# PRICING PERFORMANCE OF A DUOPSONY MEAT PACKING INDUSTRY*

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Conventional wisdom of economists, politicians and livestock producers is that the "market power" of meat packers increases as the number of packers (N) decreases. The smaller number of packers supposedly use their increasing market power to extract rents from both consumers and livestock producers by generating wider farm-wholesale price spreads (S) than would exist if there were a larger number of packers that would "compete" for the animals being marketed by livestock producers.[1] This conventional wisdom states that $\sigma S/\sigma N < 0$ [i.e., the spread increases (decreases) as N decreases (increases)].

The purpose of this paper is to explore the validity of this conventional wisdom that provides the foundation for increasing public discussion and concern about livestock prices and the structure of the meat packing industry. This paper develops the conceptual framework appropriate for specifying hypotheses about the sign of $\sigma S/\sigma N$.

## The Farm Level Market for Livestock

Meat packers apparently make key decisions regarding kill rate and hence prices they are willing to pay for live animals on a weekly basis. Thus, the relevant unit of time for packer decisions

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[1]Market power is a widely used term that is almost never defined by authors. See Bullock (2) for a discussion (definition) of the term "market power."

and for envisioning packing plant cost curves and derived demand curves for live animals is one week. All discussion and graphs that follow use one week as the unit of time.

The slaughter animal market clears each week with a quantity $Q_t$ marketed/slaughtered in week t at an average price $P_f^t$. The magnitude of $Q_t$ is determined by producers. The price offered by packers, $P_f^t$, is determined by the wholesale demand curve for meat and the cost of providing slaughter/wholesaling services at the weekly slaughter rate $Q_t$.

Consider the case of a duopsony (two firm) packing industry purchasing hogs from a large number of hog producers.

The average variable cost (excluding animal cost) curves for Firm A and Firm B are denoted as $AVC_a$ and $AVC_b$ respectively in Figure 1. $MC_a$ and $MC_b$ represent the upward sloping portion of the associated marginal cost curves. $Q_*^a$ and $Q_*^b$ are the least cost per head operating levels (weekly slaughter rates) for the two firms. Firm B benefits from economies of scale relative to Firm A as indicated by the relative magnitude of average cost in the vicinity of their respective least cost levels of weekly operation.

Both slaughter firms sell identical products into the wholesale market and produce the same yield of wholesale product per live animal at all levels of plant operation (i.e., wholesale products are obtained in fixed proportions from live animals).

The wholesale demand curve for the products produced from alternative levels of hog slaughter is represented by:

$$P_t^w = \alpha Q_t^{\beta}$$

where: $P_t^w$ = the per head value of wholesale pork products marketed during week t.

