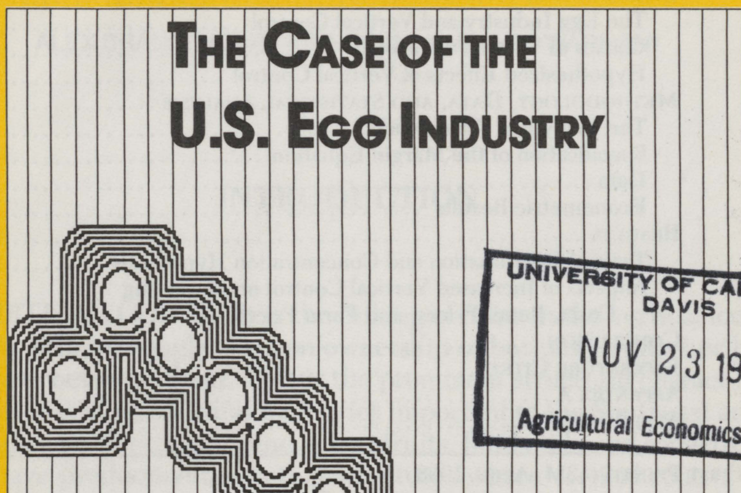
ECONOMIC EFFECTS OF INCREASED VERTICAL CONTROL IN AGRICULTURE:

THE CASE OF THE U.S. EGG INDUSTRY



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Economic Effects of Increased Vertical Control in Agriculture: THE CASE OF THE U.S. EGG INDUSTRY[1]

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INTRODUCTION

VERTICAL CONTROL is the linking of firms in the vertical food system either through common ownership of business entities or by contracts between them. This is the prominent structural characteristic of several agricultural industries important to the Southeast and Alabama. Broilers, sugar cane, citrus fruits, fluid milk, and some tree nuts have production/marketing structures where vertical control is virtually complete (29). Eggs and turkeys are rapidly approaching that status.

The purposes of this bulletin are to elucidate the economic causes of vertical control and quantify the economic impacts of vertical control on consumers, producers, and middlemen. The U.S. egg industry serves as the focus of analysis because of its importance to the agricultural economy of the Southeast and because its industry structure has moved toward one dominated by vertical control (from 12 percent of volume in 1960 to 81 percent in 1977).

The Egg Industry and Vertical Control

Since the early 1970's, the U.S. egg industry has been buffeted by a series of shocks, largely beyond its control, that has caused severe

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economic hardships for many of the industry's participants. Concerns over cholesterol, less breakfast eating, aggressive marketing of fast breakfasts, and diets containing fewer cakes, pies, and other foods using eggs have contributed to a 17.6 percent decline in per capita egg consumption between 1970 and 1985 (*3*, p. 22). Yet over the same period, improvements in production technology, nutrition, breeding, and management techniques have led to a 13.3 percent increase in layer output (*3*, p. 11). Increases in egg supply, against an inelastic and declining demand for eggs, have placed severe downward pressures on price and industry revenue. Exacerbating the effects of the downward price pressure were random supply shocks caused by the cyclical nature of egg production and disease epidemics. Of particular importance was the outbreak of avian influenza in the fall of 1983. Anticipation of a supply shortage caused retail egg prices to soar to $1.33 per dozen in February 1984 only to collapse 5 months later to 88¢ per dozen (*3*, p. 7). Such extreme price volatility makes reliance on price signals as a guide to production levels and resource allocation in the industry risky at best.

Industry response to the problems of price volatility and declining prices appears to have taken two forms. First, the industry sought government assistance by spearheading a movement that resulted in an amendment passed by the U.S. Congress in 1983 which brought eggs under the Agricultural Marketing Agreement Act of 1937. Since then, the industry has used the authority of the Act to propose a national egg marketing order. The purpose of the proposed marketing order, which was eventually defeated in a June 1987 producer referendum, was to provide for a mandatory national checkoff of 0.5¢ per dozen eggs marketed to be used to finance industry-sponsored advertising and promotion programs and other market development activities (*20*). The referendum, if passed, would have resulted in annual checkoff monies of about $25 million.

The second industry response to downward price pressure and price volatility, and the one that serves as the central focus of this study, is a restructuring of organizational relationships within the industry. According to one estimate, between 1980 and 1984, the number of commercial egg operations in the United States declined from 6,600 to 3,800 (*16*). In addition to a declining number of firms, the egg industry has evolved into a highly specialized sequence of production and marketing activities, figure 1. For example, eggs at the farm level are produced in three distinct stages—hatching, growout, and layer services—each usually being performed by a separate economic entity. Value-added activities include assembly, grading, pack-

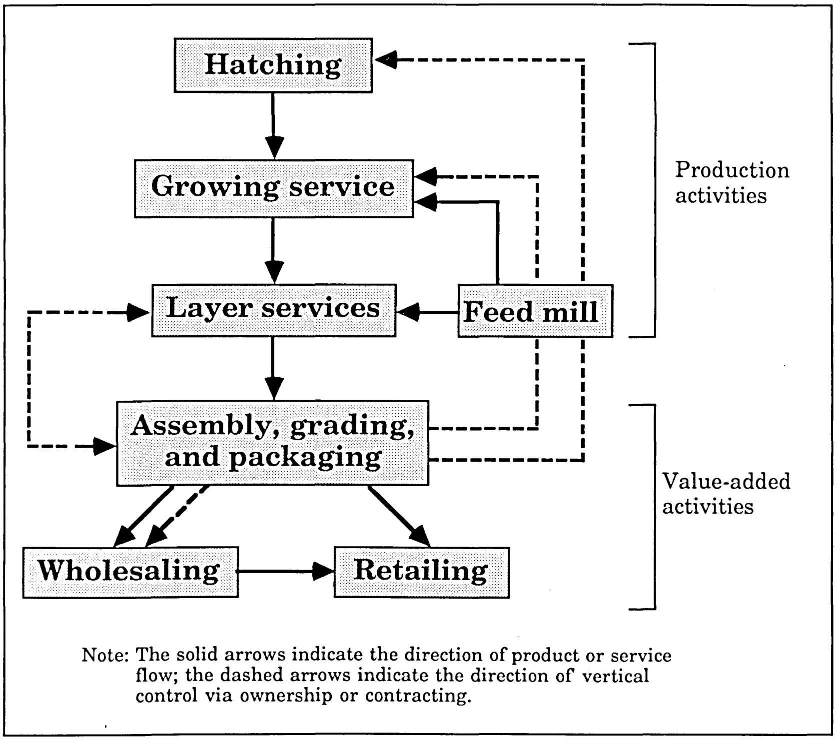

FIG. 1. Retail egg production stages and vertical control.

aging, wholesaling, and retailing and some of these, too, are performed by separate business firms.

Because the different stages are interlinked, a pivotal factor governing the performance of the total egg production and marketing system is the level and smoothness of interstage coordination and communication. There are essentially two ways in which the various stages can be linked: through market exchange or by vertical control. Under the market exchange option, vertical flow of product or services is accomplished via market transactions. For example, an egg layer operation buys replacement hens on the open market at a market-determined price. This firm generally has no voice in the affairs of the growing services firm other than the price that is to be paid for a specified number of pullets.

Under the vertical control alternative, vertical flows are accomplished via internal organization. That is, rather than relying on the market to provide inputs (outputs), the firm gains control over quantity, quality, and price through purchase of the upstream or downstream firms (vertical integration) or via contracting. Thus, the firm or industry chooses to substitute managerial and organizational skills for market transactions to achieve interstage coordination under the vertical control alternative.

In the egg industry, vertical control is both the forward and backward types. An egg packer often contracts with a layer services firm for the eggs. Or, if the egg packer owns a feed mill, a growout operation may be purchased to assure a market for feed. The packer also may forward integrate into wholesaling to assure a steady market for the packaged product. The variety of other options for achieving vertical control is illustrated in figure 1.

In the U.S. egg industry, market exchange as a coordinating mechanism has been virtually replaced by vertical control since 1970. Between 1970 and 1977, the quantity of eggs (on a dollar volume basis) produced under vertical control arrangements increased from 40 to 81 percent, table 1. Most of the increase has occurred in contracting (44 percent of the dollar volume of eggs in 1977), but integration also increased greatly (to 37 percent of dollar volume in 1977).

