by Thomas Vance Cummings

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RESALE PRICE CONTROLS AND NON-PRICE COMPETITION IN THE FLUID MILK INDUSTRY

by

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APPROVAL

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ABSTRACT

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CHAPTER 1

INTRODUCTION

The purpose of this thesis is to consider the effects of resale (retail and wholesale) price controls on the structure of an industry. Specifically, the impact of a regulated price, set above the equilibrium price, on the number of firms in a market will be examined. In an attempt to empirically estimate the effects of price regulation on the number of firms, this study will focus on the fluid milk industry. The fluid milk industry's long history of price controls provides economists with an excellent opportunity to analyze this type of problem.

Price controls were introduced into the fluid milk industry during the 1930s because of an alleged need to stabilize the industry. Kessel (1967) argues that the claimed instability was a result of producers trying to maintain a two-price system for fluid and manufactured milk.[1] In this system, producers attempted to obtain a relatively high price for fluid milk and a lower price for manufactured milk. Competition, however, led to instability in the two-price system. Because fluid milk dealers could find producers willing to sell their milk for the manufactured price, the price differential was often reduced until it only reflected cost differences. As a result, Kessel argues the two-price systems "were unstable and hence produced instability in milk prices to producers and handlers."[2]

In an attempt to stabilize the fluid milk industry, price controls were established at both the federal and state levels. The federal government, after unsuccessfully regulating retail prices, shifted its policy to establishing minimum class prices for milk sold by farmers to milk handlers. State governments, on the other hand, passed regulations for controlling milk prices at the producer, wholesale, and retail levels. The state controls, initially regarded as temporary measures, became a permanent part of the fluid milk industry. Although the number of states regulating resale prices gradually declined after 1940, the trend reversed by the late 1950s. In 1964 and again from 1966 to 1970 a post-war high of fifteen states regulated resale prices.[3] Today only Maine, Montana, Nevada, North Dakota, and Pennsylvania regulate retail milk prices. Several other states regulate producer prices.

These statistics indicate that at one time resale price controls were a major movement in the fluid milk industry. Since over 30 percent of the states have implemented price controls, it is possible price controls have had a significant impact on the number and size of fluid milk processors in the industry. The model presented in Chapter 3 argues price controls can influence the number and size of firms by restricting competition to non-price margins. The resulting non-price competition shifts the cost functions of the firms in the market. Changes in the cost of production can lead to changes in the number and size of firms. Therefore, states which have enacted price controls may have played an important role in determining the number and size of fluid milk processors.

As previously mentioned, one of the reasons given for price controls has been the argument that controls would stabilize the fluid milk industry. One method in which price controls would supposedly accomplish this stabilization goal is by preventing price wars among wholesalers and retailers. Price wars would presumably hurt dairy farmers by driving wholesalers or retailers out of business. A reduction in the number of firms would give the remaining distributors or retailers monopsony power. Although the above argument for price controls is suspicious, the predicted effects of the controls may still be valid.[4] That is, price controls may prevent smaller firms from going out of business. A USDA (1971) report indicates that states with price controls may indeed be keeping smaller firms in business. "In nine states with retail price control for all of the 18 years between 1948 and 1965, the decline in plant numbers was 44 percent, compared with 55 percent in 33 states that did not have retail price control."[5]

This study will attempt to determine the impact of resale price controls on the number of fluid milk firms in a market. The results will indicate if resale price controls have acted to keep small fluid milk processors in business, firms that might not survive in an unregulated market. Such information could be useful in determining who benefits from price controls and, therefore, who would want them.

Although this report will focus on resale price controls in the fluid milk industry, other facets of the industry are also regulated. Trade practices such as sales below cost, price discrimination, discounts, and rebates are also regulated. In addition, some states require price filing at the retail and/or wholesale level.[6] Antitrust regulation has also been extensive in the industry.[7]

In spite of the numerous forms of regulation in the fluid milk industry, this thesis will limit its scope to the effects of resale price controls on the number of firms in a market. The relevant theoretical work is reviewed in the following chapter. Chapter 3 develops a new theoretical model which tries to analyze the effects of price regulation in terms of non-price competition. Results of previous econometric analyses and the results obtained in this study are presented in Chapter 4. Finally, Chapter 5 contains the summary and conclusions of the thesis.

FOOTNOTES

[1]Reuben Kessel, "Economic Effects of Federal Regulation of Milk Markets," The Journal of Law and Economics 10 (October 1967):52.

[2]Ibid.

[3]U.S., Department of Agriculture, Economic Research Service, Dairy Outlook and Situation, (Washington, D.C., September 1971), p. 25.

[4]Johnson points out that states which regulate retail prices also regulate producer prices or have producer prices determined by a federal milk marketing order. Hence, the monopsony power of distributors would be limited. Ronald N. Johnson, "Retail Price Controls in the Dairy Industry: A Political Coalition Argument," Working paper (August 1983), pp. 3-4.

[5]U.S., Department of Agriculture, Economic Research Service, "Pricing Milk and Dairy Products: Principles, Practices, and Problems," AER No. 207, (Washington, D.C., June 1971), p. 53. Cited by Charles N. Shaw, "Economic Effects of Resale Price Regulation on Market Performance in the Fluid Milk Industry" (Ph.D. dissertation, Pennsylvania State University, 1973), p. 14.

[6]U.S., Department of Agriculture, Economics, Statistics, and Cooperative Service," Government's Role in Pricing Fluid Milk in the United States," AER No. 397, (Washington, D.C.: Government Printing Office, 1978), p. 16.

[7]U.S., Federal Trade Commission, Economic Report on the Dairy Industry, by Russel C. Parker, (Washington, D.C.: Government Printing Office, March 1973), pp. 12-22.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews previous studies which can be used to evaluate the effects of resale price regulation on the number of firms in a market. The general conclusion reached by most of these investigations is resale price regulation leads to more and smaller firms operating in the market. Although Chapter 3 will argue that there are other possible results under resale price controls, it is still important to examine these studies to see how their conclusions were reached. The discussion will begin by examining the work of Masson and DeBrock (1980).

Masson and DeBrock's Model

Masson and DeBrock have attempted to model the effects of retail price regulation on an industry. Using Chamberlin's monopolistic competition framework, Masson and DeBrock's model implies that retail price regulation results in more firms producing at a smaller rate of output (as compared to a non-regulated market). Their graphical model is reproduced in Figure 1.