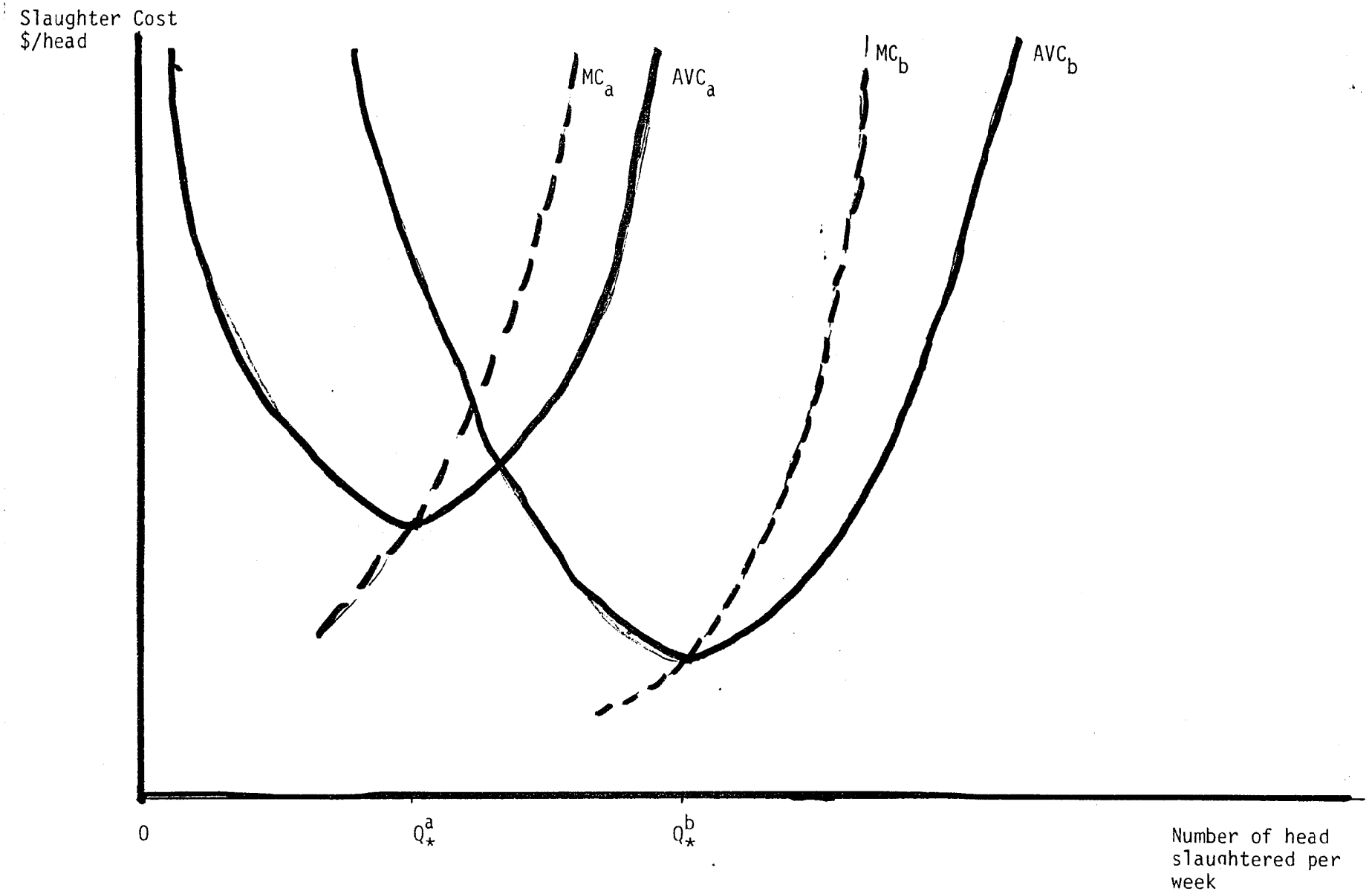


Figure 1: Average variable cost and marginal cost of slaughter (non animal costs) for Firm A and Firm B

$Q_t$ = the total number of hogs slaughtered during week t. $Q_t$ is the sum of the quantity slaughtered by Firm A and by Firm B, i.e., $Q_t = Q_t^a + Q_t^b$.

The biological nature of swine production means that the number of hogs reaching slaughter weight in week t was determined several months ago by hog producers who bred the sows that farrowed the pigs that were fed to slaughter weight in week t by the hog producers. Slaughter weight hogs, are for all practical purposes, a non-storable commodity. Thus, the number of slaughter weight hogs marketed by producers in week t is highly (almost perfectly) inelastic with respect to the market price of hogs being offered by packers in week t.

The wholesale price of pork produced in week t is defined by the willingness of wholesale buyers to purchase the pork products obtained from the predetermined number of hogs marketed in week t. The wholesale price of pork in week t ($P_t^w$) is independent of decisions and actions of pork packers. The number of hogs slaughtered each week is determined by production/ marketing decisions of producers. The wholesale price is the market clearing price for the quantity of pork placed in the market by producers.

The classical static equilibrium economic model used by IO economists to illustrate how oligopsonsists exercise "market power" assumes that (a) producers determine production in time period t as a function of the price offered by buyers in period t (i.e., there is an instantaneous production process), and (b) therefore the buyers determine industry output in time period t by setting the price they are willing to pay for the raw material.

Neither of these assumptions is a valid description of the market for slaughter hogs in week t. Even during the weeks of record low hog prices (and record high weekly slaughter rates) in 1998 and 1999, pork packers purchased all hogs placed in the market each week. Pork packers do not

generate economic rents by restricting the number of hogs slaughtered each week as is postulated (assumed) by the economic model offered by conspiracy theorists.

