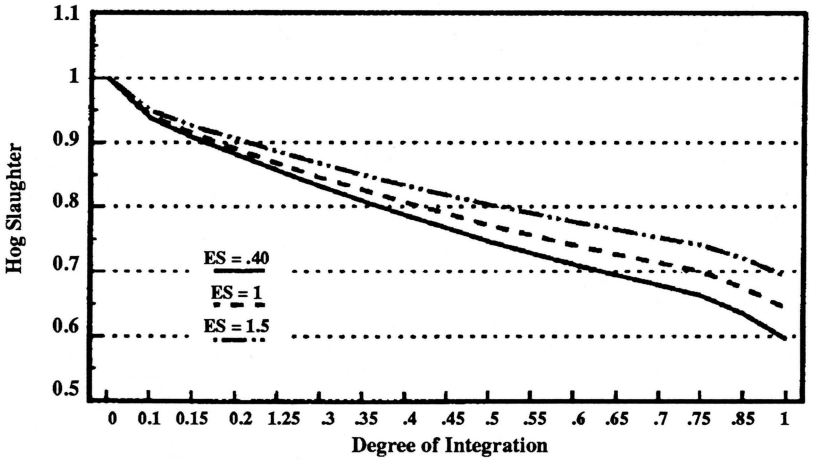

Figure 12. Degree of Integration and Price Received by Independents (ES)

According to Figure 12, the price to independents also declines with Vertical integration. At the ten percent level of integration the price paid to independents declines by about six percent. At fifty percent integration, the price declines by about 26 percent. The more responsive the hog supply curve is, the steeper the decline in the price of independents. Similarly, the more elastic the demand curve, the steeper the price received by independents. (Figure 13).

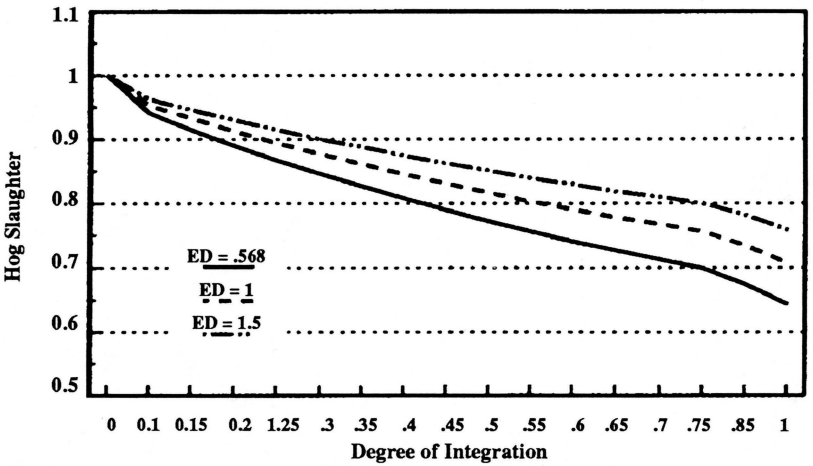

Figure 13. Degree of Integration and Price Received by Independents (ED)

CHAPTER I.

INTRODUCTION

Background

Successful performance of a "food supply system"[1] requires the coordination of thousands of decisions made by thousands of producers, processors, wholesalers, distributors, retailers and consumers. When markets are perfect, prices are the most effective coordinating force. They automatically ration consumption among those who are willing and able to buy the product, reward those who produce it, provide incentives for changes in consumption and production, and guide goods and services through the marketing channels. In this an automatic coordinating mechanism, "every consumer and producer sits in on the price committee, as it were, and casts his dollar vote as to what should be produced and consumed and what prices are needed to do the job of allocating and rationing" (Shephard, p. 90).

The ability of a "food supply system" to move the product from farm to retail depends on a) the nature of supply and demand, and b) market structure. The nature of supply and demand refers to the degree to which consumers and producers respond to price changes, in the short-run and long-run, as well as other non-price factors which influence the level of demand and supply. Market structure refers to those "organizational characteristics of a market that largely determine where the market falls in the competition/monopoly spectrum, ... and is a primary determinant of how much discretion a firm has in setting its rivalrous strategies or other aspects of firm conduct" (Connor and Wills, p.126).

Hog Supply Characteristics

Among agricultural commodities, and particularly livestock, the pork sector is characterized by cyclical output response. The cycles reflect aggregate producer response to current as well as expected profitability of the enterprise. When profit opportunities are on the horizon, individual producers expand. The combined effect of all producers expanding output subsequently depresses prices. If input prices do not decline to offset the output price decline, profits are depressed. Some producers size their operations down, others leave the business. Liquidation and exit from the business leads to smaller supplies of pork, prices tend higher again, and the cycle continues.

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[1] McCorkle defines a "food supply system" as that system which encompasses the following activities: production of raw products and other inputs such as packaging materials, the manufacturing activities which transform inputs into consumer products in their final form or into intermediate products that are combined with other inputs into a final consumer product; and the storage, marketing, and distributional activities that make food products available at a time and place to best match consumers' desires, as reflected in demand prices (pp. 2-3).

The evidence of output cyclicity (in terms liveweight production) in the hog sector can be seen in Table 1.1. Between 1950 and 1986, there were nine cycles ranging in length from two to seven years. The most frequent length was four years. Length of expansion phases ranged from one to five years with an average 2.4 years. The average length of contraction phases was 1.8 years with a range from one to three years. The cyclicity of output is complicated by the lag between the time producers decide to change output and the time actual changes materialize. It takes almost one year between breeding and finishing a slaughter hog for market, and longer than that to augment the breeding herd.

Table 1.1. Hog production cycles

Years	*Length of Cycle*	*Number of Years Increased*	*Number of Years Decreased*
1950-54	4 years	2	2
1954-58	4 years	2	2
1958-61	3 years	1	2
1961-65	4 years	3	1
1965-69	4 years	3	1
1969-73	4 years	2	1
1973-75	2 years	1	1
1975-82	7 years	5	2
1982-86	4 years	1	3
Average length of production cycles, 1950-1986			4.0 years
Average length of increased cycles, 1950-1986			2.4 years
Average length of decreased cycles, 1950-1986			1.8 years

Source: Futrell and Williams.

Holt and Johnson estimated the response of pork production to changes in the farm price of hogs, the price of corn, and interest rates. They found that an increase in hog prices actually results in decreased production in subsequent periods. The rationale for this is that hogs are both a consumption and investment good. In practical terms, when current and expected prices of hogs are on the rise, producers respond by saving more gilts and reducing sow slaughter. Only after about 4 quarters does the higher price translate into increased production. It also takes about 4 quarters before an increase in the price of corn or interest rates materializes into decreased production. Holt and Johnson's results also showed that hog production is more responsive to changes in corn price than hog price or interest rates.

Pork Demand Characteristics

Consumer demand for pork, is relatively unresponsive to price changes (inelastic). In practical terms, a one percent change in the price of pork generates less than one percent change in the quantity demanded. Consumer demand for pork is even less responsive to changes in consumer income. Table 1.2 summarizes estimates of responsiveness of the consumer purchases of pork, beef, veal, other red meats, chicken and turkey.

Table 1.2. Price Responsiveness of consumer purchases for meats.

Percentage of Change in the Quantity of:	*With respect to a one percentage change in the price of:*					
	Beef	*Pork*	*Meat*	*Other Chicken*	*Turkey*	*Expenditures*
Beef and Veal	-0.6166	0.1087	0.0714	0.0572	0.0115	0.4549
Pork	0.1910	-0.7297	0.0486	0.0908	0.0178	0.4427
Other Meat	0.5409	0.2119	-1.3712	-0.1633	0.0251	0.0607
Chicken	0.2927	0.2635	-0.1128	-0.5308	-0.0487	0.3645
Turkey	0.2083	0.1821	0.0590	-0.1701	-0.6797	0.3196

Source: Huang and Haidacher.

A 10 percent decrease in the price of pork at retail, holding the other prices constant, will bring in about a 7 percent increase in pork consumption. Increases or decreases in the price of substitutes — namely beef, chicken and turkey, also has an influence on consumer purchases of pork. Beef is the chief competitor, followed by chicken and turkey. Note, however, that a change in the pork price impacts consumer purchases of chicken almost three times more than a one percent change in the price of chicken on consumer purchases of pork, impacts consumer purchases of beef twice as much as a 1 percent change in the price of beef on pork consumption, and impacts purchases of turkey 18 times greater than a 1 percent change in the price of turkey on pork consumption. A pork-demand price elasticity of -.73, holding other prices constant, translates to a price flexibility of -1.4. In practical terms, a 10 percent increase in the quantity of pork supplied would require about a 14 percent decrease in price to clear the market.