Masson and DeBrock use the standard monopolistic competition argument where each firm perceives a relatively more elastic demand curve (curve d in Figure 1) than the demand curve it actually faces (curve D in Figure 1). This inaccurate perception is the result of each firm believing it can change its own price without other firms reacting

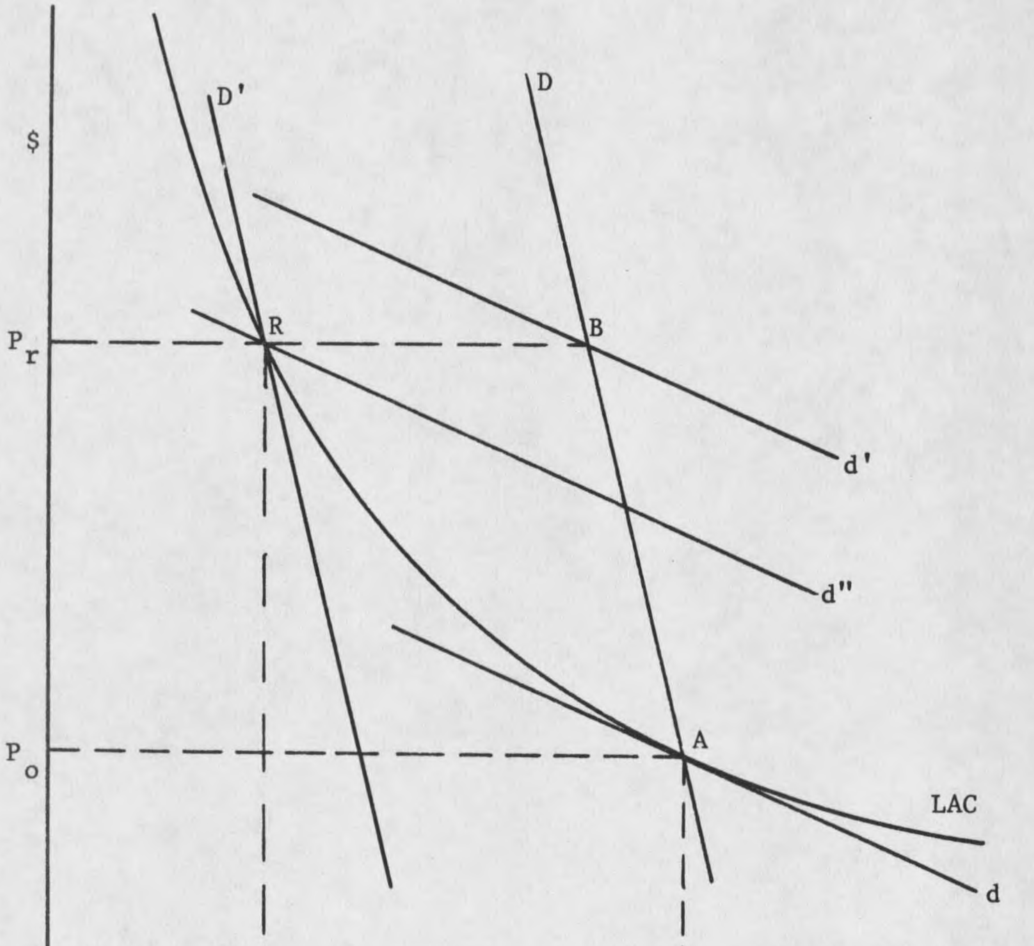

Figure 1. Masson and DeBrock Model.

Source: Robert Masson and Lawrence DeBrock, "The Structural Effects of State Regulation of Retail Fluid Milk Prices," The Review of Economics and Statistics 62 (May 1980):225.

to the price change. However, D is the appropriate demand curve because it takes into consideration the change in sales when all firms in the industry simultaneously change price. D is obtained by dividing the total market demand by the number of firms in the market.

Point A in Figure 1 represents the market equilibrium position without price regulation and equilibrium price P_o and quantity Q_o. With the introduction of price regulation, price is assumed to be set at a level higher than P_o. If P_r is the regulated price, firms will initially move to point B where they will earn profits. Profits will attract new firms into the industry; this entry will reduce each firm's market share. The reduction in market share shifts D to the left until it reaches D'. On D' firms will operate at point R where only a normal rate of return is earned, stopping entry into the industry. The result of the regulated price is, in this model, an increased number of firms operating at a smaller scale compared to the unregulated equilibrium.

Gould and Preston's Model

Looking at a similar situation under resale price maintenance (r.p.m.), Gould and Preston (1965) present a model where r.p.m. results in more and smaller retail firms. After assuming the manufacturer is successful in maintaining r.p.m. and that retailers believe they can not increase their sales volume with additional expenditures, Gould and Preston begin their argument by showing the relationship between the margin and the size of the retail outlet under r.p.m. The diagram they used to demonstrate their argument is reproduced in Figure 2.

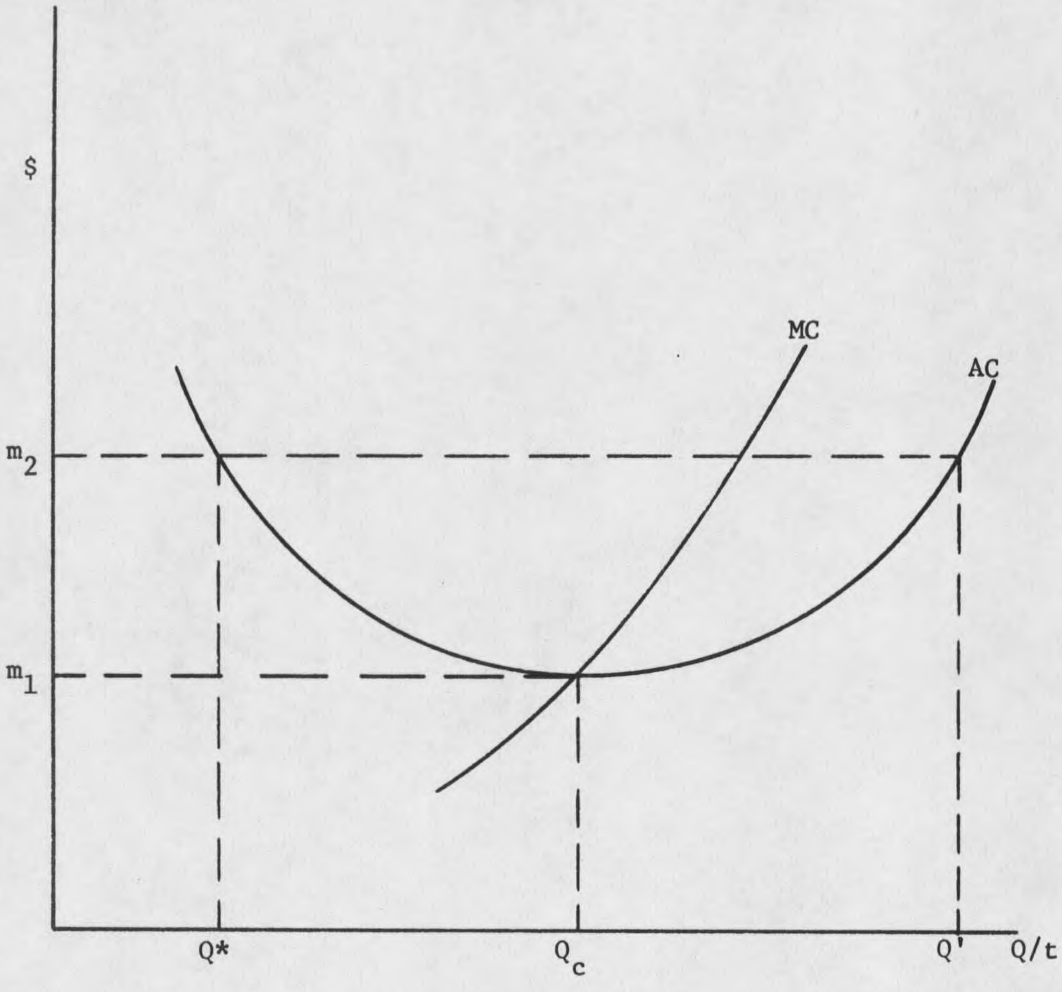

Figure 2. Gould and Preston Model.