TABLE 1. VERTICAL CONTROL IN THE U.S. EGG INDUSTRY, SELECTED YEARS, 1960-77

Year	Percent of eggs (dollar volume basis) sold under		
	Production or marketing contract	Vertical integration	Both
1960	7.0	5.5	12.5
1970	20.0	20.0	40.0
1977	44.0	37.0	81.0

Source: Rodgers, George. 1979. Poultry and Eggs. Another Revolution in U.S. Farming? USDA Economics, Statistics, and Cooperatives Service Report No. 441: 168.

Industry concentration has increased in concert with the trend towards vertical control, although occurring at a less rapid rate. The 20-firm concentration ratio, which measures the percentage of industry sales or volume conducted by the largest 20 firms, increased from 20.6 percent in 1978 (the earliest available figure) to 32.0 percent in 1986, table 2. Four-firm and eight-firm concentration ratios show a similar trend toward increased concentration, especially in recent years. The heightened industry concentration reflects a move toward industry consolidation in response to the economic pressures enumerated previously.

The research objectives of this study were to investigate the economic impacts of the foregoing structural changes. Impacts of increased vertical control and industry concentration were to be analyzed at the consumer, middleman, and producer levels, with

TABLE 2. CONCENTRATION IN THE U.S. EGG LAYER INDUSTRY, 1978-86

Year	Percent of layers owned by the largest		
	4 firms	8 firms	20 firms
1978	8.5	12.9	20.6
1979	8.5	12.9	21.6
1980	9.1	13.9	24.0
1981[1]	—	—	—
1982	9.3	14.3	25.5
1983	9.4	14.5	25.8
1984	10.8	17.0	28.7
1985	12.3	19.0	31.7
1986	12.4	19.5	32.0

[1]Not available.
Source: *Poultry Tribune*, various issues, 1978-86.

emphasis on describing and quantifying the price effects of these structural changes.

The analysis to be used proceeds as follows. First, the general economic causes of vertical control are reviewed. Next, hypotheses to explain the economic effects of increased vertical control specific to the egg industry are developed. An analytical framework for testing these hypotheses is presented. Econometric models are estimated which serve to test the hypotheses and to quantify the effects of increased vertical control on marketing margins for eggs. The analysis would then conclude with a discussion of the effects of vertical control on retail- and farm-level egg prices and likely future impacts.

Causes of Vertical Control

A review of the economics literature indicates five broad reasons for vertical control: market failure, uncertainty, declining industry, market power, and coordination economies.

Market Failure

The market failure argument contends that firms opt for vertical control when transaction costs associated with obtaining supplies (selling goods) via market exchange become prohibitively high (37). Transaction costs rise as markets become less "perfect" in their ability to efficiently allocate resources. Market imperfections occur when (1) competition among buyers and sellers is inadequate to insure price-taking behavior, (2) information gaps exist about relevant features of market exchange, (3) commodities traded are not homogeneous but differ in quality or other relevant aspects, and (4) there is uncertainty about such factors as availability of supplies, level of prices, and costs. Under these conditions, price signals are distorted, forcing firms to rely on auxiliary sources of information in determining value and costs. Depending on the relative cost of verifying the veracity of price signals, the firm substitutes internal organization for market exchange, especially if the firm possesses superior internal coordinating ability.

Because transaction costs are zero in "perfect" markets (i.e., those characterized by perfect competition, perfect information, readily identified products, and lack of risk), vertical control is seen as a strategy for coping with market imperfections. That is, under the market failure argument, vertical control is an outgrowth of market imperfections which, in turn, impose information-acquisition and other transaction-related costs. Because of these costs, the firm finds it less expensive to obtain supplies through internal organization than from market exchange.

Uncertainty

Firms also may integrate as a risk-reduction strategy. If supplies of an important input, such as eggs, are uncertain to a downstream firm (the assembler-packer), an incentive may exist to purchase the upstream firm to obtain a better estimate of the price of the uncertain input (2). Vertical control through ownership enables the integrator to achieve costs savings via improved decisions about quantities of inputs that are used in conjunction with the uncertain input. Because there is always an incentive for the downstream firm to buy more upstream firms to improve price forecasts, supply uncertainty implies a tendency toward imperfect competition, even when the industry initially is perfectly competitive.

Declining Industry

To understand the declining industry argument, it helps to view industries in a life cycle sense. Firms making new products have a limited market and, moreover, may have difficulty finding the technical expertise and requisite new inputs in the general economy and thus must fabricate their own. As the firm or industry grows, markets expand sufficiently to make specialization cost-effective. Other firms begin to supply raw materials, undertake marketing tasks, utilize byproducts, and even train skilled workers. Governing this process of specialization is economies of scale made possible by expanding markets. As the industry matures and competing products emerge, the market for the original product begins to contract. With declining demand and the associated price pressures, volume eventually becomes insufficient to support independent firms performing specialized functions. These specialized functions are reappropriated by the surviving firms via integration, perhaps employing new cost-cutting technologies (*17,27*). Based on this argument, Stigler (*36*) argues that "vertical disintegration is the typical development in growing industries, vertical integration in declining industries."

Market Power

Anticompetitive incentives for vertical control are three: (1) to practice price discrimination, (2) to circumvent monopoly, and (3) to erect barriers to entry (*36*, pp. 237-238). A firm having monopoly power in an intermediate market, such as the production of aluminum, will have an incentive to integrate forward into the customer market to practice price discrimination. If a cartel sets monopoly prices for a raw material, a buyer can avoid these prices by integrating backward into the raw materials market. The barriers-to-entry incentive is based on the notion that integration impedes entry by (1) discouraging nonintegrated entry (such firms may be subject to price squeezes and supply cutoffs), and (2) by raising the cost of entry (because capital markets would charge higher interest rates for the larger borrowings necessitated by an integrated vis-a-vis nonintegrated entry (*19*, p. 746). Also, integration may "foreclose" part of the market, thereby reducing the size of the "open" part of the market and raising the economies-of-scale barrier to entry (*21*).

Coordination Economies

Processors in the food marketing system often face variable supplies of the farm-based input due to seasonality, random factors connected with weather, pests, and other biological hazards, and inadequate information about market needs. Hence, over shorter periods of time, e.g. weekly or daily, food processing plants may experience spot shortages. Moreover, the available supplies might not meet the required quality standards. Because processors operate most efficiently when production occurs at a continuous rate, an incentive exists to seek ways to stabilize the flow and quality of raw materials via vertical control (*24*, pp. 26-28).

The potential gains from interstage coordination depend on cost conditions of the processing plant, the degree and duration of variability in raw material flows, and the cost of market transactions. If the average costs of a typical processing plant are as depicted in figure 2, minimum cost (AC°) occurs at a daily processing rate of Q° units of output. If reduced availability of raw materials causes the firm to temporarily reduce output to Q', the daily average cost of production

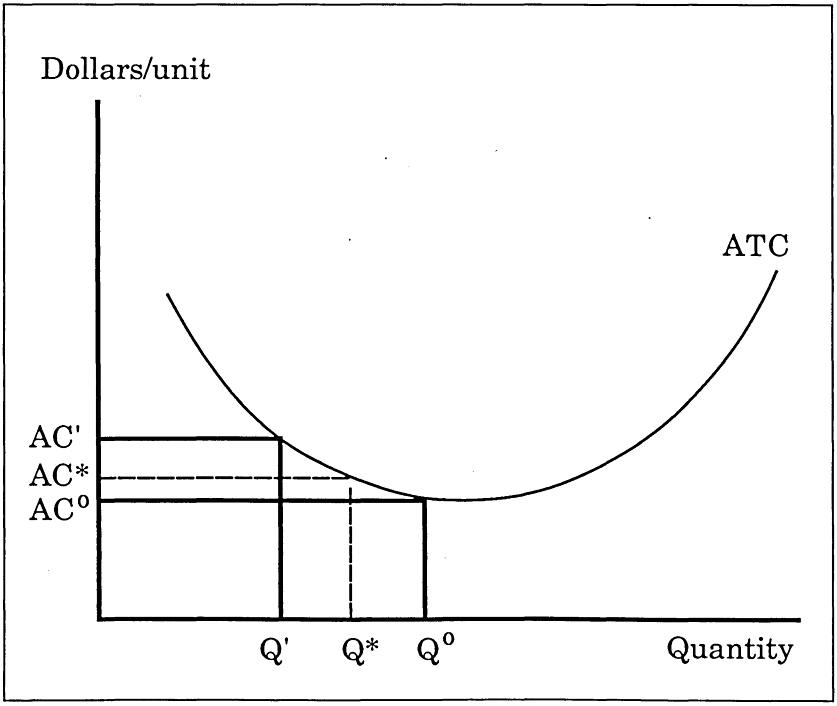

FIG. 2. Potential cost savings through vertical control.