The farm level price of hogs paid by packers is, however, directly determined by packer decisions regarding the price they are willing to pay for alternative quantities of animals placed in the market during week t. Packers are margin makers. They determine the price they are willing to pay for live hogs in week t (without regard to hog producer production costs), given (a) the wholesale level demand for pork products, (b) the total number of hogs marketed in week t, and (c) the per head slaughter costs at $Q_t$ level of operation.

The farm level demand curve for live hogs is thus derived (by packers) from the wholesale demand for pork products. By definition, the producer level derived demand for hogs is the schedule showing the maximum price that packers are willing to pay for $Q_t$ hogs during week t. In a competitive market, this price is the wholesale value of the products produced from the animal minus the cost of the slaughtering process at the weekly $Q_t$ slaughter rate [(i.e., $P_t^f = (P_t^w - C_t)$].

Bullock (1) has shown that the derived demand for hogs by an oligopsonist packing industry is identical to the derived demand curve for hogs by a competitively structured packing industry provided the cost curves of the firms in the two industries are identical. Thus, in that case the number of packers is not a factor in determining the farm level price of hogs in week t.

The questions of interest in this paper are:

1. How will the duopsony firms described above (i.e., non-identical cost curves) distribute available supplies between themselves?
2. What will be the price of live hogs in this situation?

3. Does the resulting price of hogs accurately reflect the "true" value of hogs marketed in week t as would be the case with a "competitively structured" packing industry?

Given the wholesale demand for pork products and the processing cost curves of the two packing plants illustrated in Figure 1, the derived weekly demand curve for hogs by Firm A $(DD_a)$ and Firm B $(DD_b)$ are depicted in Figure 2. [See Bullock (1) for a discussion of the derivation process.]

It is clear from Figure 2 that for sustained levels of industry output less than $Q_k$, Firm A can outbid Firm B for 100 percent of available supplies. Ongoing industry output levels $Q_L < Q_t < Q_k$ are large enough to sustain only Firm A. In this situation, Firm A would be a natural monopsonist.

At industry output levels $Q_k < Q_t < (Q_*^b + Q_s)$ Firm B can outbid Firm A for 100 percent of available supplies. Continued industry output levels in this range are large enough to sustain only Firm B. In this case Firm B would be a natural monopsonist.

The two plants can co-exist over a period of W weeks only if the average number of hogs marketed each week $Q_t \geq (Q_*^b + Q_s)$.

The derived demand curve for hogs in the duopsony packing industry is depicted in Figure 3. Over the range of sustained weekly hog production in the range $Q_L \leq Q_t \leq Q_k$ the market derived demand curve is the derived demand for hogs of Firm A. Over the range of sustained weekly hog production $Q_k < Q_t \leq (Q_*^b + Q_s)$ the market level derived demand for hogs is the corresponding segment of the Firm B derived demand curve for hogs. At weekly hog production levels $(Q_*^b + Q_s) \leq Q_t \leq (Q_m + Q_*^a)$, the derived demand for live hogs is the upward sloping segment of the Firm A derived demand curve for hogs over the $Q_s$ *to* $Q_*^a$ range. At weekly hog production levels $(Q_m + Q_*^a) < Q_t < (Q_g + Q_h)$ the market demand for live hogs is the horizontal summation of the