Source: J. R. Gould and L. E. Preston, "Resale Price Maintenance and Retail Outlets," Economica 32 (August 1965):304.

In Figure 2, Q_c represents the competitive equilibrium quantity where average per unit retail cost equals the average per unit margin (M_1). (The margin equals the retail price minus the manufacturer's price.) When the manufacturer introduces r.p.m. the margin increases to M_2. At margin M_2 there are only two possible quantities that correspond to zero economic profits, Q' and Q*. Gould and Preston argue that firms will not operate at Q' because marginal cost exceeds marginal revenue. As firms reduce output from Q' they will begin to make a profit which will induce new firms to enter the industry. Firms will continue to enter the industry until the economic profits disappear, which occurs at the output rate Q*. Gould and Preston state that "the falling phase of the average retail operating cost curve may be said to define the size of the retail firm as a function of the unit margin established by the manufacturer practicing r.p.m."[1] Therefore, Gould and Preston conclude that r.p.m. results in more and smaller firms. They ignore the possibility of firms merging in order to move down the average cost curve to obtain economic profits. Also, at Q* marginal revenue does not equal marginal cost, a fact which led them to rule out Q' as a possible equilibrium position. The possibility of merging and the fact marginal revenue does not equal marginal cost indicates Q* is a far less stable equilibrium than Gould and Preston presume.

Both Masson and DeBrock and Gould and Preston have ignored the implications of non-price competition. Although Gould and Preston do mention that firms may attempt to expand sales by special services or advertising they do not present an explicit model describing the effects of such non-price competition.[2] Telser (1960) states that the quantity sold of a product can be a function of both price and services provided with the product. He also mentions that one of the reasons manufacturers may practice resale price maintenance is that they believe retailers will be induced to provide their products with special presale services. Such special services might include demonstrations of the product or additional advertising. Manufacturers hope that these additional services will entice more consumers to buy the product, shifting the demand curve for the product to the right. It must be remembered that under resale price maintenance, manufacturers specify the minimum price at which retailers may sell their product and that this price (if it is to have meaning) is above the market equilibrium price. This situation is very similar to retail price controls where the product's price is fixed by government fiat above the market equilibrium price. It seems reasonable, therefore, that firms in a price regulated market may also try to compete in a non-price manner.

Stigler (1968) and White (1972) have looked at non-price competition in price regulated industries. Unfortunately, both studies approached the problem by holding the number of firms in the industry fixed. Nevertheless, Stigler and White present arguments which state that firms will tend to compete away potential profits by offering a higher quality product. Koutsoyiannis (1982) has also looked at this question. The rest of this chapter will be used to examine his model.

Koutsoyiannis' Model

Koutsoyiannis views the product of a firm as a multidimensional variable which may include characteristics like quality, design, style, special services, and technical attributes. These are the dimensions firms may compete on when price is regulated.

For a given market Koutsoyiannis assumes all firms produce a product equal in quality but different in some attribute like color or design. "It is also assumed that each firm produces a single variety and that within each quality grade the preferences of buyers are equally distributed."[3] Assuming costs for the same quality grade are equal across firms, Koutsoyiannis argues that the above assumptions imply firms have equal market shares.[4]

Another important assumption made by Koutsoyiannis is that average cost and demand are assumed to be increasing functions of quality, with demand increasing at a decreasing rate. That is, each successively higher level of quality will shift the demand curve to the right, with each shift being smaller than the previous one. Figure 3 represents this process. In Figure 3 each consecutively higher cost curve represents a higher quality level which has a corresponding demand curve. The price is given and denoted as $\bar{P}$.

As the firm increases the quality level of its product it moves up to a higher average cost curve and a higher level of demand. If the set of points on each of the average cost curves which represent the quantity produced for each level of quality (as determined by demand) were to be traced out, the resulting curve would be the firm's average cost option (ACO) curve.

The ACO curve shows the cost of supplying the quantities demanded for the different quality levels at the given price P. As Koutsoyiannis points out, "The shape of the ACO curve depends on the shape and shift

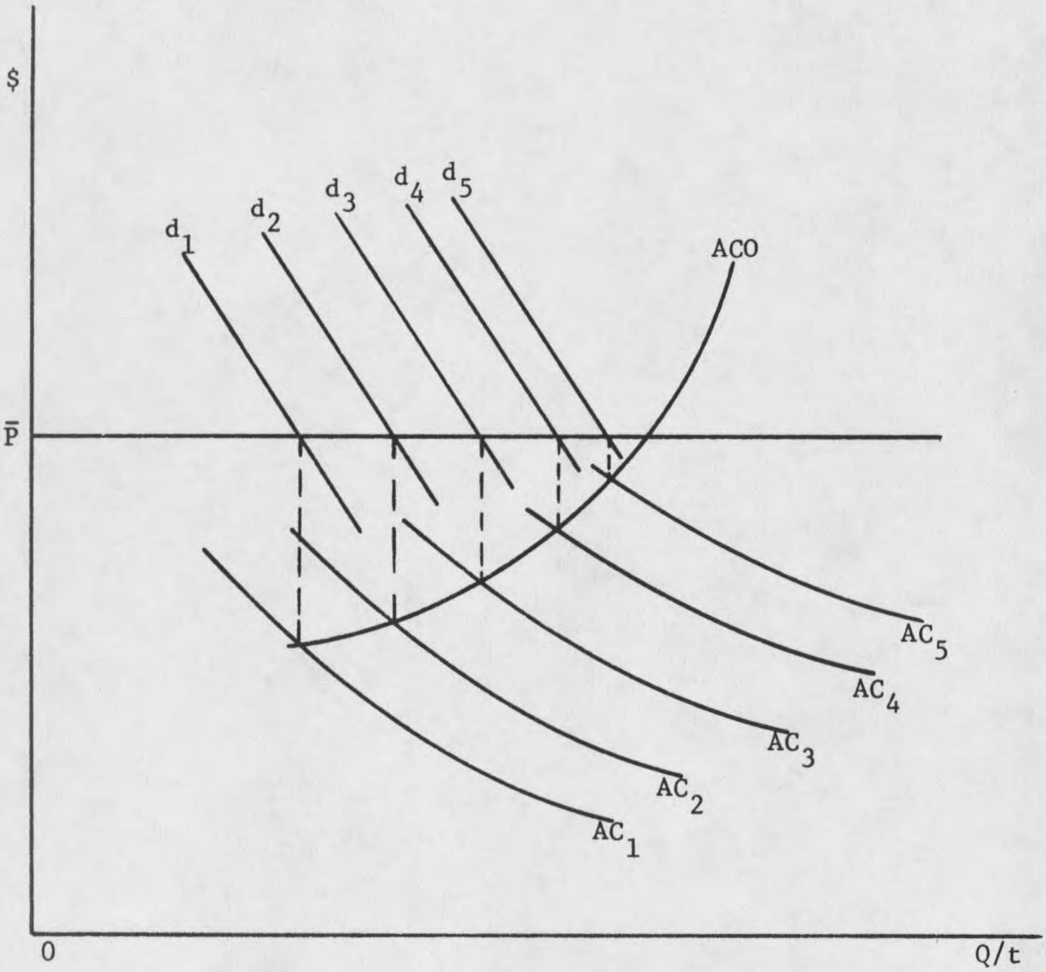

Figure 3. Derivation of the ACO Curve.