over this time period increases to AC′. Average annual production costs will increase by some amount between AC° and AC′, depending on the number of days the firm is forced to operate at reduced capacity Q′. For example, if the firm operates at reduced capacity one-half of the time, average annual output is the simple average of Q° and O′-Q* in figure 2. The corresponding average cost is AC*. The difference between AC′ and AC* is the annual cost savings that could be achieved through vertical control that stabilizes raw material supplies so that the plant could operate continuously at its optimum capacity Q°.

Of course, whether cost savings from vertical control are sufficient to encourage its adoption depends on the cost of internal organization. Firms with superior coordinating talents might find the difference between AC′ and AC* adequate inducement to adopt vertical control; others who experience greater frictions in internal organization may still find market exchange the more cost-effective means of obtaining raw material supplies.

An important element of the coordination economies argument is the sharing of cost savings between the respective stages of economic activity (*24*, p. 27). If markets continue to be competitive after vertical control is adopted, cost savings experienced by the marketing firm eventually will be shared with the producer. For example, if the processor depicted in figure 2 integrates backward into the supply market, the cost savings AC′-AC*, net of added internal organization costs, is shared with the input supplier. Thus, unless supply schedules of input suppliers are perfectly elastic, there is an incentive for both parties to adopt vertical control.

Hypothesized Effects of Vertical Control

As is evident from a review of its causes, vertical control has different economic impacts depending on the motivations of firms involved. Two basic motivations can be identified: production efficiency and market power enhancement. A firm that integrates backward in an attempt to stabilize the supply or quality of raw materials or to obtain better information about its price is motivated by efficiency concerns. This type of vertical control, assuming that the cost of internal organization to the firm does not rise appreciably, will result in net cost savings. On the other hand, a firm may integrate forward or backward in an effort to block new entrants into the industry by making financing costs higher, introducing supply risks, and reducing the size of potential markets for would-be rivals. In this case, the result may be higher costs, especially if there are correlated increases in industry concentration. Moreover, a common feature of imperfectly competitive markets is higher selling costs due to increased advertising, promotion, and other attempts by large firms to differentiate products from the competition (*22*).

Because neither motive for vertical control in the U.S. egg industry can be rejected *a priori*, two hypotheses are entertained: the coordination hypothesis and the concentration hypothesis. The coordination hypothesis posits that increased vertical control results in reduced marketing costs because of economies achieved through improved coordination of economic activity between vertical exchange points. The concentration hypothesis posits that increased vertical control results in higher marketing costs because of excess plant capacity, higher selling costs, higher profit margins, and other factors associated with enhanced market power. The next section presents an analytical framework for testing the economic implications of each hypothesis.

METHODOLOGY, DATA, AND STATISTICAL ANALYSIS

The Analytical Framework

Because vertical control relates to organizational arrangements in the vertical food delivery system and these arrangements affect marketing efficiency, a suitable analytical framework is the marketing margin model developed by Gardner (9) and extended by Fisher (8). The model consists of six equations describing a food processing sector which combines a farm based-input (factor F) with a second input called "marketing services" (factor M) to produce a retail food commodity (output R). Market equilibrium conditions are established from six equations describing retail demand, input supplies, the farm-retail production process, and marginal conditions for profit maximization. Assuming long-run competitive equilibrium, profit maximizing behavior on the part of industry participants, and a farm-to-retail production function characterized by constant returns to scale and fixed proportions production technology, the solution of the model on vertical control is indicated in figure 3 (8,9). In the upper diagram, the intersection of the farm level supply curve (S_F)with the farm level demand curve (not shown for illustrative convenience) establishes the initial equilibrium farm price of f^o. In the same diagram, the initial equilibrium retail price (r^o) is determined by the intersection of retail demand (D_R) and the retail supply (not shown) curves.

The lower diagrams indicate equilibrium in the marketing services market. S_M and D_M are defined as the supply and demand curves, respectively, for marketing services. The intersection of these curves determines the initial equilibrium price for marketing services, m^o.

If markets are perfectly competitive and the farm-based input and retail product are measured in equivalent units (so that, for example f and r refer to farm and retail price, respectively, for one dozen eggs), then equilibrium prices in the upper and lower diagrams of figure 3 are linked as follows:

$$(1) \qquad m^o = r^o - f^o.$$

Equation (1) says that the margin of retail price over farm price determines the price of marketing services. Thus, m is interpreted as the farm-retail marketing margin for eggs.

A second point to note about figure 3 is the direct linkage between quantities in the two diagrams. The assumption of fixed proportions mentioned earlier means that retail output (R) is linked in a proportional manner to inputs (F and M). Hence, a change in the quantity of marketing services utilized by the industry results in a proportional change in output.

The effects of vertical control on market equilibrium as implied by the coordination hypothesis are indicated in panel (a) of figure 3. Increased vertical control, by lowering the cost of existing marketing services (e.g., processing plant labor, transportation, energy), shifts the supply schedule for marketing services to the right. The price of marketing services (the marketing margin) decreases from m^o to m', causing utilization of marketing services to increase from M^o to M'. Under fixed proportions, the quantity demanded of the farm-based input (eggs) and quantity supplied at retail increase proportionally, causing the farm price to rise to f' and the retail price to fall to r'. Hence, under the coordination hypothesis, increased vertical control results in a shrinkage of the marketing margin, financed by a lower retail price and a higher farm price.

The economic implications of the concentration hypothesis can be described in an analogous manner by reference to panel (b) of figure 3. Here, increased vertical control causes a leftward shift in the supply schedule for marketing services. A leftward shift in the supply schedule is hypothesized because the cost of providing existing marketing services rises as the now imperfectly competitive industry begins to spend more on advertising, promotion, packaging, delivery, and service systems in an effort to differentiate products and to attract and retain new customers. In addition to higher selling costs, the added market power associated with increased vertical control may cause excess processing capacity, excess profits, and unusually large compensation for executives (*31*, p. 135). Thus, increased industry concentration leads to larger marketing margins, *ceteris paribus*, implying a reduction in farm prices and an increase in retail prices as depicted in figure 3, panel (b), upper diagram.

While the coordination and concentration hypotheses are analytically treated separately, in reality both may have validity for explaining observed changes in egg marketing margins. For example, the industry concentration effect may become relevant only in the end stages of conversion to vertical control because of the requirement for industry concentration to achieve a certain minimum level before monopoly power can be effectively exercised. Parker and Connor (*23*) suggest an industry must achieve a four-firm concentration ratio exceeding 40 percent before monopoly power can be exercised. If this scenario is valid, forces described by both hypotheses may have rel-