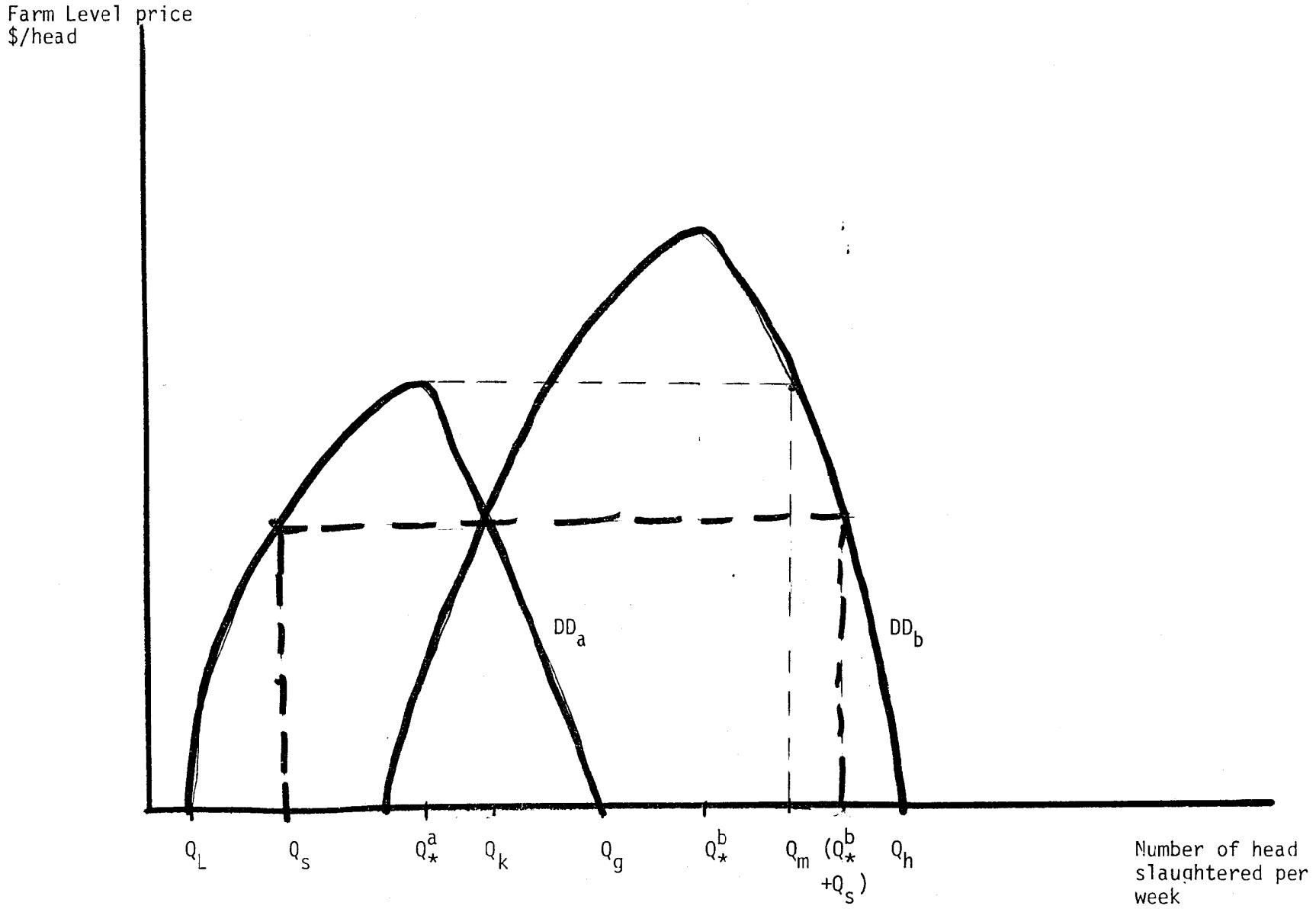


Figure 2: Derived demand for hogs by slaughter Firm A and slaughter Firm B

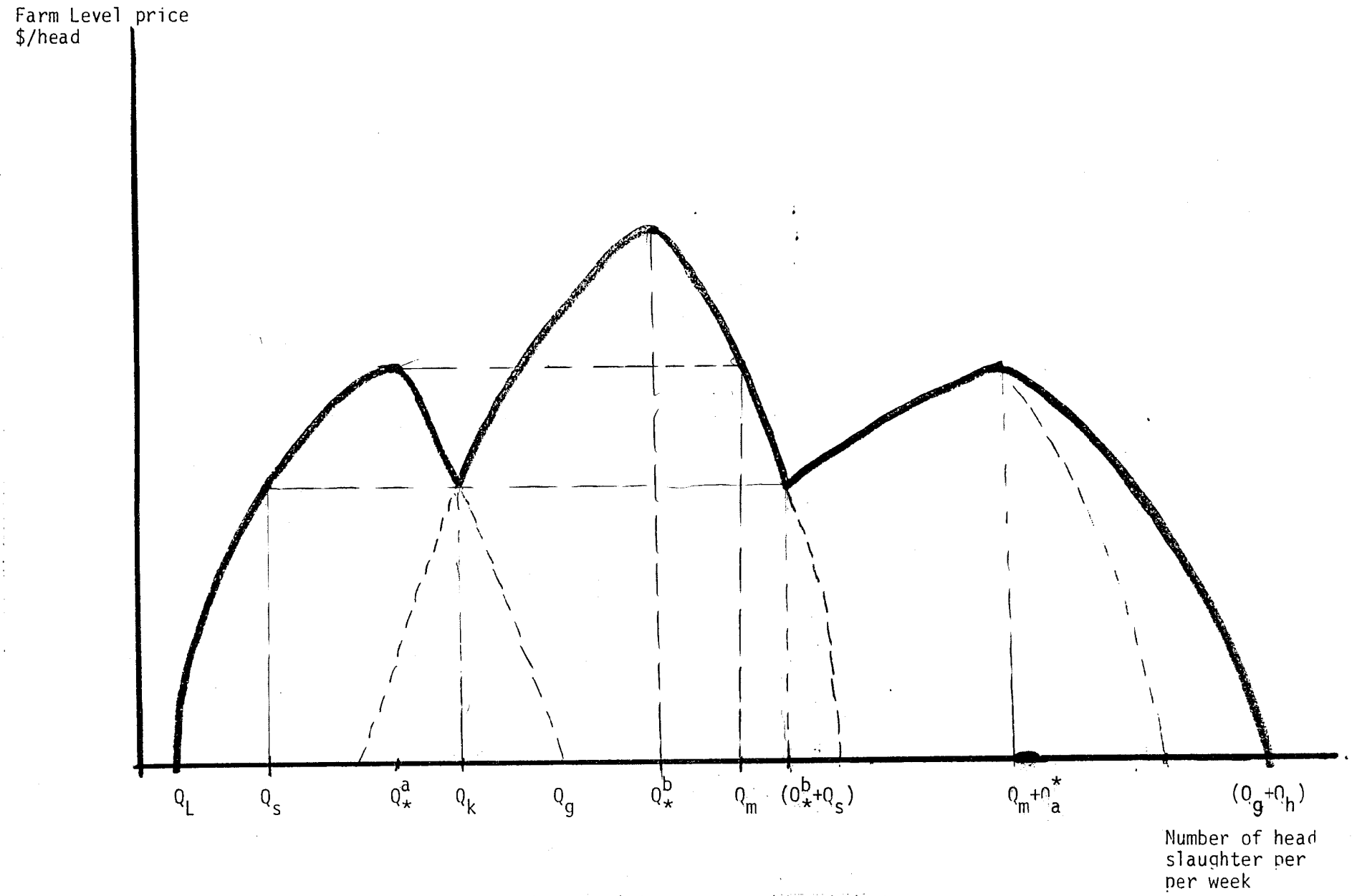


Figure 3: Market derived demand for hogs with Duopsony packing industry

derived demand for hogs by Firm A (over the range $Q_*^a$ *to* $Q_g$) and the derived demand for hogs by Firm B (over the range $(Q_m + Q_s)$ to $Q_h$. The market derived demand for hogs crosses the quantity axis at $Q_t = (Q_g + Q_h)$ given the existing capacity of the slaughter plants owned by the two firms.

At hog slaughter levels $(Q_*^b + Q_s) \le Q_t \le (Q_m + Q_*^a)$ both firms can exist and will compete for hogs. Over this range of industry output Firm A can outbid Firm B for its hogs and thus gain entry into the market. Firm A will gain market share over this range of production but will always have a smaller share than Firm B. As industry output increases from $(Q_*^b + Q_s)$ to $(Q_m + Q_*^a)$ Firm A will reduce weekly slaughter from $(Q_*^b + Q_s)$ to $Q_m$, while Firm B expands slaughter from zero to $Q_*^a$.