Source: A. Koutsoyiannis, Non-Price Decisions, New York: St. Martin's Press, 1982, p. 14.

of the average cost curves."[5] If firms were to move into the industry, the ACO curve would shift to the left. This is the result of the demand curves (d_i in Figure 3) shifting to the left, reflecting the smaller market share of each firm. Similarly, as firms exit the remaining firms will each have a larger share of the market, causing their demand curves to shift their ACO curve to the right.

Koutsoyiannis also discusses the marginal cost option (MCO) curve "which shows the rate at which cost changes in order to supply an <u>additional unit of output of improved quality</u> (his emphasis)."[6] The relationship between MCO and ACO is the same as the relationship between all marginal and average functions.

Figure 4 shows the short run equilibrium for a firm in Koutsoyiannis' framework. In the short run the firm will produce where the price $\bar{P}$ (which equals marginal revenue) equals MCO. The firm will produce the quantity Q* as determined by the demand curve d* and the average cost curve AC*.

Because the firm in Figure 4 is earning profits new firms will enter the industry. Entry will decrease each firm's share of the market and shift the demand curve d* to the left. This will generate a new set of ACO and MCO curves which are to the left of the short-run equilibrium point. Entry will continue until all the firms are making a normal rate of return. This occurs when the ACO curve is tangent to the price line as shown in Figure 5.

At the long-run equilibrium point, price $\bar{P}$ equals MCO which equals ACO. Compared to the short-run equilibrium in Figure 4, the long-run equilibrium consists of more and smaller firms ($Q'<Q^*$).

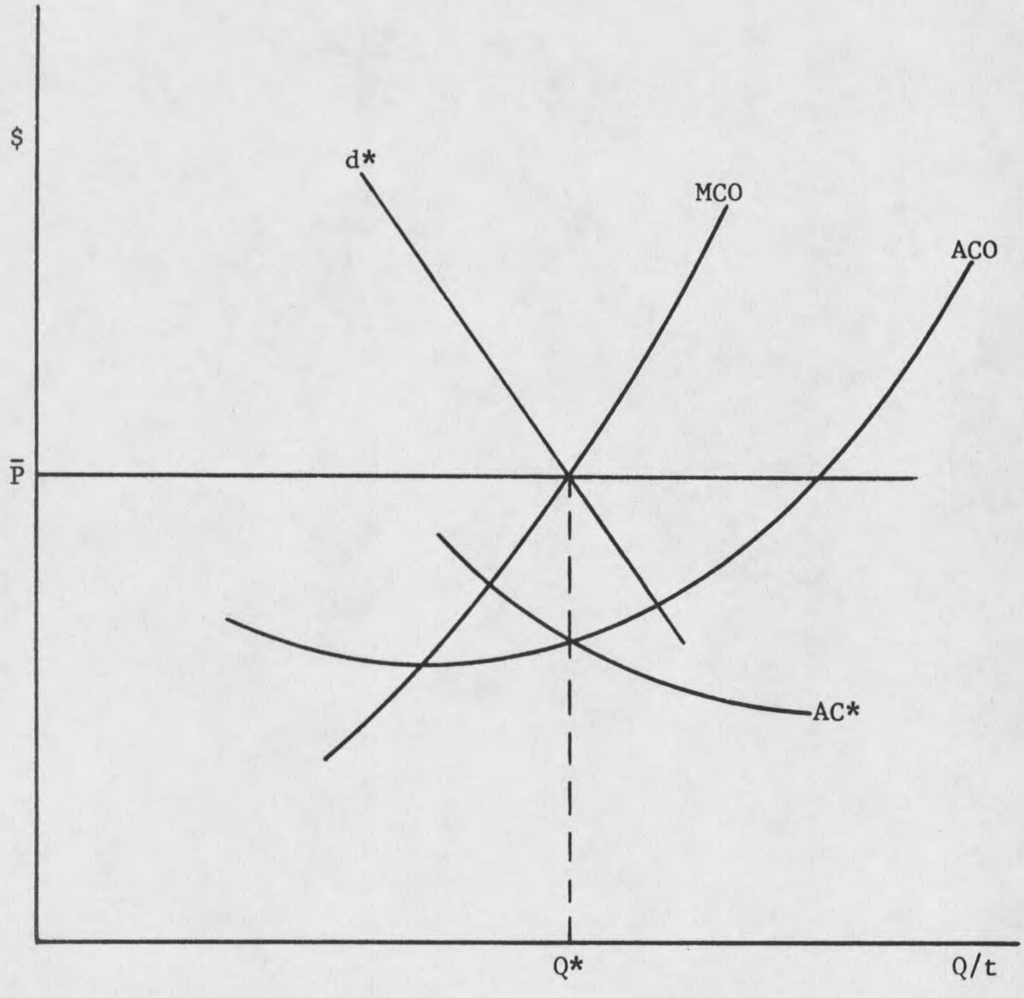

Figure 4. Short-Run Equilibrium.

Source: A. Koutsoyiannis, Non-Price Decisions, New York: St. Martin's Press, 1982, p. 18.