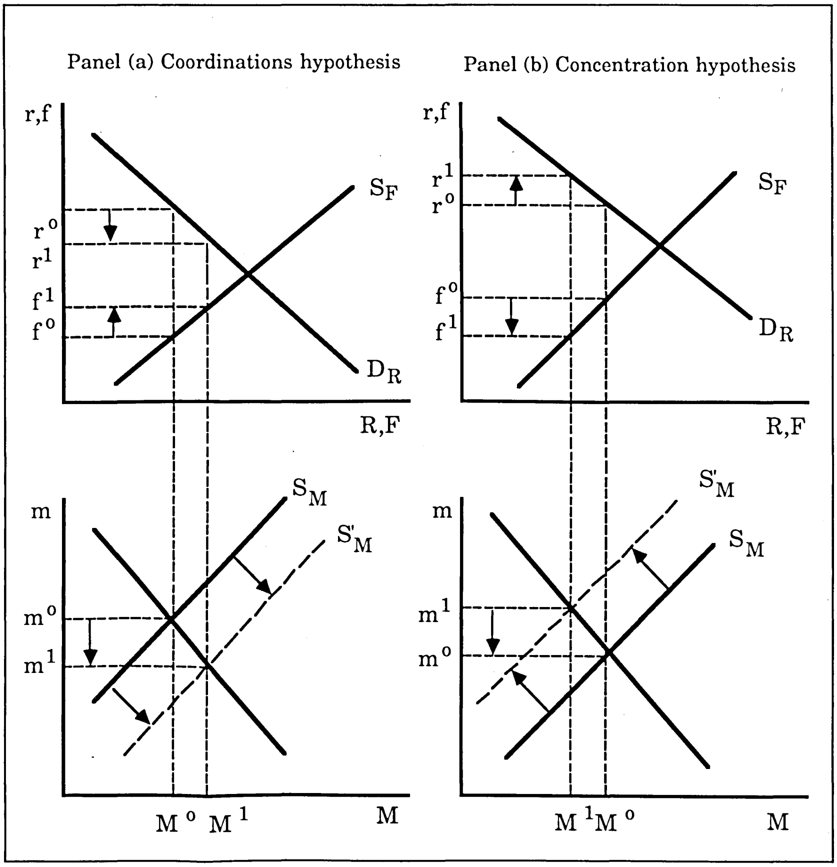

FIG. 3. Hypothesized effects of vertical control on egg marketing margins, retail prices, and farm prices.

evance after some point of conversion to vertical control.

As indicated in figure 3, the effect of vertical control on marketing margins and hence on the appropriateness of the coordination and concentration hypotheses depends critically on the magnitude and direction of the vertical control-induced shift in the marketing services supply schedule. The next section presents the econometric procedures used to estimate the direction and magnitude of this shift.

Specification of the Margin Equation

To empirically distinguish the coordination hypothesis from the concentration hypothesis and to estimate the effect of increased vertical control on egg marketing margins, two alternative specifications of the price spread equation are utilized. First is a conventional markup equation (Heien) of the form:

$$(2)\quad m_t = \alpha_0 + \alpha_1 r_t + \alpha_2 c_t + \sum_{i=3}^{5} \alpha_i S_{it} + \alpha_6 CV_t + \alpha_7 VI_t + \alpha_8 D_t + \mu_t$$

where:

t = 1, 2, 3, ..., 52 (first quarter 1972 through fourth quarter 1984),
m_t = farm-to-retail marketing margin for grade A large eggs,
r_t = retail price of eggs in cents per dozen,
c_t = an index of labor cost specific to the food marketing industry,
S_{it} = a vector of three quarterly dummy variables to indicate seasonality in egg marketing margins with the first calender quarter serving as the omitted category,
CV_t = coefficient of variation of weekly wholesale egg prices,
VI_t = percentage of eggs produced or marketed under vertical control,
D_t = a dummy variable assigned the value of one for the period of heightened industry concentration (1980, quarter 1 - 1984, quarter 4) and zero otherwise, and
μ_t = a random error term.

All price variables (m, r, c) are deflated by the consumer price index for all items (1967 = 100). More precise empirical definitions of each variable are provided in the data appendix.

According to the markup pricing hypothesis, isolated increases in retail price or input cost lead to increases in the marketing margin; hence, 1 and 2 are expected to have positive signs. Because of anticipatory or monopolistically competitive pricing behavior on the part of the retailers, egg margins are expected to differ seasonally *(28)*. However, the actual pattern of seasonal differences in margins cannot be determined *a priori*; hence, no expectations are placed on the signs of the coefficients of the seasonal dummy variables.

Following Brorsen et al. *(6)* and Grant et al. *(12)*, the CV variable is specified to account for the influence of price risk on marketing margins. Because of an inelastic demand for eggs *(10)* and random supply shocks due to disease and other biological hazards, the egg industry is subject to significant price volatility. (Over the sample period, the coefficient of variation of wholesale egg prices averaged 6.8 percent and ranged from 1.5 to 18.1 percent.) If egg marketing firms are risk-averse and price risk is a significant factor affecting costs, $\alpha_6$is expected to have a positive sign.

The VI variable is specified to reflect the effect of vertical control on farm-retail egg margins. The sign of its coefficient depends on which hypothesis is exerting a stronger influence over the sample period in question. If forces described by the coordination hypothesis dominate, the sign of α_7 is expected to be negative. If, on the other hand, concentration effects are more prominent, the sign α_7 is expected to be positive.

The D_t variable is specified in an attempt to separate concentration and coordination effects. Because the two effects work in opposition to one another, holding the influence of one of the factors constant via specification of an additional variable in the model should increase the estimated effect of the other factor. This reasoning, coupled with the fact that industry concentration did not increase appreciably until the 1980s, table 2, led to the inclusion of D_t to represent the concentration effect, net of the coordination effect. Because D_t is defined to assume the value of one for the 1980-84 period and zero otherwise, its coefficient is expected to have a positive sign.

An implicit assumption of the markup model, equation (2), is that margin changes are caused by changes in either retail demand or farm supply, but not both. If this assumption is invalid, i.e., if margins are being influenced by simultaneous shifts in retail demand and farm supply, then equation (2) may give biased parameter estimates (*9,18*). In the egg industry, retail demand has been declining steadily over time due in part to cholesterol concerns. At the same time, supply shocks have occurred due to random events associated with disease as well as technological change in egg production. Thus, it appears quite possible that coincident changes in supply and demand were occurring over the sample period.

To investigate the extent to which potential specification error in equation (2) might affect the results, an alternative margin specification suggested by Wohlgenant and Mullen (*38*) was estimated. This model, called the "relative price" model, assumes the following form:

$$(3) \qquad m_t = B_0 + B_1 r_t + B_2 c_t + B_3 r_t \cdot Q_t + \sum_{i=4}^{6} B_i S_{it} + B_7 CV_t + B_8 VI_t + B_9 D_t + u'_t$$

where the as yet undefined variable Q_t represents industry output of eggs expressed in dozens per capita.

The essential difference between markup and relative price specifications is the inclusion of the interaction term, $r_t \cdot Q_t$, in the latter. An additional technical difference is that the relative price model omits an intercept term. Because of problems associated with estimating an equation without an intercept (*11*), equation (3) is specified to include an intercept. Because the two models differ both conceptually and empirically, each serves as a test against the other for robustness of statistical results.

Data

Equations (2) and (3) were estimated using national quarterly data for the period 1972-84. Quarterly data were selected in part to avoid the necessity of modeling lag structures, since margins appear to adjust fully to cost changes in 2 months or less (*28*). Also the assumption of predetermined supply implicit in the specification of price spread models (*6*) is more appropriate for quarterly data than for annual data.

Data availability was the primary determinant of the sample period. The particular data series on egg price spreads used in this study was terminated by the USDA in 1984. Prior to 1972, reliable quarterly data on labor cost in food marketing were not available.

Data depicting vertical control were not continuous over the sample period and therefore had to be estimated. Under the assumption that institutional innovations like vertical control follow a time path similar to technological innovations (*13*), a logistic growth function was estimated as follows (t-ratios in parentheses):

$$(4) \quad \ln [VC_t/(K - VC_t)] = \underset{(16.3)}{-13.299004} + \underset{(15.6)}{.1908997\,T}$$

$$R^2 = .957 \qquad N = 13$$

where VC_t equals percentage of eggs sold under vertical control in year T and K is the highest level of vertical control attainable by the U.S. egg industry. Following Griliches (*13*), a value for K was determined empirically by reestimating the growth function under alternative values of K until the explanatory power of the model (as measured by R^2) was maximized. Such a procedure yielded $K = .95$, meaning that eventually 95 percent of all eggs marketed in the United States will move through channels involving vertical control.

The trend variable T was specified to assume the values of 60 through 70, 75, and 77, indicating the years in which actual observations on vertical control were available. The observations on vertical control for the years 1960 through 1970, 1975, and 1977 were obtained from Rogers (*25;26*).