Structural Change — Hog Production

Figure 1.1 shows the structural trends in hog production as represented by the number of U.S. farms selling hogs and pigs by size groups. Between 1959 and 1987, the number of farms selling hogs and pigs declined by more than 80 percent (from 1,273,000 to 239,000 farms). The largest decline, 89 percent, has been in the category marketing less than 100 head. For categories selling between 100

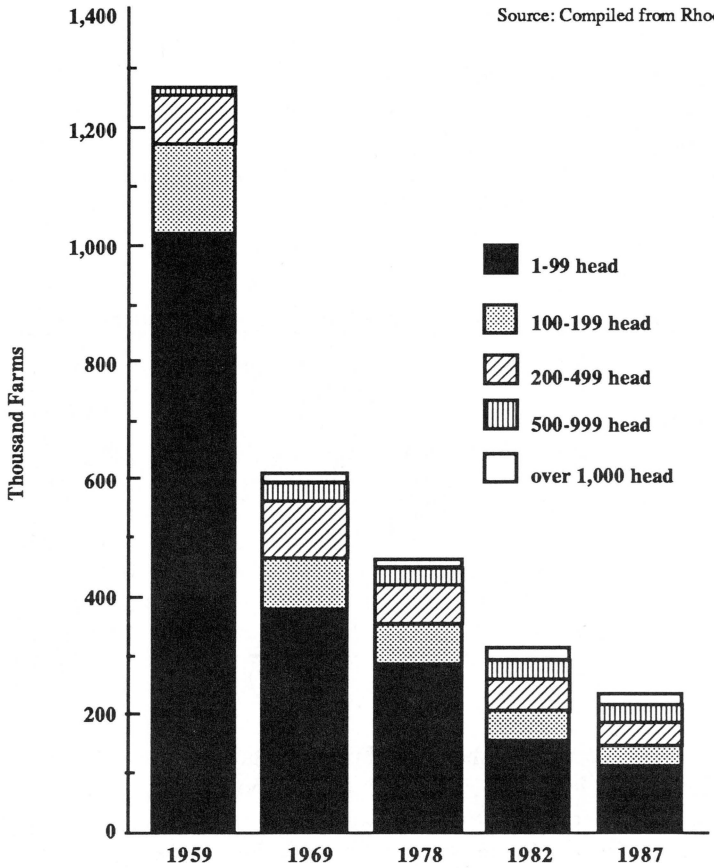
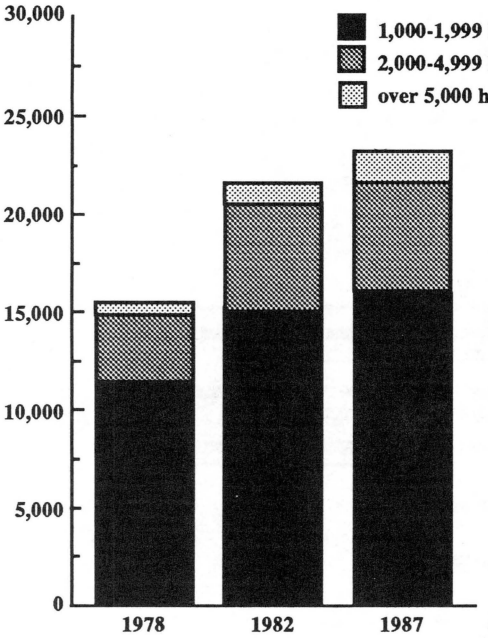


Figure 1.1: Number of U.S. Hog Farms by Size Groups

and 199 head, and 200 and 499 head, the decline has been 79 percent (from 1,018,000 to 110,000 farms) and 44 percent (from 81,000 to 45,000 farms), respectively. The only category showing a secular upward trend in numbers is the category with more than 1000 head in sales (from 1,500 to 24,000). More interestingly, within the 1000 and more category, the largest percentage increase in the number of farms are those selling 5000 head and more (Figure 1.2). They increased by 65 percent between the 1978 and 1987 census years (from 727 to 1,630 farms).

Larger size farms are also important in terms of their share of total hogs and pigs marketings (Figure 1.3). The share in marketings of farms selling 1000 head and less decreased from 66.4 percent to 42.5 percent in 1987. The share in marketings of farms selling 1000 head and more increased from 34 percent in 1978 to 58 percent in 1987. Likewise, the most noticeable increase in the share



Source: Compiled from Rhodes (1990)

Figure 1.2: Number of Large U.S. Farms Marketing Hogs by Size Groups

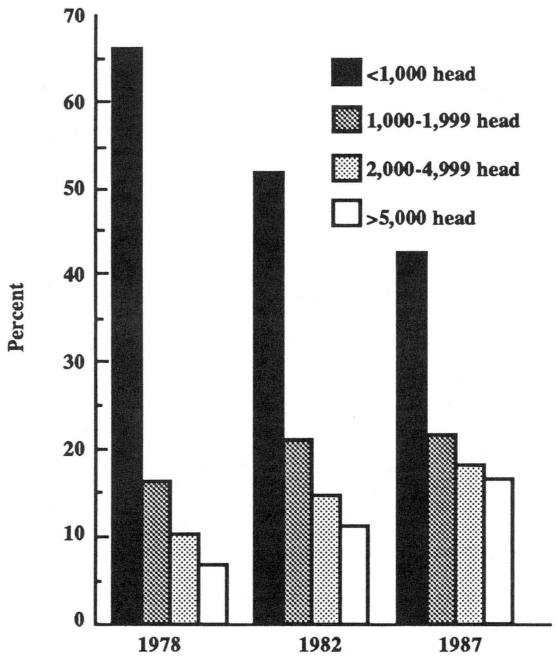


Figure 1.3: U.S. Marketings of Pork by Size of Farm

Source: Compiled from Rhodes (1990)

of marketings took place in farms selling 5000 head and more. Their share of total marketings increased from 7 percent in 1978 to 17.1 percent in 1987.

Figure 1.4 gives market shares of hogs and pigs by size of farm and by region. The regions are the West North Central Region (WNC), the East North Central Region (ENC), the Northeastern Region (NE) the South Atlantic Region (SA) the South Central region (SC), and the Western region (W) (See Appendix for definition of regions).

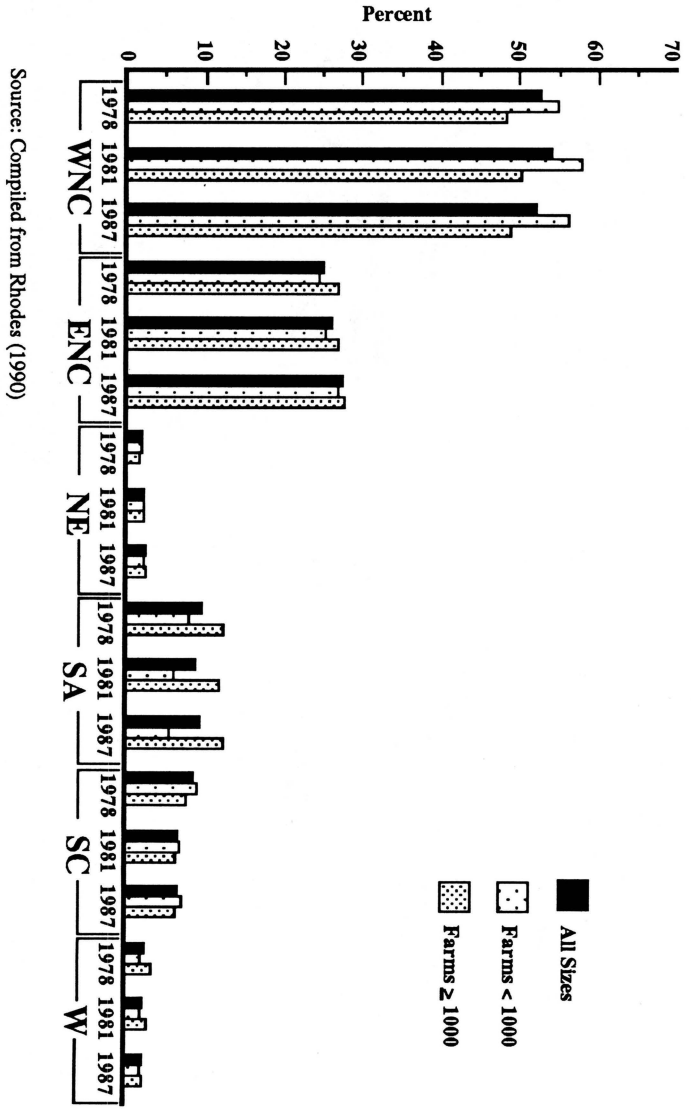
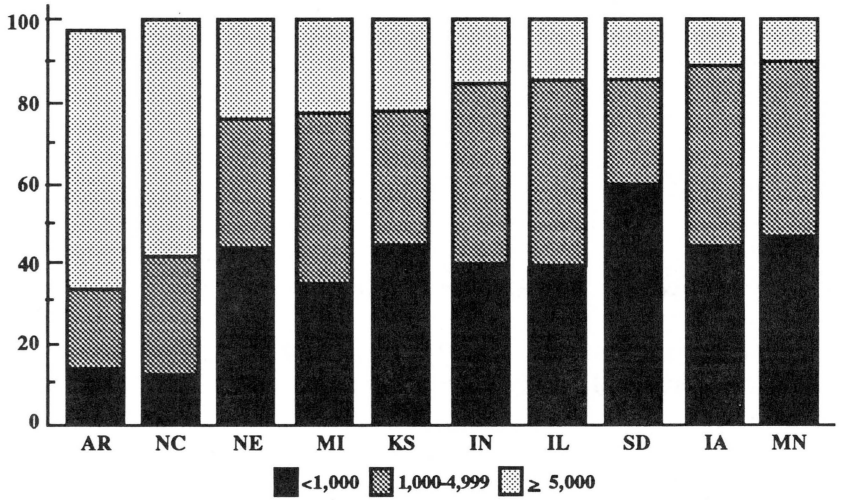