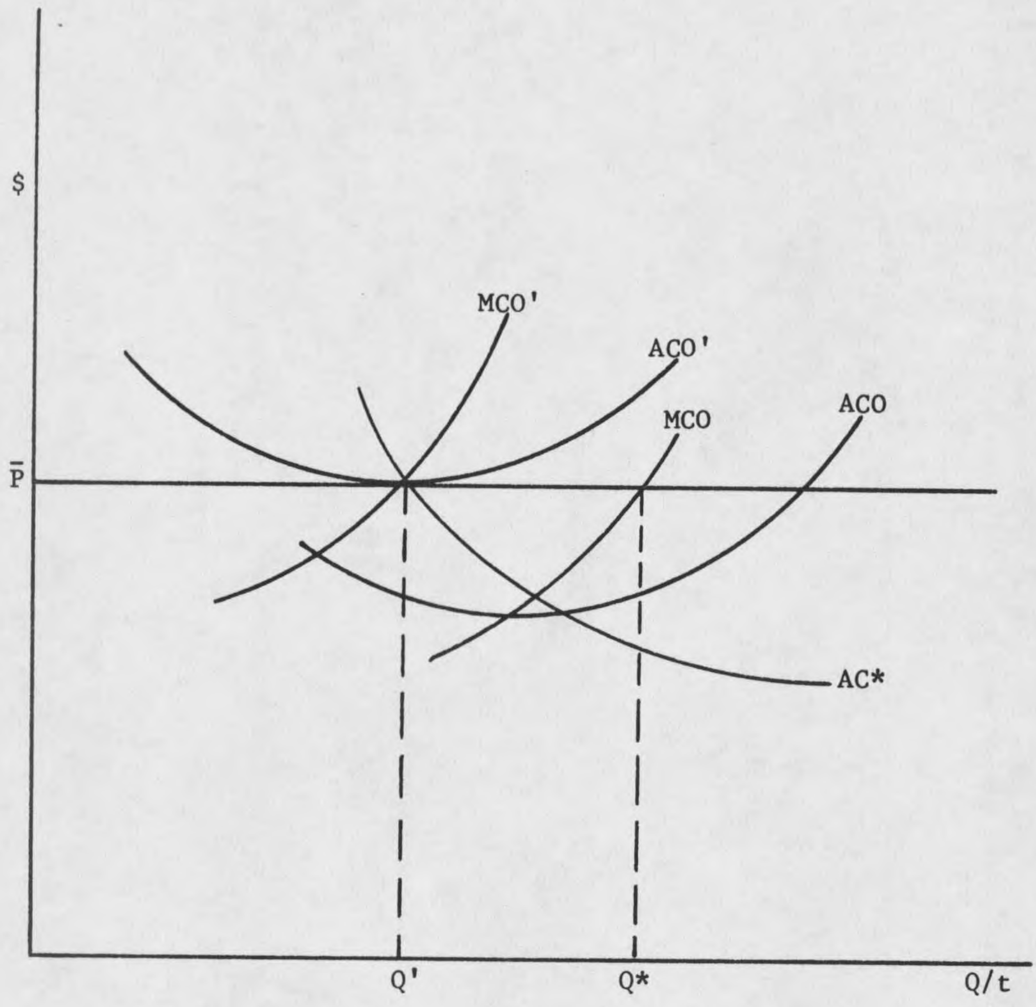

Figure 5. Long-Run Equilibrium.

Source: A. Koutsoyiannis, Non-Price Decisions, New York: St. Martin's Press, 1982, p. 19.

It is important to note that Koutsoyiannis has assumed that the market price is given. By this he means:

> Price can be given either by custom, by government regulation, by a leader, by collusion, or it may have been established in the market without collusion as a result of the historical evolution of moves and counter moves of rival firms; or price may have been set by a previous decision of the firm.[7]

If it is assumed that the price level in the long-run equilibrium position shown in Figure 5 is unregulated and that regulation establishes a price above $\bar{P}$, then the equilibrium position under price regulation will be to the left of Q'. (The adjusting mechanism would be the same as that described above.) This implies that even when non-price competition is considered, retail price controls will lead to more and smaller firms operating in the market, a conclusion consistent with Masson and DeBrock and Gould and Preston.

Although Koutsoyiannis claims the equilibrium represented in Figure 5 is a long-run equilibrium, he fails to explain why a firm does not expand output along AC*. Apparently, Koutsoyiannis' assumption of equal market shares and equal distribution of buyer preferences is supposed to constrain firms from expanding sales. Unable to expand sales, firms presumably operate to the left of the minimum point on the average cost curve AC*. However, if firms somehow broaden the appeal of their product (by producing the product in a wide variety of colors, for example) then sales could possibly expand, allowing firms to move down AC*. If this possibility is considered, then Koutsoyiannis' long-run equilibrium, as shown in Figure 5, appears to be based on a tenuous argument.[8]

Chapter Summary

This chapter has examined the models of Masson and DeBrock, Gould and Preston, and Koutsoyiannis. Masson and DeBrock and Gould and Preston's models were found to be lacking because they did not consider non-price competition in price regulated markets. Although Koutsoyiannis' model focused on non-price competition, it contains questionable assumptions. The long-run equilibrium in his model does not appear to be stable because firms are not operating at the minimum point on the average cost curve (AC* in Figure 5).

The next chapter presents a model for non-price competition in a price regulated market. The model considers the effects of non-price competition on a firm's cost function. Specifically, the model explores how non-price competition in a competitive environment shifts a firm's cost curves. The shift in the cost curves for firms in the regulated market is then related to changes in the number and size of firms in the market.

FOOTNOTES

[1] J. R. Gould and L. E. Preston, "Resale Price Maintenance and Retail Outlets," Economica 32 (August 1965): 304.

[2] Ibid., pp. 311-312.

[3] A. Koutsoyiannis, Non-Price Decisions: The Firm in a Modern Context (New York: St. Martin's Press, 1982), p. 12.

[4] Ibid.

[5] Ibid., p. 15.

[6] Ibid., p. 17.

[7] Ibid., footnote 16, p. 12.

[8] Koutsoyiannis offers a model of cut-throat product competition which results in an equilibrium where firms operate on the minimum point of AC* (pp. 29-30). He develops the cut-throat model by assuming firms are willing to accept losses in order to increase their market share, firms believe an increase in quality will force other firms out of the market, and firms maximize sales not profits. However, the model presented in Chapter 3 also obtains an equilibrium where firms operate at the minimum point on their average cost curves. The model obtains this equilibrium without the assumptions of cut-throat product competition.

CHAPTER 3

A MODEL FOR NON-PRICE COMPETITION IN THE FLUID MILK INDUSTRY

The previous chapter discussed different models that could be used to analyze the effects of resale price controls on the number and size of firms in a market. This chapter presents an alternative model. It is argued that when an industry is regulated by price controls the firms in the industry compete in a non-price fashion through changes in the service level. Furthermore, it is shown that this non-price competition is difficult to adequately model and, as a result, it is difficult to predict what will happen to the size and number of firms in the regulated industry.

Assume an industry is in a long-run competitive equilibrium position with price P^o, total production Q^o, and firm production q^o, as shown in Figure 6. If resale price controls are introduced and the regulated price p^r is set above the equilibrium price P^o, firms will be making an economic profit at the output rate q^o. Gould and Preston argued that firms will enter the market until production per firm drops to q'. However, they failed to mention the incentive for firms to merge, move down the average cost curve, and obtain economic profits. Furthermore, as Stigler and White have argued, firms will try to increase their share of the market by offering a higher quality product, and in the process, compete away any potential profits.