The high R^2 (.957) and significant coefficients of equation (4) suggest that the logistic growth function adequately mimics the time path of vertical control for the egg industry. To estimate actual values of vertical control to be used in later econometric analysis the following transformation of equation (4) was employed:

$$(5) \qquad \hat{V}C_t = \frac{K}{1 + e^{-(a + bT)}}$$

where $\hat{V}C_t$ equals the predicted value of vertical control, K equals .95, a equals 13.299004, b equals .1908997, and T equals the year in question (1972, 1973, ..., 1984).

Evaluation of the prediction performance of the logistic growth function suggests that early values may overstate and later values may understate somewhat the actual level of vertical control in the industry as suggested by the following comparison of actual and predicted values:

Year	*Actual*	*Predicted*
1970	40.0 percent	49.0 percent
1975	69.0 percent	69.8 percent
1977	81.0 percent	76.2 percent

However, the terminal (1984) estimate of 89.2 percent seems reasonable. Further, replacing the growth function estimates with estimates of vertical control based on linear interpolation and extrapolation from historical values had little effect on estimated regression coefficients to be discussed later. Thus, the reasonableness of the growth function estimate coupled with the robustness of regression results with respect to measurement of the vertical control variable allays concerns about the appropriateness of the technique. Finally, based on the observation by Kilmer (*17*) that vertical control changes in a smooth manner over time, linear interpolation from estimated annual values was used to obtain quarterly figures, Appendix B.

The risk variable is measured as the coefficient of variation of weekly wholesale egg prices. Other variables are measured by conventional means. The actual data, along with a more precise empirical definition of each variable and a listing of sources, are provided in the data appendix.

Econometric Results

Econometric results relative to the markup and relative price models are presented in table 3. Initial analysis indicated the presence of first-order serial correlation; hence, the Cochrane-Orcutt procedure was used to obtain generalized least squares estimates of the parameters. Each model was estimated twice: once using the entire data set (conventional model), and again using all data except the 1983, quarter 4, observation (outlier model). Results based on the entire data set are discussed first. Then the rationale for the second set of estimates and associated regression results are presented.

The overall summary statistics suggest that both models are well-specified. Based on the F-statistic, each regression is significant at the .01 level. The R^2's show 92 percent or more of the observed var-

TABLE 3. GENERALIZED LEAST SQUARES ESTIMATES OF ALTERNATIVE SPECIFICATIONS OF THE FARM-RETAIL EGG MARKETING MARGIN EQUATION, UNITED STATES, 1972-84 QUARTERLY DATA

Variable	Conventional models		Outlier models	
	Markup	Relative price	Markup	Relative price
Constant	21.033	19.097	17.354	16.517
	(3.19)[1]	(2.84)	(3.93)	(3.68)
r	.067	−.035	.075	.022
	(2.87)	(−.35)	(4.77)	(.33)
c	.067	.058	.094	.088
	(1.04)	(.92)	(2.21)	(2.07)
r·Q	—	.018	—	.009
	—	(1.05)	—	(.79)
S2	−.281	−.239	−.195	−.173
	(−.82)	(−.69)	(−.73)	(−.63)
S3	−.648	−.571	−.544	−.507
	(−1.89)	(−1.63)	(−2.16)	(−1.98)
S4	−.541	−.630	−2.18	−.267
	(−1.65)	(−1.85)	(−.82)	(−.97)
CV	−.016	−.014	.005	.006
	(−.45)	(−.39)	(.19)	(.23)
VI	−.203	−.171	−.205	−.188
	(−5.86)	(−3.82)	(−9.08)	(−6.16)
D	−.196	−.355	.132	.030
	(−.32)	(−.57)	(.31)	(.07)
$\hat{\rho}$	.037	−.009	−.119	−.147
R^2	.917	.917	.949	.948
DW	1.99	1.99	2.01	2.01
F-statistic	62.1	56.1	101.58	90.5
N	51	51	50	50

[1]Numbers in parentheses are t-values.

iation in egg marketing margins being "explained" by the specified variables. The Durbin-Watson statistic indicates lack of serial correlation in the generalized least squares residuals. Moreover, the relatively small estimated values for the first-order autoregressive coefficient ($\hat{\rho}$) suggest only mild serial correlation prior to adjustment. Thus, both models appear to be well specified.

The estimated coefficients of the markup model agree in sign with *a priori* expectations and are, in general, significant. Retail price and labor cost have positive net relationships with the egg marketing margin. Margins are smaller in the third and fourth quarters compared to the first quarter, and price risk has no discernible effect on egg margins. The vertical control variable has a negative coefficient and is significant at the .01 level, providing results consistent with the coordination hypothesis. The coefficient of the dummy variable to indicate the concentration effect is not significant.

Turning to the relative price model, results are generally consistent with the markup model, suggesting that specification error of the type mentioned previously is not adversely affecting results. The interaction term is positive as expected, but not significant at usual probability levels. The estimated vertical control effect is highly significant and is consistent with the markup model estimate in sign but is of smaller magnitude (−.171 versus −.203). As in the markup model, the concentration dummy is not significant.

Because regression results can be adversely affected by "influential" observations (*4*), several diagnostic tests to determine the presence of outliers were undertaken. An analysis of residuals indicated an "extreme" observation in the post-1979 period. In particular, the regression residual for 1983, quarter 4, assumed a large negative value, placing it well outside the 95 percent confidence band in the TSP-generated residual plot. Further analysis revealed an unusually small marketing margin in this quarter (9.5¢ per dozen compared to 11.5¢ in the immediately preceding quarter and 13.3¢ in the succeeding quarter). Apparently, the avian influenza which affected the industry in late 1983 had the effect of severely squeezing the egg marketing margin.

The sharp change in the marketing margin in 1983, quarter 4, was of concern because of its potential effect on the estimated coefficient for the concentration dummy variable. Recalling that this dummy variable was specified to indicate the effect of heightened industry concentration in the post-1979 period, the occurrence of an extraordinarily large negative residual in this period may vitiate attempts to estimate the concentration effect. In particular, the dummy variable may be measuring the effect of the avian influenza and not the desired concentration effect.

To examine this hypothesis and to further assess the robustness of regression results, the markup and relative price models were reestimated with the 1983, quarter 4, observation deleted, (table 3, outlier models). Qualitatively the outlier models are identical to the conventional models: the concentration effect remains insignificant, the coordination effect is still highly significant, and corresponding coefficients change only slightly. However, significance of several of the coefficients in both markups and relative price models improves with deletion of the "outlier." The stability of coefficients across estimation procedures and model specifications increases confidence in the accuracy of the estimated concentration and coordination effects.

RESULTS

With econometric estimates of the margin equations in hand, it is now possible to discriminate empirically between the coordination and concentration hypotheses. In addition, the econometric results can be used to quantify the effects of vertical control on egg marketing margins, retail prices, and farm prices.

Tests of Coordination and Concentration Hypotheses

The coordination hypothesis posits a net negative relationship between increases in vertical control and marketing margins. To test this hypothesis, 99 percent confidence intervals for the estimated coefficients of the vertical control variable were constructed. Results show an estimated coordination effect that is clearly negative in sign, table 4. Thus, evidential support is provided in favor of the coordination hypothesis. Apparently the increased vertical control observed in the egg industry over the 1972-84 period has led to im-

TABLE 4. TESTS OF COORDINATION AND CONCENTRATION HYPOTHESES

Hypothesis	Parameter value: Hypothesized sign	Parameter value: Estimated value	Result
Coordination	Negative	−.292 to −.114 −.286 to −.056	Accept
Concentration	Positive	−1.78 to 1.38 −1.96 to 1.25	Reject

[1]Ninety-nine percent confidence intervals. Upper numbers were estimated from the markup model; lower numbers from the relative price model.

proved coordination in the egg production/marketing system, thereby lowering costs.