Figure 1.4: Regional Market Shares of Pork Marketed by Size of Farm

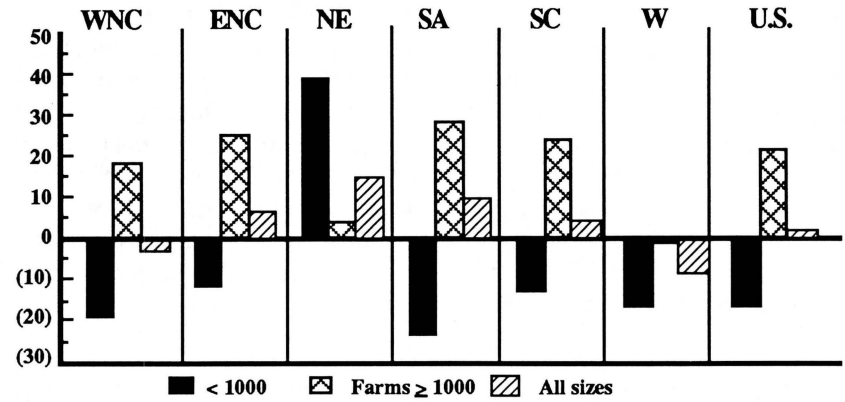
Note that while market share of the corn belt has been pretty stable between 1978 and 1987, the contribution of the region's smaller farms to total marketings of hogs and pigs is proportionately higher than in other regions. The picture is clearer on a state level. Figure 1.5 shows the distribution of marketing of pigs by size of farm for the ten leading states in 1987. In Iowa, the leader in the total number of total hogs marketed, about 43 percent of hogs still come from smaller farms compared to 10 percent from larger farms. On the other hand, in North Carolina, which ranks 6th in total hog marketings, close to 58 percent of the volume comes from farms marketing 5000 head and more. We may tentatively conclude, that the further away hog production is from corn production, the larger the volume (in percentage terms) from larger farms.



Source: Compiled from Rhodes (1990)

Figure 1.5: Distribution of Marketing of Pork by Size of Farm

The growth rates of marketings by size of farm also vary by region (Figure 1.6). Between the year 1982 and 1987 the largest growth in marketings from all sizes occurred in the NE region. The WNC has actually shown a decline of 2 percent in marketings. However, for the corn belt (WNC and ENC) as a whole, there has been a net increase of only 4.6 percent. This compared to more than 14 percent in the NE and 10 percent in the SA region. The growth rate in marketings from small farms (<1000 head) showed a decline in all regions except the Nebraska growth in marketing from larger farms (>1000 head) was positive for all regions with the largest gain in the SA region.



Source: Compiled from Rhodes (1990)

Figure 1.6: Growth Rates, 1978-87 of Marketing Pork by Region and Farm Size

Structural Change — Hog Slaughter

While the hog slaughtering and processing industry has not experienced significantly increased national concentration compared to beef (Table 1.3), it has undergone major regional transformation in the 1980's. With the expansion of IBP into hog slaughter, and the emergence of Excel and Conagra as major players in the industry, the leading packers in the seventies have been replaced by companies that specialize in high volume and low cost slaughter (Hayenga and McDaniel). Evidence of this shift toward high volume hog slaughter is shown in Figure 1.7 The growth in number and relative importance of hog slaughtering plants has occurred only in those plants slaughtering more than one million head annually. The share of the latter plants in total hog slaughter increased by more than 100 percent between the year 1972 and 1988 and amounted to more than 75 percent of total U.S. hog slaughter (Figure 1.8). The consensus among those who follow the industry closely is that hog slaughtering concentration will increase over the next few years (Ward, 1990).

Table 1.3. Concentration Ratios For U.S. Meatpacking, 1947-1987

	Beef		*Veal*		*Lamb*		*Pork*	
	CR4	*CR8*	*CR4*	*CR8*	*CR4*	*CR8*	*CR4*	*CR8*
				Percent				
1947	—	—	—	—	—	—	—	—
1954	36	43	49	56	61	74	42	56
1958	31	38	41	50	60	69	39	53
1963	26	34	36	44	54	67	36	50
1967	26	35	37	50	57	73	33	48
1972	30	42	27	46	55	76	37	50
1977	25	36	32	56	58	82	37	55
1982	44	55	55	74	59	86	39	59
1987	74	92	85	99	76	99	40	60

CR4 and CR8 are respectively the percent of industry value of shipment by the plants of the four and eight leading firms.

Source: Connor

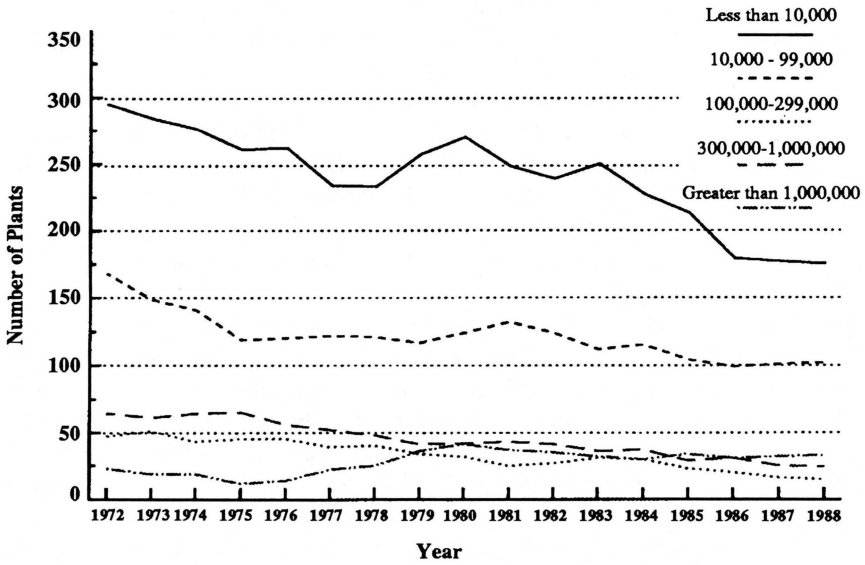


Figure 1.7: Number of U.S. Hog Slaughtering Plants by Size Categories — 1972-1988

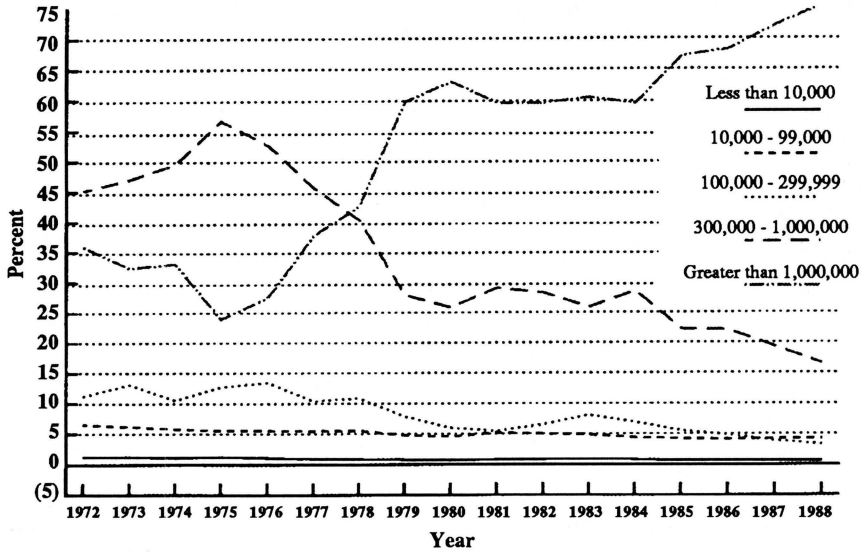


Figure 1.8: Percent of Total Hog Slaughter Source: Compiled from Rhodes (1990)

During this period of industry transformation, more than 600 plants have shut down across the United States, as have 217 auction yards, 372 dealer and order buyers and three terminal markets (McNabney). A consequence of this decline is that fewer outlets are available for producers to sell their hogs. In a recent Farm Bureau Survey, it was found that 76 percent of those that responded have access to only one or two markets (McNabney).

With these structural changes, the question of competition, or lack thereof, is often raised. There is concern among producers that fewer buyers may translate to lower prices for their live animals. This concern is also voiced by economists who believe that, since the bulk of the costs of business in meatpacking firms is livestock, and selling margins are on the order of one to two percent, packers can boost overall profits by 50 percent simply by lowering prices paid to farmers by just one tenth of one percent.