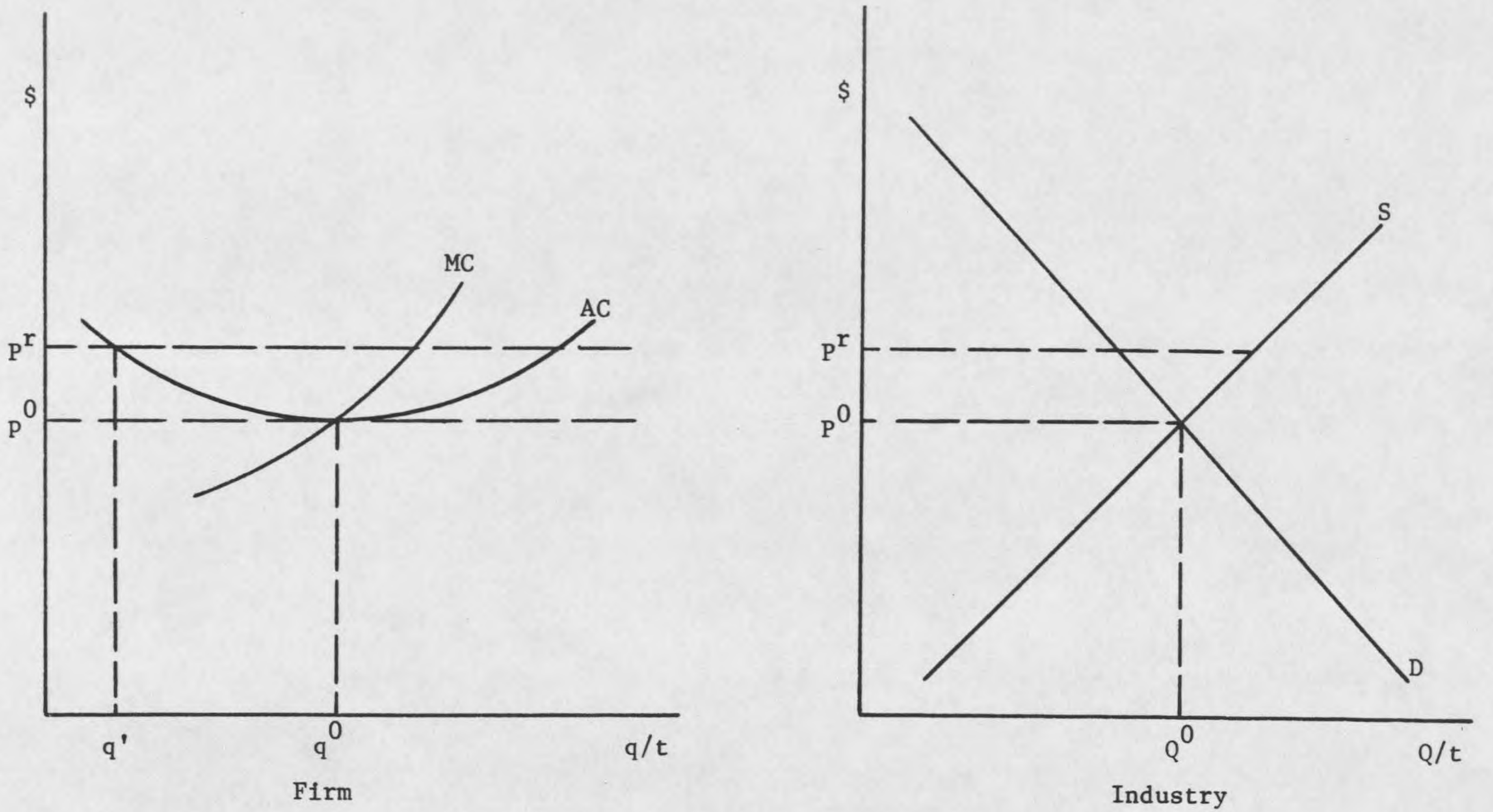

Figure 6. Long-Run Competitive Equilibrium.

Non-Price Competition in the Milk Industry

The milk industry has exhibited both of these effects (mergers and non-price competition). A 1973 report on the dairy industry done by the Federal Trade Commission shows the industry has averaged 160 mergers per year between 1920 and 1972.[1] The report also mentions some of the forms non-price competition has taken. The report states:

> It has been customary in the dairy industry for the processors to finance some capital investments for their customers. A typical example is in store refrigeration equipment such as the dairy case. This and other equipment might be provided on a long-term, interest-free basis as a means of retaining the customer as an outlet.[2]

Campbell and Marshall (1975) have stated that in markets with fixed prices, handlers tend to compete for store accounts by marking prices, stocking, arranging display cases, and providing other services.[3] A study by Williams et al. (1970), on the midwest dairy industry states that in the fluid milk and ice cream industries:

> Implicit price competition and non-price competition involve a variety of practices, such as providing advertising allowances or rebates, providing free display cases, servicing and repair of display equipment, and loans or other financing of retailers. The existence of these practices is well established in the literature . . . .[4]

Bartlett has also noted the existence of such practices.[5]

But as was mentioned in the introduction, trade practices are regulated in the milk industry. In 1981, 25 states regulated trade practices in the milk industry.[6] Federal laws also apply to many of the trade practices in the industry.[7] The existence of such laws implies that many of the above mentioned forms of non-price competition are illegal. The presence of resale price laws will lead firms to practice illegal forms of non-price competition if the expected benefits are greater than the expected costs. Bartlett has written:

> State control of retail prices has created a situation in which efficient distributors are prevented from offering the consumer the benefit of their savings. Under such conditions some distributors have sought to increase sales by offering wholesalers services and discounts that are considered illegal. The total number of individuals, locations and opportunities available for breaking the law is so great that adequate policing is nearly impossible.[8]

Williams et al. have also mentioned that firms are competing illegally by using some forms of non-price competition in the fluid milk industry. In discussing the enforcement problem they state:

> Much of the legislation is inherently difficult to enforce, both because it is hard to define the prohibited practices precisely and because many of those practices, such as granting rebates, are easily hidden yet accepted as general practice by the trade.[9]

This evidence indicates that even though many forms of non-price competition in the fluid milk industry are illegal, they are nevertheless practiced. This is an important point because the model developed in this chapter will center on the possible results of non-price competition in a price-regulated market. Since the model will be applied to the fluid milk industry it will be argued that firms in that industry compete along non-price margins even though it is illegal to do so.

Non-Price Competition and the Firm's Cost Function

As firms begin to compete in a non-price manner their costs will increase. Because cost curves are derived from some production function

$$Q = f(X_1, X_2, \ldots, X_n)$$

where the X_is are factor inputs and Q is a uniform output, a change in the product implies a new production function and a new set of cost curves. Non-price competition may involve adding new inputs or mixing previous inputs in a new manner in order to obtain the change in product.

Without knowledge of the cost functions it would seem difficult to predict where the new average cost curve (for the new product) is located in relation to the previous cost curve. Although the new average cost curve will be located above the old curve, it appears difficult to determine where above the old curve it will be. The new curve could be to the left, right, or directly above the previous average cost curve. Furthermore, if changes are made to the physical product it appears inappropriate to even compare outputs resulting from two different production functions.

In order to avoid problems of comparing rates of output, the assumption that no changes are made to the physical product in non-price competition will be made. Instead, it will be assumed that firms compete by offering increased levels of service. This assumption seems especially appropriate for the fluid milk industry where changes in the physical product have been limited and competition through service levels is known to exist.

A modified version of Silberberg's (1978) analysis of factor price changes for firms in a long-run equilibrium shall be used to demonstrate the possible effects of non-price competition. Assuming no changes in the physical product, the difficulty of predicting the shifts in a firm's cost function (caused by a change in the service level) is demonstrated. In trying to determine the shifts of the cost curves resulting from a change in the service level, the analysis will center on the output rate associated with the minimum average cost.

In a highly competitive model where the firms are price takers the point of minimum average cost can be represented by

$$MC(\bar{w}, y', \alpha) = AC(\bar{w}, y', \alpha) \qquad (1)$$

where MC and AC are the marginal and average cost functions, respectively. These costs are written as functions of a factor price vector $\bar{w}$, the output rate associated with the minimum unit cost y', and a shift parameter α. The shift parameter is used to displace the equilibrium of the firm and can be interpreted as the service level associated with the output rate y'.