The concentration hypothesis posits a net positive relationship between increases in vertical control and marketing margins. Ninety-nine percent confidence intervals of the estimated coefficients of the concentration dummy variable show values that range from negative to positive, table 4. Thus, it is not possible to conclude that the increase in egg industry concentration associated with greater vertical control has had inimical economic effects. For different results with respect to the beef sector, see Hall et al. (*14*). However, rejection of the concentration hypothesis by these data does not mean that the concentration issue is settled. As indicated previously, a four-firm concentration ratio of 40 percent or higher may be necessary before monopoly power can be effectively exercised. In 1984 (the last year of the data period), the egg industry's four-firm concentration ratio was 11 percent, well below the requisite 40 percent. Because the industry appears inexorably headed toward increased concentration, table 2 and (*1*), it is quite conceivable that a follow-up study some years hence could show a significant concentration effect. Still for the 1972-84 period analyzed in this study, no significant concentration effect was isolated.

Impacts of Increased Vertical Control on Marketing Costs, Retail Prices, and Farm Prices

According to the coordination hypothesis, increased vertical control leads to reduced marketing costs. An estimate of the extent to which marketing margins for eggs have declined due to vertical control can be obtained from the estimated coefficients of the vertical control variable. These coefficients are $-.203$ from the markup model and $-.171$ from the relative price model, table 3. Each coefficient tells how the marketing margin is affected by a 1 percentage point change in vertical control, assuming other factors affecting the margin remain unchanged. Thus, multiplying each coefficient by the actual change in vertical control over the sample period gives an estimate of the net effect of increased vertical control.

As indicated in figure 4, egg margins declined continuously between 1973 and 1983 in real terms. The actual decline over this period was 8.2¢ per dozen in 1967 dollars (3). To calculate the percentages of the observed decrease attributable to vertical control, the previously mentioned coefficients were multiplied by the change in vertical control (26 percentage points: from 62 percent of industry

FIG. 4. Real farm-retail price margin for eggs in 1967 dollars, United States, 1972-84.

volume in 1973 to 88 percent in 1983). Results indicate an expected margin decline of between 4.45¢ (−.171 × 26) and 5.27¢ (−.203 × 26). Comparing these estimates with the actual margin change (8.2¢) suggests that between 54 and 64 percent of the observed decrease may be attributable to vertical control. Stated differently, if vertical control in the egg industry had remained constant at its 1973 level, real farm-retail egg margins over the 1973-83 period would have declined by only 3 to 4¢ per dozen instead of the observed 8.2¢. Based on an average margin over the sample period of 15.4¢ per dozen, these results suggest increased vertical control reduced average marketing costs in the egg subsector by about 26 percent (19.4¢ without increased vertical control versus 15.4¢ with increased vertical control).

Because the data reject the concentration hypothesis, competition in the egg industry should be sufficient to insure that cost savings at the middleman level are passed along to producers and consumers. To estimate the extent to which consumers and producers have benefited from cost savings achieved by the egg marketing sector through vertical control, the following expressions (derived in the appendix) were employed:

$$\Delta f = \frac{\lambda f^o}{\epsilon}, \tag{6}$$

$$\Delta r = \frac{\lambda r^o}{\eta}, \text{ and} \tag{7}$$

$$\lambda = \frac{\eta \, \epsilon \, \Delta m}{r^o \epsilon - f^o \eta}. \tag{8}$$

Equations (6) and (7) define price changes at producer and consumer levels, respectively, and equation (8) establishes the magnitude of the shift in the marketing services supply schedule associated with vertical control, figure 3. This shift is a function of: (1) the retail demand elasticity for eggs (η), (2) the farm level supply elasticity for eggs (ϵ), (3) the estimated margin change associated with increased vertical control (Δm), (4) initial retail price (r^o), and (5) initial farm price (f^o).

To apply equations (6) - (8), the following assumptions were made:

1. The retail demand elasticity (η) for eggs is $-.330$;
2. The farm supply elasticity (ϵ) for eggs is .942;
3. The initial farm price (f^o) of eggs is 39.37¢ per dozen (1967 dollars);
4. The initial retail price (r^o) of eggs is 58.90¢ per dozen (1967 dollars); and
5. The estimated change in the margin due to vertical control is -5.27¢ per dozen (1967 dollars).

TABLE 5. SENSITIVITY ANALYSIS OF ESTIMATED IMPACT OF VERTICAL CONTROL ON MARKETING MARGINS AND INCIDENCE OF MARGIN CHANGES, U.S. EGG INDUSTRY, 1973-83

Vertical control coefficient	Retail demand elasticity (η)	Farm supply elasticity (ϵ)	Estimated effect/dozen of vertical control on[1]			Proportion of the margin change reflected by a change in	
			Farm retail egg marketing margin[2] (Δm)	Retail egg prices (Δr)	Farm egg prices (Δf)	Retail egg prices	Farm egg prices
			Cents	*Cents*	*Cents*	*Pct.*	*Pct.*
−.203	−.330	.942	−5.27	−4.27	1.00	81	19
−.171	−.330	.942	−4.45	−4.09	.36	83	17
−.203	−.165	.942	−5.27	−4.72	.55	90	10
−.203	−.660	.942	−5.27	−3.59	1.68	68	32
−.203	−.330	.471	−5.27	−3.59	1.68	68	32
−.203	−.330	1.884	−5.27	−4.72	.55	90	10

[1]In 1967 dollars.
[2]The actual marketing margin declined 8.2¢ per dozen between 1973 and 1983.

Assumptions 1 and 2 are based on elasticity estimates obtained from a recent econometric analysis of the U.S. egg industry (7). Assumptions 3 and 4 are based on the 1973 average annual values of these two prices (3). Assumption 5 follows from the markup model estimate of the vertical control coefficient.

Combining assumptions 1-5 with equations 6-8 indicates that the estimated 5.27¢ per dozen decline in egg marketing margins affected prices as follows: the retail price declined 4.27¢ per dozen and the farm price increased 1.00¢ per dozen. Thus, it appears that egg consumers are the primary beneficiaries of the vertical control-induced cost savings, although egg producers benefited as well.

Because calculation of the incidence of the margin change is sensitive to assumptions about the magnitudes of relevant elasticities and the vertical control effect and there is uncertainty about the true values of these parameters, the incidence for a range of parameter values was recomputed. Results show variations in the estimated magnitude of the margin change attributable to vertical control and in the relative distribution of associated benefits to consumers and producers, table 5. In particular, the estimated portion of the observed margin change attributable to vertical control is quite sensitive to the magnitude of the vertical control coefficient. Further, the incidence of the estimated margin change appears to be most sensitive to either increases in the absolute value of the demand elasticity or decreases in the supply elasticity. Still, the basic conclusion that vertical control has substantially reduced egg marketing costs and that consumers have benefited from this cost reduction more than producers remains unchanged.

CONCLUSION

The purpose of this study was to investigate the economic impacts of increased vertical control in the U.S. egg industry. Results suggest a benign impact: middlemen became more efficient and, as a result, consumers paid less for eggs and producers received more. However, it is important to recognize that these results, strickly speaking, hold only for the study period (1972-84) and may not be reflective of the eventual longer run impact. A reason for citing this caveat is the continuing increase in industry concentration.

The statistical results of this study showing the coordination effect dominating the concentration effect may reflect a lack of sufficient industry concentration within the sample period. If this hypothesis is correct, it will become necessary to reexamine the concentration hypothesis before a definitive statement can be made about the economic impacts of vertical control in the egg industry. Of course, to adequately restudy the concentration hypothesis with time series data, sufficient time must elapse to provide the necessary additional observations.

Finally, it should be noted that the econometric results showing a 4¢ to 5¢ per dozen decline in real egg marketing costs over the 1973-83 period due to increased vertical control may overstate the magnitude of the vertical control effect. The vertical effect may be exaggerated because new egg processing technology was being adopted by the industry over the study period and this technology (mainly equipment that permits efficient on-farm packaging of eggs) likely led to reduced marketing costs. To the extent that the econometric model inadequately captures cost savings realized from new marketing technologies, the estimated vertical control effect may contain an upward bias. Further research to obtain more precise estimates of the vertical control effect might consider description and measurement of the relevant egg marketing technologies. In addition to improved estimation accuracy, such an approach might yield improvements in understanding about the interplay of technology adoption and vertical control. Still, while vertical control would accomplish less without the benefit of cost-cutting technology, it appears safe to conclude on the basis of this study that in the case of eggs, increased vertical control has resulted in benefits to egg producers and consumers alike.