Evidence to support packer competition or lack thereof is mixed. Miller and Harris, using regional data, found that, indeed, an increase in packer concentration does depress live hog prices. Schroeter and Azzam (1990), using national data, concluded that 47 percent of the farm-to-retail margin for pork, can be attributed to market power in the total meat industry from packing to retailing. The part of the marketing channel which exerts the power is not clear in the analysis. Azzam et al., also using national data, found no evidence of packer power during the eighties and the farm-to-wholesale pork margin was just enough to cover hog processing costs. In another study, Schroeter and Azzam (Forthcoming) attempted to determine how much of the variation in the farm-to-wholesale pork margin is due to market power and how much is due to output price risk.

Interestingly, Market power was the weakest component, while output risk was the most prominent component in the margin.

The Economic Problem

The aforementioned characteristics of the sector, namely output and price fluctuations, the trend toward more concentrated hog production and marketings in larger size operations, and the trend toward larger scale slaughter operations seem to suggest that the hog/pork sector is a good candidate for vertical integration. The incentives for vertical integration, according to the popular view, are created by the existence of transactional economies.

In practical terms, transactional economies exist when the cost of open market exchange exceeds the costs of gaining control over quality, quantity, and price of the intermediate product either through direct ownership or contracting. If processors integrate to achieve the transactional economies and the market remains competitive, the cost savings from integration eventually will be passed on the producers or consumers.

Another less obvious phenomenon which gives rise to several incentives for processors to vertically integrate, aside from transactional economies, is imperfect competition. Imperfect competition may arise, for example, when there is only one or a few hog buyers in the area. The incentives come from three sources: internalization of the efficiency losses from imperfect competition, 2) the ability to extract rents from the competitive producers, and 3) the ability to price discriminate between the competitive producers of the intermediate inputs (Perry, 1978).

Objectives:

The specific objective of this report is to provide some insights on the likely impacts of vertical integration when the incentives arise due to imperfect competition. The report is not normative, i.e., designed to tell individual producers what actions to take or not to take in the face of the changing structure of the hog/pork industry. Rather, the report is to provide those representing the interests of hog producers with an economic framework for evaluating the likely price and quantity impacts of vertical integration under imperfect competition.

As a background, the next chapter will a) examine the concepts and determinants of vertical integration in greater detail (both under the transactional economies and the imperfect competition argument), b) report on results of a survey of vertical integration by packers, and c) use the theory of vertical integration under imperfect competition to develop a simulation model useful in assessing the likely impacts of vertical integration in the pork industry.

The general objective of this report is to provide some insights into the nature and determinants of vertical integration, and provide a theoretical and empirical assessment of the likely impact of increased vertical control in the hog industry on prices and quantities.

CHAPTER II

VERTICAL INTEGRATION

Definition

The simplest definition of vertical integration, for our purposes, is the linking of two or more adjacent stages in the production-marketing process either through direct ownership or contractual arrangements. This brings about the question of how to define a stage. At the extreme, a stage of production can be defined as any "distinct" activity involving the transformation of a raw product into a consumer product. Using this definition, packers can be characterized as vertically integrated already; they kill the animal, clean the carcass, chill it, box it, and perhaps transport it.

To avoid the extreme definition of a vertical chain, Ikerd and Higgins (pp. 9-10) suggest redefining vertical integration, especially in reference to food processing, as "a combination of two or more stages of production and marketing where a salable product exists at each stage or at least existed at some time in the past."

Vertical integration may either be forward (closer to the consumer) or backward (closer to the farmer). An example of forward integration would be a packer (the upstream firm) vertically integrating into retailing (the downstream firms). An example of backward integration would be a packer vertically integrating into hog production. This report deals exclusively with backward integration.

Backward integration may be accomplished through full ownership, contractual arrangements, or a combination thereof. Under full ownership, a business gains permanent and complete control over neighboring stages of production and distribution. Under contractual arrangements, the link between the stages is accomplished through contracts although ownership of the stages does not change. "The greater the degree of control and the longer the duration of contracts, the nearer contractual integration comes to being equivalent to integration through ownership. The less the degree of control and the shorter the duration of contracts, the nearer contractual integration comes to being equivalent to open market coordination" (Ikerd and Higgins, p.11).

Some Determinants of Vertical Integration:

As was alluded to earlier, the two broad determinants of vertical integration are transactional economies and imperfect competition. Under transactional economies, we shall discuss three main sources for the incentive to integrate, namely risk and uncertainty, economic efficiency and assuring adequate supply of inputs (Crieg).

Transactional Economies

The more prone an industry is to uncertain supply of a material input, the more likely it will opt for vertical integration or contracts as a risk-reducing strategy. The economic rationale for this behavior is simple. Other inputs, such as labor for example, have to be combined with the material input to produce a final output. Thus, as the material input becomes more "uncertain", the ability to utilize the cost-minimizing levels of all inputs becomes more difficult. While economies of scale may exist at all stages of production and/or marketing, it may happen that one stage is subject to substantially more scale economies that the next or previous stage. Earlier discussion in Chapter I on the emerging structures in hog packing and hog production points to the divergent scales between the two stages. Consequently, a packer may opt for integration though ownership or contracts with several producers to match his scale of operation and, hence, improve economic efficiency.

Uncertainty about the quality of inputs also induces business to integrate in order to have a say about how the material input is produced. Obviously, vertical integration through ownership gives the processor complete management control. Contractual integration through market-specification contracts or resource providing contracts also gives the processor some control over production practices.

Assurance of adequate supply is perhaps the most often cited incentive for processors to integrate backward into agricultural production. According to Perry (1989), the notion of "assuring supplies" is more than just avoidance of random fluctuations in input markets. It entails the inability to obtain the quantity and quality of inputs that the firm would like to purchase at the prevailing price. As such, it is a market imperfection and gives rise to transaction costs. The latter are different from production costs in that they arise from using the open market for transactions. Whether a business opts for market exchange or integration depends on cost conditions of the processing plant, variability of the raw material flows, and the cost associated with market exchange (Brand et al.). Following Brand et al. consider Figure 2.1 where the U-shaped curve represent the average cost

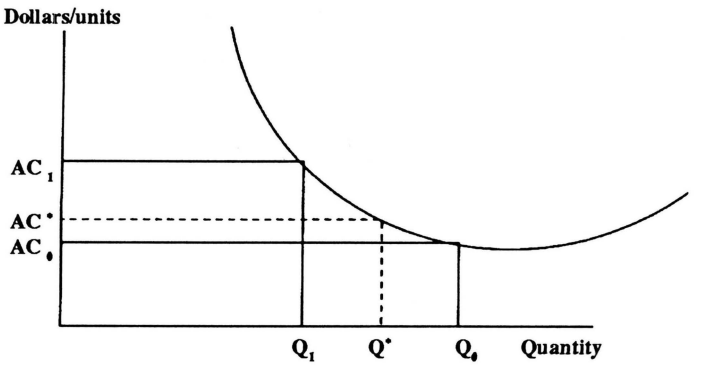


Figure 2.1

function for a typical processing plant. The minimum average cost of production occurs at point Q_0. If the firm is only able to purchase quantity Q_1, its average cost of processing rises from AC_0 to AC_1 Whether the increase in costs is actually between AC_0 and AC_1 or somewhere in between depends on the number of days (shifts) the firm is compelled to operate at less than full capacity. For example, if the processor operates at less than full capacity half of the time, then its annual production will be at Q^* at an average cost of AC^*. The potential cost saving due to integration are represented by the distance AC_0 to AC^*. Whether a business integrates backward to assure supplies, depends on whether the cost savings more than offset the costs of internally producing the material input or acquiring it through contracts.

Imperfect Competition

Economic theory predicts that when a market for an intermediate input is dominated by one buyer (monopsonist) or few buyers (oligopsonists) the price and quantity of the intermediate inputs would be less than what they would be had the market been perfectly competitive. The degree to which the quantity and price of the input diverge from the competitive level depends on the degree of market power exercised by the buyers of the intermediate inputs. The degree of market power is a function of three things: The number of firms, the nature of strategic behavior between the buyers, and the degree of supply response of the producers of the intermediate inputs.

Economic theory also predicts that when the price of the intermediate inputs diverges from its competitive levels, an efficiency loss arises. In practical terms, the efficiency loss is the difference between the dollar loss to consumers and producers (engendered by market imperfections) and the extra profits made by the processor (also engendered by market imperfections). Interestingly, one way for the processor to convert the efficiency loss to profits is through backward integration.