Because the change in the output rate associated with the minimum average cost (y') caused by a change in the service level (α) is being considered, the function

$$y' = \hat{y}(\alpha) \qquad (2)$$

is assumed to exist. In order to use the implicit function theorem it is sufficient for the partial of the function

$$MC(\bar{w}, y', \alpha) - AC(\bar{w}, y', \alpha) = 0$$

with respect to y' to not equal zero. That is,

$$\frac{\partial MC}{\partial y'} - \frac{\partial AC}{\partial y'} \neq 0 \ . \qquad (3)$$

The term $\partial AC/\partial y'$ equals zero since y' is the output rate at the minimum point on the average cost curve. If we assume the typical U shaped average cost curve, then $\partial MC/\partial y'$ is greater than zero at the minimum of the average cost function.

Substituting (2) into (1) results in

$$MC(\bar{w}, \hat{y}(\alpha), \alpha) = AC(\bar{w}, \hat{y}(\alpha), \alpha). \tag{4}$$

Differentiating (4) with respect to α yields

$$\frac{\partial MC}{\partial \alpha} + \frac{\partial MC}{\partial y'}\frac{\partial \hat{y}}{\partial \alpha} = \frac{\partial AC}{\partial \alpha} + \frac{\partial AC}{\partial y'}\frac{\partial \hat{y}}{\partial \alpha}. \tag{5}$$

Again, $\partial AC/\partial y' = 0$. This means the last term in (5) drops out. Solving (5) for $\partial \hat{y}/\partial \alpha$ yields

$$\frac{\partial \hat{y}}{\partial \alpha} = \frac{1}{\frac{\partial MC}{\partial y'}}\left[\frac{\partial AC}{\partial \alpha} - \frac{\partial MC}{\partial \alpha}\right] \tag{6}$$

Equation (6) represents the change in the output at minimum average cost due to a change in the service level. Since $\partial MC/\partial y' > 0$ the change in y depends on the magnitudes of $\partial AC/\partial \alpha$ and $\partial MC/\partial \alpha$. The relative size of these partial derivatives cannot be determined without a more restrictive set of assumptions or additional information. Consequently, it is not possible to determine which way the cost curve shifts when the service level is changed. If the marginal cost curve shifts less than the average cost curve the minimum point of the new average cost curve will be to the right of the old minimum and vice versa. It is also possible for the two magnitudes to cancel each other out, leaving the new minimum point at the same output rate (but at a higher level of cost).

It is possible for the cost curves to make these kinds of shifts if the service level is increased. For example, if an increase in service means servicemen must do more work then their wages may have to be increased. Silberberg has shown that an increase in a factor price can, if the output elasticity of the factor is greater than one, shift the cost curves to the left. If the elasticity equals one the curves shift straight up. An elasticity less than one shifts the curves to the right.[10] Also, if the firm purchases a new piece of equipment to increase its service level, its fixed costs increase. The increase in fixed costs shifts the firm's average cost curve up along the marginal cost curve. This shift results in the minimum point of the new average cost curve to be located to the right of the old minimum.

In any event, it is clear from equation (6) that without additional information regarding the cost functions of a firm, it is difficult to predict where the firm's cost curves will shift. This point has important implications. Referring back to Figure 6, p^o and q^o represent the long-run equilibrium price and output for a firm. If retail price controls are introduced and the regulated price p^r is set above p^o, the market is thrown out of equilibrium. Producers would like to produce more at the higher price than consumers are willing to pay. Firms will use non-price competition in an attempt to increase their market share. Non-price competition, such as a higher level of service, will increase the firm's costs. Unfortunately, the ambiguous results of equation (6) means a priori reasoning can go no further. The firm's new rate of output can be greater than, less than, or equal to the initial equilibrium output rate q^o.

Up to this point the analysis has concentrated on the effects of non-price competition on a single firm. Equation (6) has been used to demonstrate that non-price competition shifts to the firm's cost curves in indeterminate fashion. Now the discussion will turn to the subject of how non-price competition in a price-regulated market influences the number of firms in the market. In order to determine the changes in the number of firms, the effects of non-price competition on the demand for the product must be considered.

From the firm's viewpoint, non-price competition is used to try to expand the firm's market share. When a firm can not compete by price, it turns to different margins of competition, such as a higher quality product or an increased service level. But if the quantity sold of a product is a function of both price and quality (or service level) an increase in quality means an increase in demand. The higher quality level persuades more consumers to buy the product.

Figure 7 portrays this situation. In Figure 7 the initial long-run equilibrium occurred at price p^o and output rates q^o for the firm and Q^o for the market. Price controls raise the price to p^r. Firms will initially try to set their marginal cost equal to their marginal revenue (p^r). The presence of profits induces other firms to enter the market. However, the higher price means quantity demanded decreases to Q^r. This means the firms are competing for sales in a smaller market. Each firm will try to attract new customers by offering higher service levels or increasing the product's quality. With demand being an increasing function of product quality and service level, non-price competition shifts the demand curve out. This is represented in Figure 7 by the shift from D' to D". Unfortunately, without more information it is difficult to predict how far the demand curve will shift. Being unable to quantify this shift only serves to make predicting the number of firms in the market more difficult.