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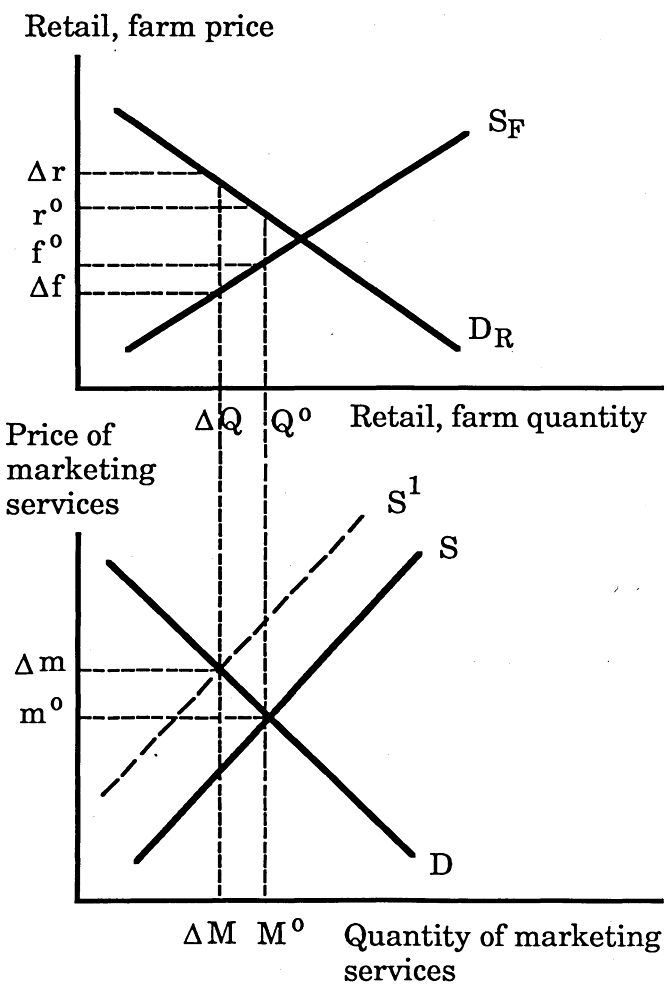
APPENDIX A
Derivation of the Equations to Calculate the Incidence of Margin Changes

The expressions to calculate how farm and retail prices are affected by an exogenous shift in the marketing services supply schedule can be derived with the aid of the following diagrams:



In initial equilibrium the retail price is r^o, the farm price is f^o, the marketing margin $(r^o - f^o)$ is m^o, Q^o units of retail product are produced and sold, requiring M^o units of marketing services. Now, assume that an exogenous increase in marketing cost shifts the marketing services supply schedule upward to S′. This causes the marketing margin to increase by Δm, resulting in a decrease in quantity demanded of marketing services of ΔM. Let the magnitude of this decrease be represented by the equation

$$\Delta M = \lambda M^o \tag{A.1}$$

where λ is the proportional decrease in marketing services from its initial equilibrium level when supply decreases from S to S′.

Under fixed proportions production technology, it is not possible to substitute the farm-based input (eggs) for the marketing services input. Moreover, because marketing services and farm eggs are combined in fixed proportions to produce the retail product, a reduction in either input (eggs or marketing services) implies an equivalent proportional reduction in output. Hence, from the diagram:

$$\Delta Q = \Delta M = \lambda Q^o \tag{A.2}$$

i.e., a reduction in marketing services leads to an equivalent proportional decrease in the quantity of eggs available for sale at retail.

Reduced supply of eggs at retail implies a lower farm price and a higher retail price, i.e., a widening of the marketing margin. The portion of the margin change attributable to a retail price change (Δr in the diagram) can be approximated from the retail demand elasticity:

$$\eta \simeq \frac{\Delta Q}{\Delta r}\frac{r^o}{Q^o}. \tag{A.3}$$

Rewriting equation (A.3) in terms of Δr yields:

$$\Delta r \simeq \frac{\Delta Q}{\eta}\frac{r^o}{Q^o}. \tag{A.4}$$

Substituting (A.2) into (A.4) to eliminate Q and simplifying yields:

$$\Delta r \simeq \frac{\lambda r^o}{\eta}. \tag{A.5}$$

Expression (A.5) gives the desired change in retail price as a function of: (1) the magnitude of the shift in the marketing services supply schedule (λ), (2) the initial level of retail price (r^o), and (3) the magnitude of the retail demand elasticity (η). Note that a more inelastic demand, *ceteris paribus,* implies a greater change in retail price.

The portion of the margin change attributable to a change in the farm price (Δf in the diagram) can be approximated from the farm level supply elasticity for eggs:

(A.6) $$\epsilon \simeq \frac{\Delta Q}{\Delta f}\frac{f^o}{Q^o}.$$

Solving (A.6) for Δf yields:

(A.7) $$\Delta f \simeq \frac{\Delta Q}{\epsilon}\frac{f^o}{Q^o}.$$

Substituting equation (A.2) into equation (A.7) and simplifying yields:

(A.8) $$\Delta f \simeq \frac{\lambda f^o}{\epsilon}.$$

From expression (A.8) it is obvious that the supply elasticity is pivotal in determining how farm price is affected by a shift in the marketing services supply schedule. In general, the more inelastic the farm supply response to price, the greater the impact on farm price.

Expressions (A.5) and (A.8) define the incidence of a margin change between farm and retail price, but to make them operational an expression defining the value of λ is needed. Such an expression was obtained as follows. First, define:

(A.9) $$\Delta m = \Delta r - \Delta f.$$

Substituting expressions (A.5) and (A.8) into (A.9) and simplifying yields:

(A.10) $$\Delta m \simeq \frac{\lambda\,(r^o\,\epsilon - f^o\,\eta)}{\eta\epsilon}.$$

Solving expression (A.10) for λ yields the desired expression:

(A.11) $$\lambda \simeq \frac{\eta\,\epsilon\,\Delta m}{r^o\epsilon - f^o\,\eta}.$$

Given values for elasticities and initial price levels, expression (A.11) can be used to calculate the magnitude of the shift in the marketing services supply schedule, provided an estimate of the associated margin change (Δm) is available. In this study, the margin change associated with increased vertical control is estimated econometrically via procedures described in the text.

A caveat in using expressions (A.5), (A.8), and (A.11) to calculate the incidence of a margin change is that they are only approximations. Their accuracy depends on the size of the equilibrium displacement and the type of elasticity used. If the shift in the marketing services supply is small (say 10 percent or less) and arc elasticities are used to represent η and ϵ, expressions (A.5), (A.8), and (A.11) will provide near exact results.