To illustrate this economic phenomenon, Figure 2.2 shows the link between the output market (panel a) and the input market (panel b). For our purposes, the output market is the market for pork, and input market is the market for slaughter hogs. In panel a, the demand for pork is shown as the downward sloping demand curve D. The horizontal line, also in panel a, stands for the marginal processing costs of slaughter hogs. For simplicity, we assume marginal cost (MC) is equal to average cost (AC). The vertical distance between the demand curve D and the horizontal line MC=AC is the derived demand (DD) for live hogs (shown in panel b). The curve S(Q,1) is the supply curve of live hogs, where Q stands for both live hogs and pork. The intersection of DD and S(Q,1) gives the (equilibrium) quantity of slaughter hogs, Q(1) bought by packers had the market been perfectly competitive. The equilibrium price paid to producers is w(1). The pork is sold to the consumer at price p(1) in panel a. If there is only one buyer in the market, or a few buyers who behave like one, quantity Q(0) is the only quantity consistent

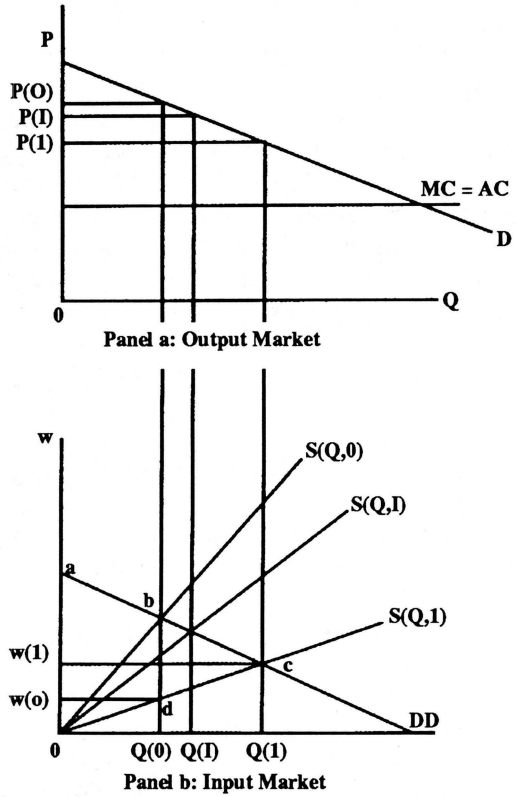


Figure 2.2: A Graphical Illustration of the Relationship Between Integration, Prices and Quantities

with maximum profit. It is the quantity resulting from DD and S(Q,0). S(Q,0) is the schedule of additional expenditures a single buyer in the market must incur to acquire additional hogs. At quantity Q(0), the price paid to the (non-integrated) producer is w(0), and the price paid by the consumer at retail is p(0). Hence, as one would expect, the margin under imperfect competition, P(0)-w(0); is wider than the margin under perfect competition, P(1)-w(1). The efficiency loss from restricting quantity and lowering the price to the producer is represented by the triangle bcd.

To see how integration converts the area bcd to profits, note that profits to the packer at Q(0) are represented by the area w(0) abd. At Q(1), they are represented by area w(1)acd. The difference between the two areas is the triangle bcd. The area w(0) abd is the difference between the net revenue to the packer (net of other processing costs) OabQ(0) and the cost of hogs 0w(0)dQ(0). The area w(0)abcd is the net revenue 0abQ(1) minus production costs OcQ(1) plus the rent paid to the producers who integrate with the packer Ow(0)d.

As will be apparent from the survey results, complete integration in hog production is nonexistent. So one has to look at what is likely to happen when a packer only partially integrates. The concept of partial integration can be easily understood intuitively but is extremely difficult to handle theoretically. The reason is that one has to a) say something about what the hog supply curve looks like when there is partial integration, and b) what happens to the price received by the independent producers. Professor Perry (1978), an eminent industrial organization economist, has devised an economic model which handles the issue of partial integration.

In the next chapter, we will outline our survey results. Our aim in the final chapter of this report is to operationalize Perry's model and simulate likely impacts on prices, quantities, and earnings of independent producers by degree of integration in the industry.

CHAPTER 3

CURRENT STATUS — SURVEY

To assess the extent of contractual and/or ownership integration by packers, requests for information were sent to both cattle and hog packers (small and large) in the continental United States. From the surveys returned, 185 contained usable information. The packers who responded did so voluntarily and may or may not be representative of packers who did not respond. Therefore, one should be cautious in drawing inferences about the whole population.

Characteristics of Respondents

A total of 185 packers responded to our survey: 83 from the North Central (NC) region, 41 from the East Cost (EC) region, and 61 from the rest of the nation (RON). Of the 185 packers, 130 slaughtered hogs: 62 in NC, 30 in EC and 38 in RON. Of the 130 who slaughtered hogs, 72 reported annual slaughter of less than 10,000 head, 27 slaughtered between 10,000 and 100,000 head, 9 slaughtered between 100,000 and 300,000, and 14 slaughtered more 300,000 head. Seven of the respondents did not report their slaughter volume. Of the 83 respondents in NC, 25 percent slaughtered cattle only, 30 percent slaughtered hogs only, and 45 percent slaughtered both. The total number of packers who slaughtered hogs was 62. About 85 percent of those slaughtering hogs also engaged in further processing and 32 percent produced brand labels. Ninety four percent of the hog packers operated 1 shift operations while 6 percent operated a 2 shift operations. The 62 hog packers represented a daily slaughter capacity of 138,000 head. The actual daily slaughter by the 62 firms was about 115,000 head/day, or 83 percent of capacity. Sixty seven percent of total hog slaughter was done by the upper 9 percent of hog packers.

Twenty seven percent of the respondents in EC handled cattle only, 22 percent hog only, and 51 percent handled both. The total number of hog packers was 30, 87 percent of whom did both slaughter and processing, 37 percent did slaughter and brand labels, and 27 percent engaged in slaughter, processing and brand labels. Total slaughter capacity reported was 29,543 head/day. Actual slaughter reported was 26,136 head/day. This represents about 78 percent capacity. Ten percent of the respondents slaughtered 94 percent of the total slaughter in the region.

Thirty nine percent of the respondents from RON slaughter cattle only, 20 percent hogs only, and 43 percent do both. The maximum slaughter capacity reported by hog packers in RON was 1000 head/day. The total head/day capacity for all the respondents is 4520. Actual slaughter reported was 3294 head/dy, or 73 percent capacity. Forty percent of slaughter was handled by 5 percent of the respondents.

Contractual and Ownership Integration

Both hog and cattle packers were asked to indicate the percentage of cattle and hogs acquired from public markets, direct purchase, forward contracts, custom lots/facilities and company owned lots/facilities. Responses were first categorized by size of annual slaughter capacity nationally, then by region and size of slaughter capacity. The annual slaughter size categories, for both cattle and hogs, are < 10,000, 10,000- 99,999, 100,000-299,999, and 300,000 head and over.

National Breakdown by Size

As shown in Figure 3.1, hog packers who slaughtered 10,000 head or less annually acquired about 38.56 percent of their hogs from public markets, 58.64 percent by direct purchase, and 2.67 percent through forward cash contacts. The percentage of hogs actually owned and fed by the hog packer in company owned facilities represented only 0.13 percent. The seventy two hog packers who responded to the survey represent more than half the actual packer population in the < 1,000 category reported in 1988. Assuming the response to our survey is representative of this category, and knowing that close to 500,000 hogs were slaughtered by packers in the 10,000 head and less category, roughly 70,000 hogs were owned and fed in packer-owned facilities. Figure 3.1, also shows the same breakdown for beef packers in the same size category. It is worth noting that while acquiring cattle through contracts represents only 1 percent in this size category, compared to 3 percent in hogs, about 5 percent of the cattle is actually owned in this category. About two percent is owned and fed in custom lots and 3 percent is owned and fed in company-owned lots.

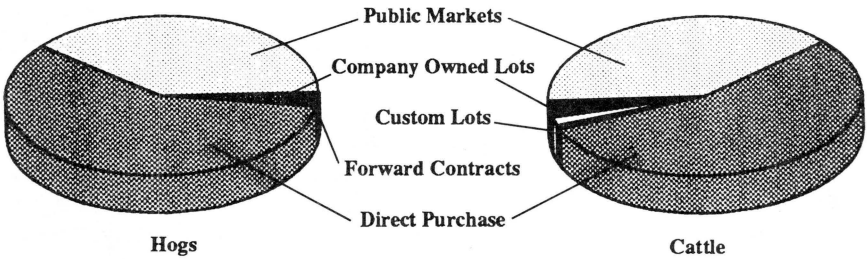


Figure 3.1: Slaughter Hogs/Cattle by Source Packer Size < 10,000 head

Packer ownership of hogs in company-owned facilities is little bit higher in the 10,000 to 100,000 head category. It represented about 1.07 percent of all hogs in this category a range from 10 to 20 percent. The rest was acquired from either public markets or direct purchase (Figure 3.2). Figure 3.2 also shows how the distribution of hogs by source compares with cattle. Again, cattle owned and fed in company facilities in this category is more than three times that of hogs. One beef packer in this category reported owning 100 percent of his slaughter cattle.