At hog production levels $(Q_m + Q_*^a) \le Q_t < (Q_g + Q_h)$ both firms will be operating on the upward sloping portion of their respective marginal cost curves and will hence have downward sloping derived demand curves for hogs. The two firms will compete for all production in this interval of industry output. Changes in market share over this interval will be determined by the relative slopes of the two firms' marginal processing cost curves over the $Q_*^a$ *to* $Q_g$ range for Firm A and over the $Q_m$ *to* $Q_h$ range for Firm B.

The firm having the steepest sloping marginal cost curve will lose market share as industry output expands beyond $(Q_m + Q_*^a)$. Given that at these levels of processing $\frac{Q_a}{Q_*^a} < \frac{Q_b}{Q_*^b}$ it is likely that Firm A will gain market share as industry production expands beyond $(Q_m + Q_*^a)$ since $\frac{\sigma C_a^m}{\sigma Q_a} < \frac{\sigma C_b^m}{\sigma Q_b}$ over this range.

In order to maintain both Firm A and Firm B in operation, total weekly slaughter must average more than $(Q_*^b + Q_s)$ and not exceed $(Q_g + Q_h)$ if hog prices are to be above zero.

A couple of observations can be derived from this exercise.

First, and most significant, since meat packers possess zero buyer market power, even with only two packing plants. Therefore, hog producers will receive the competitive value for their hogs $P_t^f = (P_t^w - C_t)$ where $C_t$ is the cost of slaughtering the $Q_t$th hog in week t. Rivalry between the two packers for market share to insure that the rival does not buy hogs at "bargain prices," generates the same farm prices that would exist if there were "large numbers" of packer buyers.

The cost of slaughter in week t (i.e., $C_t$) is the marginal cost of slaughter for Firm B and is the average cost of slaughter for Firm A. Note that as industry output level increases from $(Q_*^b + Q_s)$ to $(Q_m + Q_a^*)$ that Firm A gains market share by expanding production along the downward sloping portion of its AVC curve and offering farm level prices of $P_a^f = (P_w - AVC_a)$. At the same time Firm B loses market share by moving to the left along its *MVC* curve and paying the farm level price of $P_t^f = (P_w - MVC_b)$. Since both firms sell at the same price $P_w$ and purchase slaughter animals at the same price $P_a^f = P_b^f$ it follows that at the respective slaughter rates in period t $MVC_t^b = AVC_t^a = C_t$ thus, Firm A is not accruing producer surplus as it expands from $Q_s$ to $Q_*^a$ level of slaughter. However, Firm B is accruing producer surplus on all animals slaughtered although its market share and operating profits are reduced by the participation of Firm B as industry output expands beyond $(Q_*^b + Q_s)$. Both firms accrue producer surplus only when industry output exceeds $(Q_m + Q_a^*)$.

It is theoretically possible that Firm A and Firm B will decide to collude and simply agree to widen the spread $S - (P_w - P_f)$ beyond the "competitive" levels discussed above. Evidence of this non-competitive behavior by the packers would appear as above normal profit levels for the industry. Proponents of such a conspiracy theory are welcome to pursue this model. However, observed rates of profit on either sales or investment in the packing industry are not consistent with the collusion

theory. To the contrary, observed profit rates of meat packers is quite consistent with the model described above.

Second, we know that the number of animals marketed/slaughtered per week fluctuates substantially during the year. Given the ongoing existence of more than one packer, we can conclude that the average value of $Q_t$ in recent years has been greater than $(Q_*^b + Q_s)$ and has ranged between $(Q_*^b + Q_s)$ and $(Q_g + Q_h)$ since no packer has temporarily closed because of short supplies and then reopened when supplies increased. Moreover, we can conclude that in late 1998 and early 1999, $Q_t$ was quite close to $(Q_g + Q_h)$.

The packing industry model depicted here can, with no loss of generality, be viewed as either a duopsony or as an industry with $N_1$ identical smaller firms and $N_2$ identical larger firms where the larger firms benefit from economies of scale. Suppose that we change the problem setting so that $AVC_a$ represents the aggregate of $N_1$ identical firms and $AVC_b$ represents the aggregate of $N_2$ identical firms. In this case numerous "small" firms confront numerous "large" firms in the process of buying hogs and selling wholesale pork products. The market outcome is not dependent on the number of firms in either category.