APPENDIX B

RAW DATA USED TO ESTIMATE THE MARGIN EQUATIONS

obs	m[1]	r[2]	c[3]	VI[4]	CV[5]	Q[6]	CPI[7]	POP[8]
1972.1	19.88682	42.03719	113.5812	57.90000	5.960000	7.417353	123.7000	206.3000
1972.2	18.76504	39.53489	114.1941	58.95000	4.640000	7.231701	124.7000	206.3000
1972.3	18.04452	42.05087	114.0699	60.00000	6.810000	6.954217	125.8000	207.5000
1972.4	19.14894	46.25690	115.6028	61.05000	16.56000	6.897831	126.9000	207.5000
1973.1	19.96892	54.93395	117.4825	62.10000	6.490000	6.674976	128.7000	208.6000
1973.2	19.16350	52.85171	116.3498	63.10000	5.540000	6.742569	131.5000	208.6000
1973.3	18.75000	64.88095	114.7321	64.10000	10.83000	6.471851	134.4000	209.6000
1973.4	20.05814	62.57267	115.1889	65.10000	5.270000	6.631679	137.6000	209.6000
1974.1	19.23621	64.07355	115.4173	66.10000	8.300000	6.606550	141.4000	210.7000
1974.2	17.51373	46.63461	114.3544	67.02000	9.630000	6.631704	145.6000	210.7000
1974.3	16.72218	47.30180	113.7908	67.95000	10.54000	6.379489	150.1000	211.6000
1974.4	17.88723	53.72651	113.3506	68.87000	4.510000	6.402174	154.3000	211.6000
1975.1	18.47134	51.97452	116.4331	69.80000	4.920000	6.298072	157.0000	212.7000
1975.2	16.73981	44.63950	116.4890	70.65000	2.950000	6.251528	159.5000	212.7000
1975.3	16.14487	45.73358	115.6538	71.50000	7.770000	6.252573	162.9000	213.8000
1975.4	17.16012	48.64048	116.4350	72.35000	9.090000	6.341441	165.5000	213.8000
1976.1	17.35488	50.50867	119.0305	73.20000	8.450000	6.288837	167.1000	215.0000
1976.2	16.84397	44.03074	119.3262	73.95000	4.550000	6.219069	169.2000	215.0000
1976.3	16.46306	49.09832	119.3136	74.70000	4.960000	6.182029	171.9000	215.9000
1976.4	16.39816	50.74798	120.4258	75.45000	6.580000	6.264937	173.8000	215.9000
1977.1	16.84568	52.51555	122.3290	76.20000	8.570000	6.109678	176.9000	217.0000
1977.2	15.99336	41.00719	121.7488	76.87000	8.830000	6.164516	180.7000	217.0000
1977.3	15.54828	43.75341	122.0404	77.55000	3.720000	6.112333	183.3000	218.1000
1977.4	16.62169	40.31300	123.8532	78.22000	8.270000	6.467675	185.3000	218.1000
1978.1	14.80106	40.79576	126.4721	78.90000	6.150000	6.285779	188.5000	219.4000
1978.2	15.20165	36.81489	124.8707	79.50000	6.580000	6.359161	193.4000	219.4000
1978.3	16.27085	39.91915	124.1536	80.10000	5.070000	6.277551	197.9000	220.5000
1978.4	14.61120	40.01981	124.8143	80.70000	7.420000	6.567347	201.9000	220.5000
1979.1	15.94203	42.94686	125.3140	81.30000	5.040000	6.414337	207.0000	221.8000
1979.2	14.99299	38.72022	123.0266	81.82000	6.200000	6.465284	214.1000	221.8000
1979.3	14.78969	37.04206	120.6694	82.35000	4.790000	6.437668	221.1000	223.0000
1979.4	14.14763	37.12654	120.2988	82.87000	8.510000	6.621973	227.6000	223.0000
1980.1	15.43340	35.13742	119.0275	83.40000	6.860000	6.535205	236.5000	224.4000
1980.2	13.87755	30.81633	117.5918	83.85000	5.820000	6.348485	245.0000	224.4000
1980.3	14.10256	34.85577	118.5497	84.30000	7.910000	5.905141	249.6000	225.6000
1980.4	13.62398	36.27871	118.6843	84.75000	9.310000	6.574025	256.9000	225.6000
1981.1	14.34005	34.84214	119.3990	85.20000	3.520000	6.408991	262.9000	226.9000
1981.2	13.27137	32.23048	118.7732	85.60000	6.170000	6.325695	269.0000	226.9000
1981.3	12.61294	32.20094	117.5280	86.00000	4.530000	6.332602	276.7000	227.9000
1981.4	12.78945	33.87959	116.3520	86.40000	4.370000	6.546292	280.7000	227.9000
1982.1	13.03887	34.34629	118.6572	86.80000	6.260000	6.301178	283.0000	229.1000
1982.2	13.43543	29.93387	118.9001	87.12000	8.420000	6.287647	287.3000	229.1000
1982.3	12.50000	28.92760	117.9986	87.45000	5.810000	6.240660	292.8000	230.2000
1982.4	12.20177	29.34560	118.5753	87.77000	2.480000	6.434405	293.4000	230.2000
1983.1	12.82401	28.92224	120.1569	88.10000	4.290000	6.201470	293.2000	231.3000
1983.2	11.58639	29.13439	119.5352	88.37000	3.790000	6.073930	296.9000	231.3000
1983.3	11.48087	30.64892	118.6689	88.65000	5.570000	6.025829	300.5000	232.3000
1983.4	9.534807	34.57605	119.6965	88.92000	10.22000	6.113646	303.1000	232.3000
1984.1	13.34857	41.44909	118.7337	89.20000	9.270000	5.998287	306.4000	233.5000
1984.2	12.91572	34.48499	118.2112	89.45000	18.11000	6.035118	309.7000	233.5000
1984.3	11.59374	28.20185	116.5762	89.70000	1.520000	6.093003	313.1000	234.4000
1984.4	11.79455	27.77426	116.3919	89.95000	7.030000	6.272611	315.4000	234.4000

See page 35 for footnotes.

[1]Farm-to-consumer price spread by Grade A large eggs expressed in cents per dozen and deflated by the Consumer Price Index for all items (1967 = 100). Quarterly figures were obtained from a simple average of corresponding monthly values. Source is Baker and Armstrong (3), p. 8, table 13. This particular data series was discounted in 1984 because of declining farm prices.

[2]Average retail prices for Grade A large eggs in cents per dozen deflated by the CPI (1967 = 100). Quarterly figures were computed from a simple average of corresponding monthly values. Source is Baker and Armstrong (3), p. 7, table 11.

[3]An index of labor cost specific to the food marketing industry deflated by the CPI (1967 = 100). Data were made available by Dennis Dunham, USDA, ERS.

[4]Percentage of eggs sold under vertical control (contracting and ownership) in the United States. Values are estimated from a logistic growth function (*13*) based on data provided in Rogers (*25,26*). See text for additional details.

[5]CV is the quarterly coefficient of variation of weekly nominal wholesale prices for Grade A large eggs in the United States. The coefficient of variation was obtained by computing the standard deviation of the weekly wholesale egg prices for each quarter and dividing by the average weekly wholesale price for eggs for the quarterly and multiplying by 100. Basic data source is USDA, ARS (*33*).

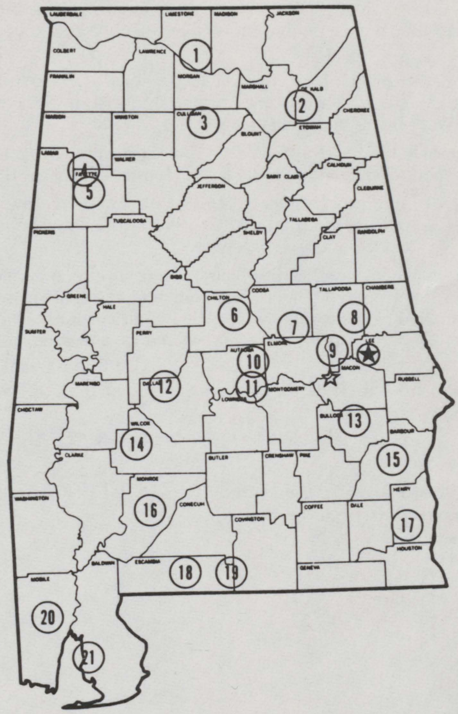
[6]U.S. production of Grade A large eggs divided by U.S. population. Basic data source is USDA, ARS (*34*).

[7]CPI is the consumer price index (1967 = 100). Source is U.S. Department of Labor, Bureau of Labor Statistics (*36*).

[8]POP is the population of the United States in millions. Source is U.S. Department of Commerce, Bureau of Census (*35*).

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

⊛ Main Agricultural Experiment Station, Auburn.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Plant Breeding Unit, Tallassee.
10. Forestry Unit, Autauga County.
11. Prattville Experiment Field, Prattville.
12. Black Belt Substation, Marion Junction.
13. The Turnipseed-Ikenberry Place, Union Springs.
14. Lower Coastal Plain Substation, Camden.
15. Forestry Unit, Barbour County.
16. Monroeville Experiment Field, Monroeville.
17. Wiregrass Substation, Headland.
18. Brewton Experiment Field, Brewton.
19. Solon Dixon Forestry Education Center, Covington and Escambia counties.
20. Ornamental Horticulture Substation, Spring Hill.
21. Gulf Coast Substation, Fairhope.