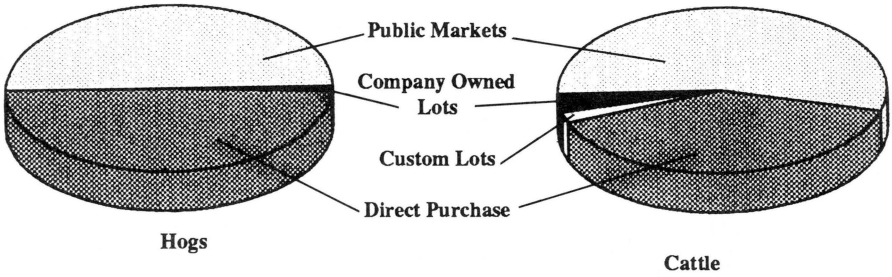


Figure 3.2: Slaughter Hogs/Cattle by Source. Packer Size 10,000 - 99,999 head

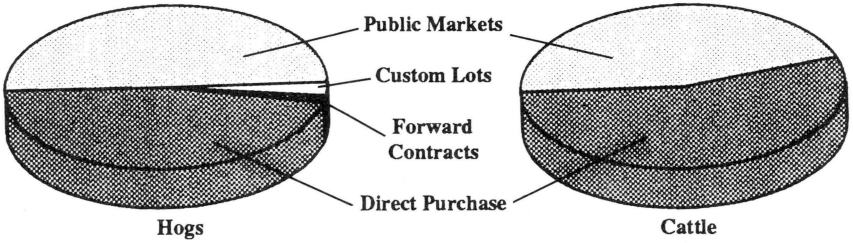


Figure 3.3: Slaughter Hogs/Cattle by Source. Packer Size 100,000 - 299,999 head

Figure 3.4: Slaughter Hogs/Cattle by Source. Packer Size > 300,000 head

Figures 3.3 and 3.4 show the distribution of hogs by source for the two size categories 100,000-299,999 head and > 300,000 head, respectively.. In the 100,000-299,999 head category, none of the hogs were contracted or owned. On the other hand, 1.43 percent of cattle in the same category were forward contracted and close to 3 percent were owned and fed in custom lot facilities.

In the higher category, > 300,000 head (Figure 3.4), close to 8 percent of hogs fall in the captive category, of which 3.64 percent is forward contracted, 2 percent is owned and fed in custom facilities, and 1.86 percent in company-owned facilities. Assuming the proportion of the captive hog supplies are representative of the population (57 plants), the total number of hogs in > 300,000 category is roughly 5.8 million head. Beef packers in this category, on the other hand, acquired about 11 percent of their supply through contracts and 1.4 percent through ownership and feeding in custom lots.

Figure 3.5 summarizes the above information across sizes. It is worth noting that while contracting and ownership of cattle seems to take place across all sizes in beef packing, it is mostly prevalent among the large sizes in hog packing.

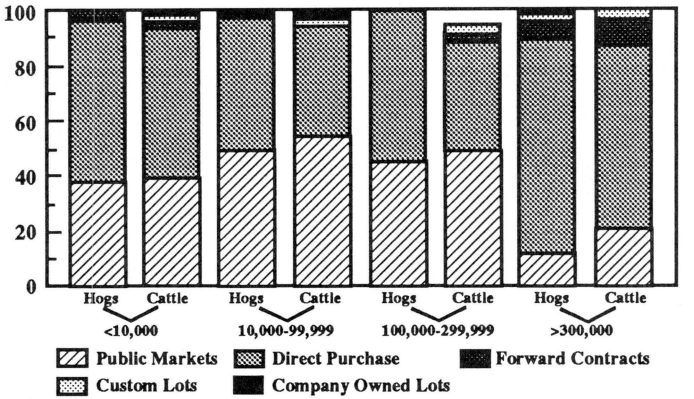


Figure 3.5: Slaughter Hogs/Cattle By Source and Category

Regional Breakdown by Size

North Central Region

Thirty one of the respondents from NC reported annual hog slaughter of 10,000 or less, eleven reported annual slaughter between 10,000 and 300,000 head, 6 between 100,000 and 300,000 head and, 3 slaughtered over 300,000 head annually, and 3 did not answer. Figure 3.6 shows the percentage of hogs by slaughter capacity and source. The percentages indicate on the average, the bulk of slaughter hogs in NC are still acquired through public markets (43 percent) and direct purchase (53 percent). Cash forward contracts were less than 1 percent of all volume. The breakdown of source of hogs by slaughter capacity, on the other hand, shows contracting activity among the large packers only (4 percent of the hogs in this category were acquired through forward contracts).

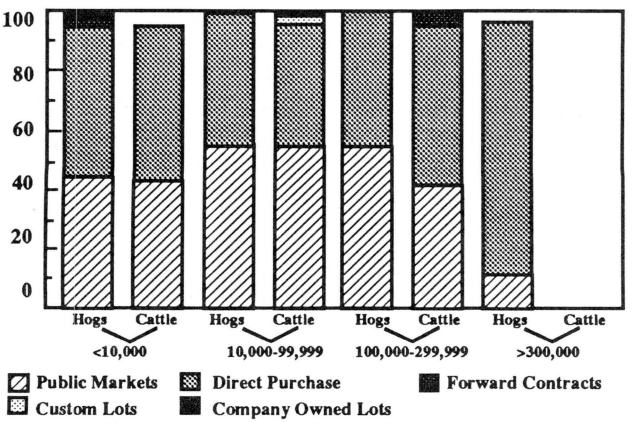


Figure 3.6: NC Slaughter Hogs/Cattle By Source and Category

East Coast Region

Eighty one of the respondents from EC reported annual hog slaughter of 10,000 or less, 5 reported annual slaughter between 10,000 and 300,000 head, 1 between 100,000 and 300,000 head , and 5 slaughtered over 300,000 head annually. Figure 3.7 shows the percentage of hogs acquired by slaughter capacity and by source. The average for the region indicate that close to 10 percent of the hogs falls in the category of captive supplies, of which 7.33 percent were acquired through forward contracts, 1.04 percent through ownership in custom facilities, and 1.33 percent through ownership in company-owned facilities. The eighteen packers in the < 10,000 category reported an average captured supply of 11.23 percent, 10.67 of which was acquired through contracts and .56 percent through ownership in company-owned facilities.

The five packers in the top slaughter category (>300,000) reported an average captured supply of 20 percent, 2 percent of which was through forward contracts, 9.33 through ownership in custom facilities, and 8.67 percent in company-owned facilities. Ownership in custom facilities ranged from no-ownership to 28 percent. Ownership in company-owned facilities ranged from 1 to 22 percent.

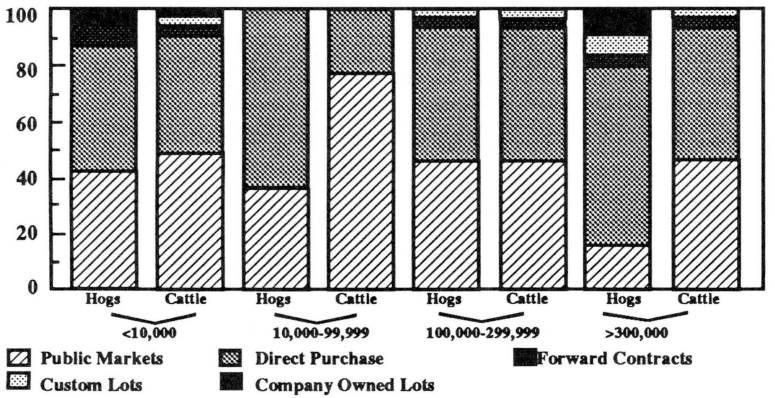


Figure 3.7: EC Slaughter Hogs/Cattle By Source and Category

Rest of Nation

From the 37 packers who reported hog slaughter in RON, 24 were in the < 10,000 category, 11 in the 10,000-100,000 category and only 2 in the 100,000 and over. The percentages for the RON were as follows: 32.41% of the hogs were acquired from public markets, 66.78% by direct purchase, and .81 percent through ownership in company owned facilities. Company ownership of hogs was reported in 10,000-100,000 category where the average percentage of hogs obtained through company-ownership was 2.73 percent, with a range from 10 to

20 percent. Figure 3.8 summarizes the percentage of hogs acquired by region and by source.