Thus, given the existing slaughter capacity of the $N_1 + N_2$ firms, the market level derived demand curve is simply a scaled up version of the market derived demand curve depicted in Figure 3. Given industry slaughter capacity of the two groups of firms, the weekly market demand curve for hogs has three upward sloping sections and three downward sloping segments over the output range $Q_L \le Q_t \le (Q_g + Q_h)$.

Since the current industry consists of more than one packing firm and these firms are not of identical size, we can conclude that in recent years hog production (slaughter) has exceeded

$(Q_*^b + Q_s)$ in all periods. Thus this segment of the market derived demand curve for hogs is relevant for purposes of our discussion here.

Variation in Market Share and Farm-Wholesale Price Spreads

Select two levels of industry output $Q_i$ and $Q_j$ such that

$$(Q_*^b + Q_s) < Q_i < Q_j < (Q_g + Q_h).$$

Three possible situations exist depending on the magnitudes of $Q_i$ and $Q_j$.

I. $(Q_*^b + Q_s) < Q_i < Q_j < (Q_m + Q_*^a)$

In this situation, as output increases from $Q_i$ to $Q_j$ the wholesale price of pork decreases but the farm price of hogs increases and therefore the farm-wholesale price spread decreases.

II. $(Q_m + Q_a^*) < Q_i < Q_j \leq (Q_g + Q_h)$

In this situation as output increases from $Q_i$ to $Q_j$, both the wholesale price of pork and the farm price of hogs decrease and the farm-wholesale price spread widens reflecting the rising marginal slaughter cost of both packers (groups of packers).

III. $Q_i < (Q_m + Q_*^a) < Q_j < (Q_g + Q_h)$

In this case the wholesale price of pork decreases as output increases from $Q_i$ to $Q_j$. However, at the farm, level $P_i^f \gtreqless P_j^f$ depending on the relative magnitude of $[Q_j - (Q_m + Q_*^a)]$ and $[(Q_m + Q_*^a) - Q_i]$, therefore the farm-wholesale spread may increase, decrease, or remain unchanged as retail prices decline in response to an increase in the number of animals marketed/slaughtered over this interval of total number of hogs marketed/slaughtered.

These situations and the resulting conclusions are not dependent on the magnitude of $N_1$ or $N_2$ (provided $N_1 \geq 1$ and $N_2 \geq 1$ since industry output exceeds the levels where natural monopsonies

would exist. Moreover the conclusions are not changed if the model is expanded to accommodate M > 2 groups of firms.

Clearly $\sigma S/\sigma N = 0$ and there is no theoretical basis for arguing that meat packer spreads will increase as the number of packers decreases. The relevant variable explaining changes in the farm-wholesale price spread is the magnitude of $Q_t$ relative to the existing weekly slaughter capacity of the packing industry.

Note that the only assumptions of this model are:

1. The wholesale demand for pork is downward sloping with respect to the number of animals marketed each week.
2. That the number of animals marketed each week exceeds the number required for the existence of a natural monopsony.
3. That one firm (group of firms) enjoy economies of scale relative to the other firm (group).
4. The number of animals marketed/slaughtered in week $t$ was predetermined several months ago by the collective decisions of hog producers.
5. Packers purchase and slaughter all hogs marketed in week $t$ as long as $Q_t < (Q_g + Q_h)$.
6. Packers are margin makers and act in their own best interest in determining the farm level price of hogs each week.

Bottom Line: The wholesale price of pork, the farm price of hogs, and hence the farm-wholesale price spread for hogs is not a function of the number of pork packers. Therefore calculation of, and references to, packer concentration ratios is an irrelevant and useless activity in

trying to understand and explain changes in the price of hogs and the farm-wholesale price spreads. More importantly, the focus of market observers and policy markers on industry structure (concentration ratios) leads to the wrong conclusions about the existence and use of packing industry "market power." Government policies and programs based on the inappropriate conclusions from the calculations of concentration ratios can lead to inappropriate allocation of resources and prevent the development of public understanding of the complex livestock market.

References

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