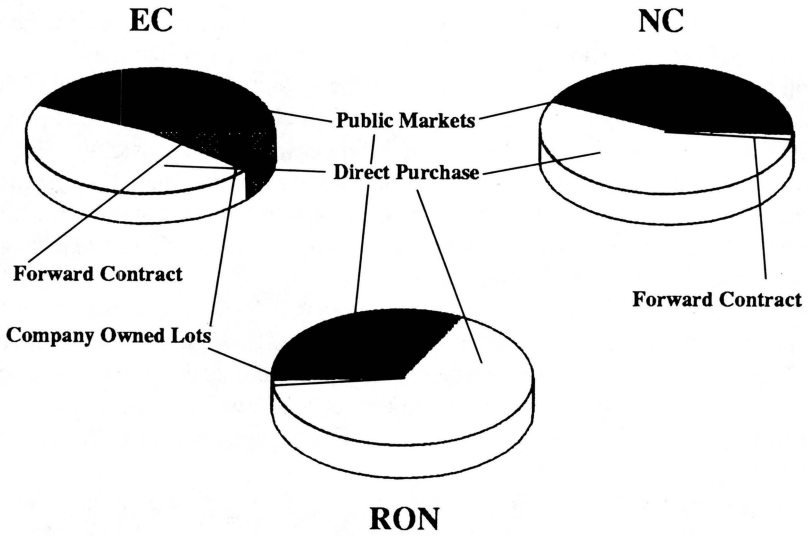


Figure 3.8: Slaughter Hogs by Source and Region

CHAPTER IV

PRICE AND QUANTITY IMPACTS OF VERTICAL CONTROL IN IMPERFECT MARKETS

a) The Graphical Model

The graphical illustration of the simulation model is presented in panel b of Figure 2.2. Let (I) denote the degree of integration, i.e, the fraction of hog suppliers integrated with the packer. Then S(Q,I) is the new supply curve after that partial integration. Note that as the degree of vertical integration, I, increases S(Q,0) moves toward S(Q,1), the supply curve of the industry which represents the production costs of the processor when he integrates totally in the production of hogs, i.e I=1. In the egg industry, for example, (I) would be close to 98 percent. Note also as S(Q,0) rotates clockwise toward S(Q,1), the quantity of slaughter hogs produced approaches the quantity under perfect competition. Hence, when a processor is fully integrated, theory predicts a larger quantity of processed material would be produced and the consumer will benefit from the lower price p(1).

At the new supply curve S(0,I), the quantity is Q(I). The question is what is the impact on the quantity of hogs and the price of hogs paid to independent producers as the degree of integration (I) increases. To answer the question, we developed a simple economic simulation model based on Perry's theoretical insights. Following Perry (1978), we avoid the complication of modeling strategic behavior between several processors, and model the problem if there was one sole buyer or a dominant buyer with a competitive, though insignificant, fringe. The model is presented without complete mathematical detail. The complete derivations are available form the author.

The Algebraic Presentation

Let the initial quantity Q(0) be 100 and the initial price W(0) be 1. Denote the hog supply elasticity by (es), denote the hog (derived) demand elasticity by (ed), the total quantity of slaughter hogs processed by the packer by (Q), and the price of slaughter hogs by w. Let the supply function S(Q,1) (see graph 2.2) take the constant elasticity form:

$$S(Q,1)=BQ^{s} \qquad where\ s=1/es \tag{1}$$

The derived demand function, DD on the graph, takes the constant elasticity form:

$$w = A^{-}Q^{t} \qquad where\ t=1/ed \tag{2}$$

A and B are constants. The schedule S(Q,0), marginal to S(Q,1), is then

$$S(Q,0) = (1+s)BQ^s \quad (3)$$

The schedule S(Q,I), between S(Q,0) and S(Q,1), is represented by the following relationship:

$$S(Q,I) = BQ^sZ^s(1+s) \qquad where\ Z = \frac{1}{1 + I\left[(1+s)^{\frac{1}{s}}-1\right]} \quad (4)$$

Note that when the degree of integration is complete (I=1) we are back to equation (1) which gives the supply function under full integration, and this supply function becomes the packers' internal cost schedule of production hogs.

When there is no integration (I=0), we are back to equation (3) which stands for the marginal expenditure function of a monopsonist. To solve for the actual quantity of hogs slaughtered (Q) after a given degree of vertical integration (I), we must equate (2) and (4) and solve for Q(I). To do so however, remember that, since the supply price is initialized to 1 and the initial quantity supplied is initialized at 100, B must be equal to 100^{-s}, and A must be equal to 100/(1+s). With that in mind, the quantity of hogs slaughtered (Q) at each level of integration (I) is given by

$$Q(I) = [A^tBZ^t(1+s)]^{(1/t-s)}$$

the price received by independents is,

$$w(Q,I) = B(QZ)^t$$

and the net earnings (revenues minus variable costs) by independent producers as a function the degree of integration are

$$R(I) = ((1-I/(1+s))w(Q,I)q^tZ^t$$

Simulation Results:

To simulate the above model, we need information on the elasticities (degrees of response) of hog supply and derived demand. For the initial run, we set the elasticity of hog derived-demand at -.568 (estimated independently by Schroeter and Azzam (1990)) and varied the elasticity of supply from .403 (also estimated by Schroeter and Azzam (1990)) to 1 and then 1.5. This pretty much covers the range of available supply elasticities available in the literature (short and long run). Figure 4.1a plots the numerical results under the three scenarios. Indeed, as the degree of integration increases, hog slaughter also increases. For example, at an elasticity of demand of -.568 and an elasticity of supply of .40, a level of 10 percent integration will bring forth about 3.8 percent increase in hog slaughter. Figure 4.1 also shows that as hog supply becomes more responsive, the quantity

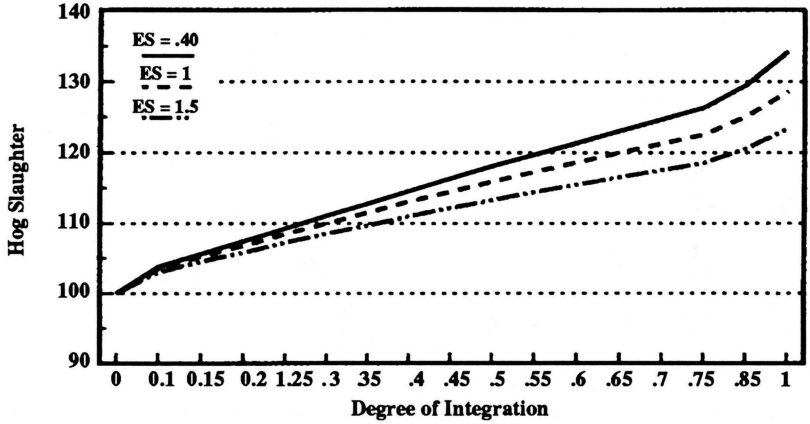


Figure 4.1a: Degree of Integration and Hog Slaughter for Different ES

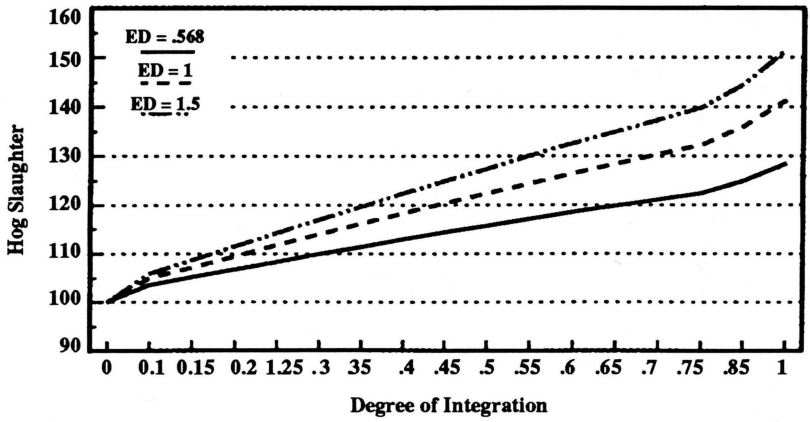


Figure 4.1b: Degree of Integration and Hog Slaughter for Different ED

of hogs forthcoming in the market is also higher. Figure 4.1b shows the relationship between the degree of vertical integration and hog slaughter under varying demand responses, holding the supply elasticity at a value of .40. The more responsive is the demand curve the more quantity of hogs forthcoming under increasing levels of vertical integration. This also implies that the consumer benefits from lower prices of pork as output expands.

Figure 4.2a demonstrate the relationship between the degree of integration and the quantities of hogs purchased from independents. Obviously, although the total quantity of hogs slaughtered increased, the quantity purchased from independent hog producers is predicted by the model to decrease by more than the increase slaughter. For example, at 10 percent level of integration, total slaughter goes up by 3.8 percent but the quantity purchased form independents

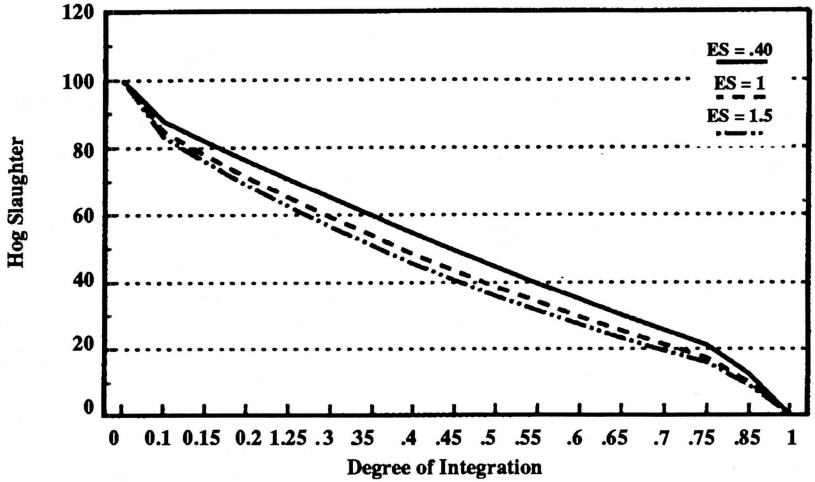


Figure 4.2a: Degree of Integration and Quantities from Independents (ES)

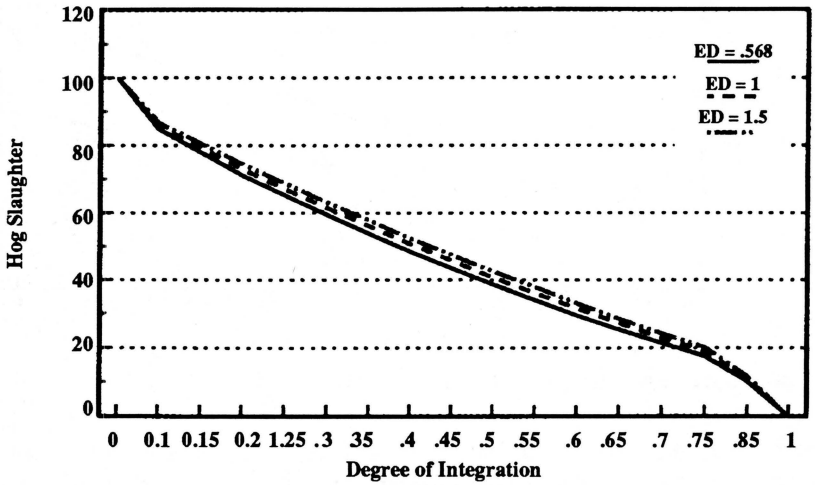


Figure 4.2b: Degree of Integration and Quantities from Independents (ED)

declines by 13.3 percent. This means, given the magnitude of supply and demand elasticities, that the 17 percent of the hogs is being captive by the processor. Figure 4.2b shows the same relationship between the degree of integration and purchases of independents under varying demand responses.

According to figure 4.3a, the price to independents also declines. At the ten percent level of integration the price paid to independents declines by about six percent. At fifty percent integration, the price declines by about 26 percent. The more responsive the hog supply curve, the steeper the decline in the price of

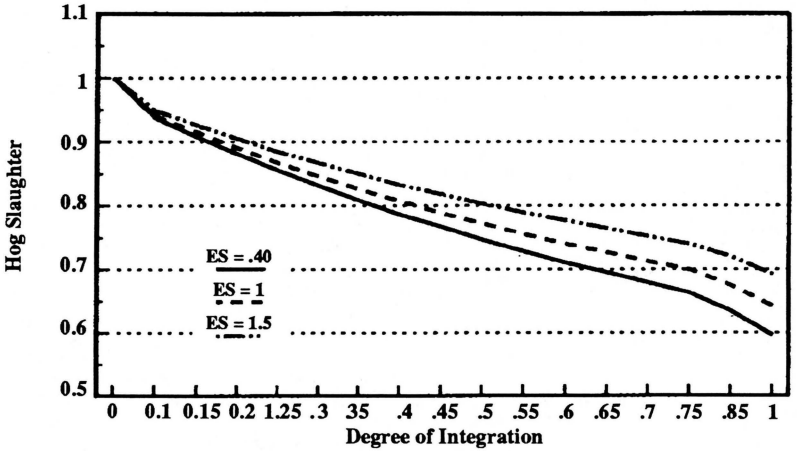


Figure 4.3a: Degree of Integration and Price Received by Independents (ES)

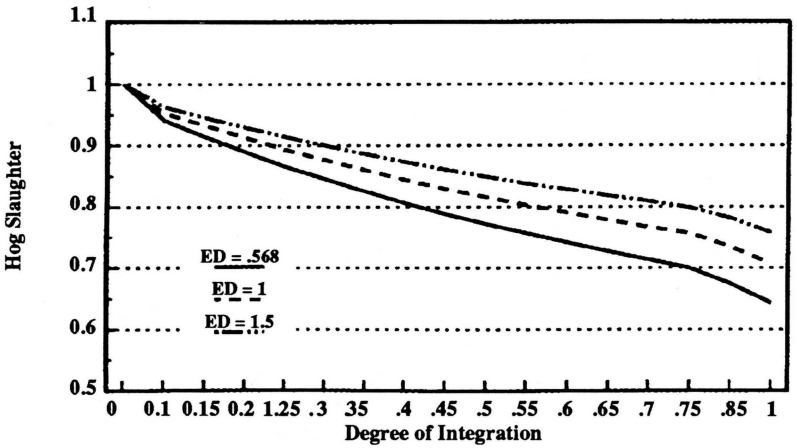


Figure 4.3b: Degree of Integration and Price Received by Independents (ED)

independents. Similarly, the more elastic the demand curve, the steeper the price decline received by independents.

Figure 4.4 shows the decline in earnings as the degree of vertical integration increases. Since both the price paid to independents and quantity purchased from independents decline with vertical integration, their earnings naturally decline. However, the decline in earnings is faster than the decline in both the price and quantity. For example, at a level of vertical integration of 10 percent, the quantity purchased from independents declines form 100 to 88 (12 percent), price declines from 1 to .937 (6 percent), and earnings decline from 100 to 82.13 (18 percent). Note also that the more responsive the supply curve, the steeper the decline in earnings to independents.

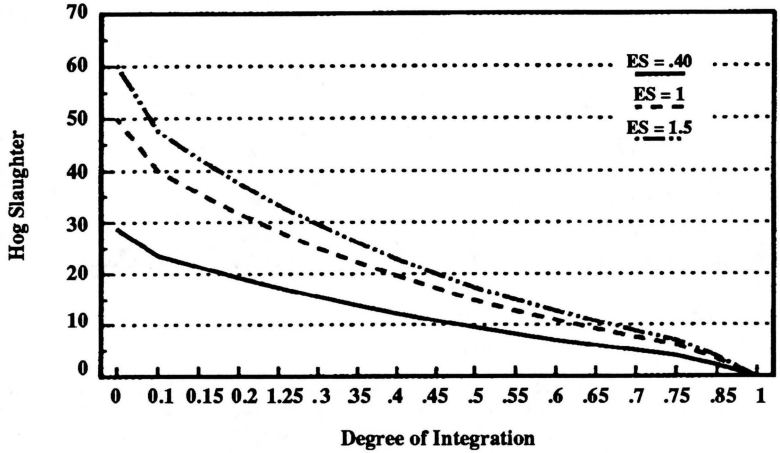


Figure 4.4a: Degree of Integration and Earnings of Independents (ES)

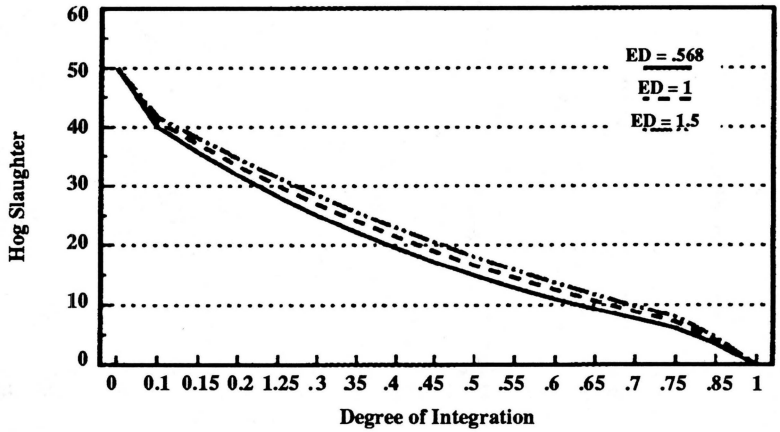


Figure 4.4b: Degree of Integration and Earnings of Independents (ED)

We should remind the reader that the importance of the above results lie in their qualitative rather than quantitative dimensions. They also provide a background for various hypotheses to be tested as integration proceeds in the industry. The quantitative results are the creature of the nature of supply and demand response assumed to be taking place in the hog/pork complex. As one assumes different supply and demand elasticities one would get different quantitative results. However, the qualitative directions indicate that increased packer integration in the hog industry is likely to increase overall pork production, reduce prices to the consumer, lower the price of hogs to the independent producer.

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APPENDIX

Definition of Regions

West North Central Region (WNC)
- Iowa
- Kansas
- Minnesota
- Missouri
- North Dakota
- Nebraska
- South Dakota

East North Central Region (ENC)
- Illinois
- Indiana
- Michigan
- Ohio
- Wisconsin

Northeastern Region (NE)
- Connecticut
- Massachusetts
- Maine
- New Hampshire
- New Jersey
- New York
- Pennsylvania
- Rhode Island
- Vermont

South Atlantic Region (SA)
- Delaware
- Florida
- Georgia
- Maryland
- North Carolina
- South Carolina
- Virginia
- West Virginia

South Central Region (SC)
- Alabama
- Arkansas
- Kentucky
- Louisiana
- Mississippi
- Oklahoma
- Tennessee
- Texas

Western Region (W)
- Arkansas
- Arizona
- California
- Colorado
- Hawaii
- Idaho
- Montana
- New Mexico
- Nevada
- Oregon
- Utah
- Washington
- Wyoming