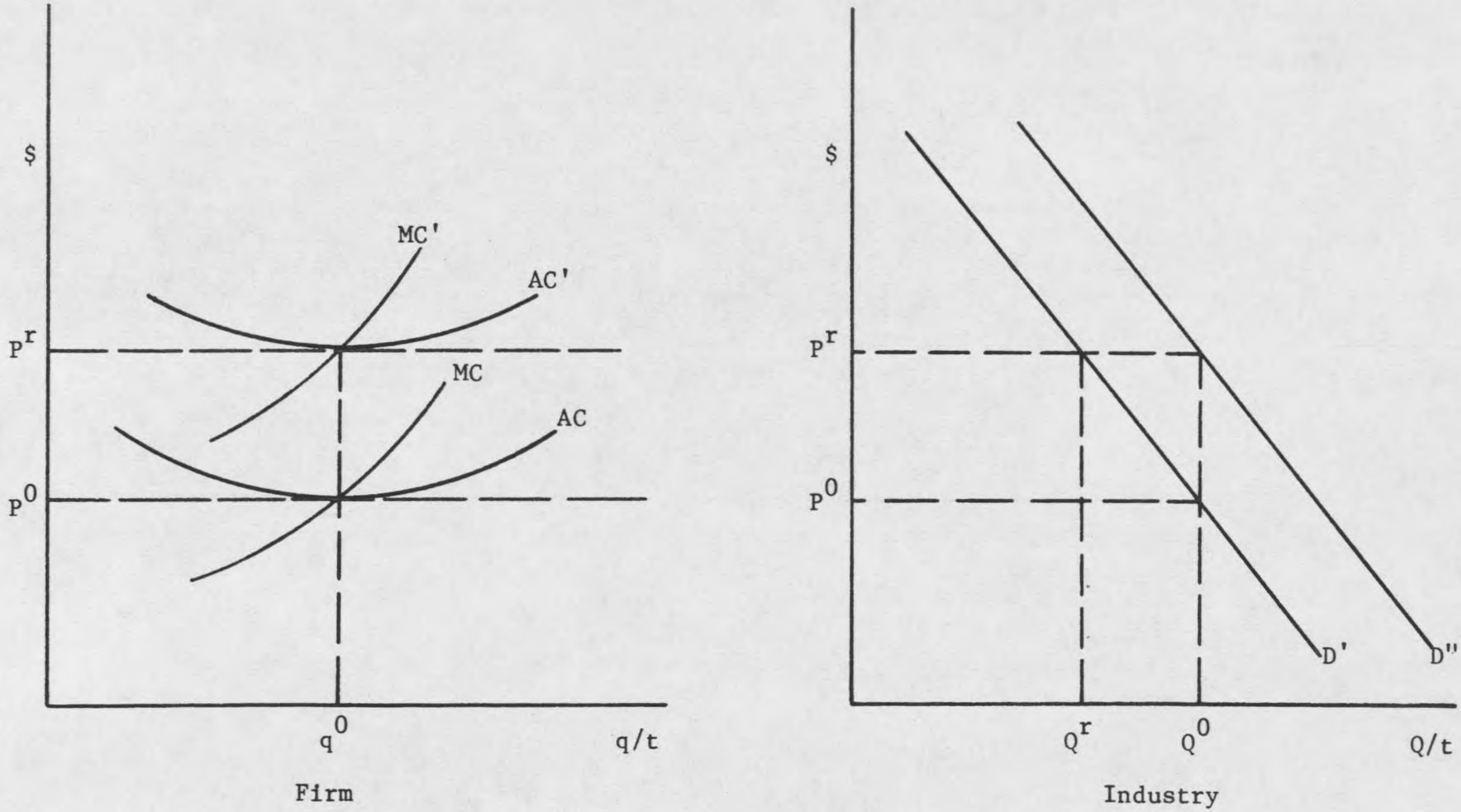

Figure 7. Possible Result of Non-Price Competition.

For example, consider the situation if the demand curve shifts to D" and quantity demanded moves to Q^o from Q^r. Assume an increase in the service level causes the firm's average cost curve to shift straight up (as in Figure 7). Since the output rates have not changed, the number of firms must be the same. If the average cost curves shift to the left, the number of firms would increase. If the average cost curves shift to the right, the number of firms would decrease. As seen in this example, even when the total quantity demanded is held at its initial level, Q^o, one cannot determine what happens to the number of firms in the market without knowing how the cost curves shift.

Fluid Milk: A Special Case

Before this model can be applied to the milk industry it must be modified. In Chapter 4 this thesis empirically examines the effects of resale price controls on the number of fluid milk processors. Because fluid milk processors work at the wholesale level, it is the effects of wholesale price controls on the number of processors that is being studied. Therefore, in the context of the present model wholesalers are the sellers and retailers are the buyers. In this framework non-price competition occurs at the wholesale level as distributors attempt to get retailers to sell their milk. Since the non-price competition is aimed at retailers it is unlikely that consumer demand will be significantly affected. That is, it is not likely that non-price competition among wholesalers will dramatically influence consumers' demand for fluid milk. Hence, in order to apply the model presented in this chapter to the fluid milk industry, it is assumed that non-price competition among processors does not substantially increase the derived demand for milk. Referring back to Figure 7, it is assumed that the increase in the service level shifts the demand curve D' by a small amount, if at all.

Chapter Summary

In summary, the effects of resale price controls are indeterminant. From an a priori basis it is difficult to say what effects resale price controls have on the number and size of firms producing the price-regulated product. In order to determine what effects these controls have on an industry empirical work must be done. The next chapter describes the econometric results obtained from studying the fluid milk industry in an attempt to determine how resale price controls affected the number of firms in the industry.

FOOTNOTES

[1]This statistic was determined by using the information in Table 1 in Economic Report on the Dairy Industry, FTC, 1973, pp. 13-14.

[2]Ibid., p. 20.

[3]John R. Campbell and Robert T. Marshall. The Science of Providing Milk for Man (New York: McGraw-Hill Book Co., 1975), p. 415.

[4]Sheldon W. Williams et al., Organization and Competition in the Midwest Dairy Industries (Ames, Iowa: Iowa State University Press, 1970), p. 134.

[5]Roland Bartlett, "Is State Control of Consumer Milk Prices in the Public Interest?" Bulletin 705, University of Illinois Agricultural Experiment Station, January 1965, pp. 22-24.

[6]U.S., Department of Agriculture, Economic Research Service, Dairy Outlook and Situation, (Washington, D.C.: September 1971), p. 26.

[7]Ronald Knutson, "The Economic Consequences of the Minnesota Dairy Industry Unfair Trade Practices Act," The Journal of Law and Economics 12 (October 1969): 377.

[8]Bartlett, p. 22.

[9]Williams et al., p. 27.

[10]Eugene Silberberg. The Structure of Economics: A Mathematical Analysis (New York: McGraw-Hill Book Co., 1978), p. 211.

CHAPTER 4

ECONOMETRIC ANALYSIS OF THE EFFECTS OF RESALE PRICE CONTROLS ON THE FLUID MILK INDUSTRY

In the previous chapter the argument was made that without additional information or more limiting assumptions, the effects of resale price controls on the size and number of firms are indeterminate. This conclusion was based on the argument that firms which cannot compete by price may turn to non-price methods of competition. As firms compete along non-price margins their cost functions change. Unfortunately, it is difficult to predict the changes in the cost functions. As a result, the influence of resale price controls on the number and size of firms is not clear.

In an effort to determine the possible effects of resale price controls on the number of firms in a market, this chapter will discuss the results of an empirical investigation into the relationship between the number of fluid milk plants and state regulation of fluid milk prices. To simplify the analysis, for the remainder of this study the terms "plant" and "firm" will be used synonymously. That is, all firms are assumed to be single plants. Also, the empirical investigations considered in this chapter will focus on states that control retail milk prices. Johnson (1983) has shown states that regulate retail prices tend to regulate wholesale prices.[1] This is an important point since fluid milk plants operate at the wholesale level.

The discussion will begin by examining the empirical work of Masson and DeBrock (1980) and Needy (1982). Problems in the data set and the misinterpretation of a dependent variable in the data set used by these authors will be reviewed. Next, the chapter will consider the econometric analysis developed specifically for this study.

Masson-DeBrock Model

Masson and DeBrock have investigated the structural effects of state retail price regulation on the fluid milk industry. The model they estimated consists of the following system of simultaneous equations:

$$C = \gamma_o + \gamma_1 P + \gamma_2 Y + \gamma_3 E1 + \ldots + \gamma_{10} E8 + \varepsilon_1$$

$$M = \alpha_o + \alpha_1 N + \alpha_2 Q + \alpha_3 Pr + \alpha_4 R + \alpha_5 D + \varepsilon_2$$

$$N = B_o + B_1 Q + B_2 L + B_3 R + B_4 D + \varepsilon_3$$

In this system, C is per capita consumption of whole fluid milk (half gallons) and P is the price of milk per half gallon. P is defined to equal the sum of M, the margin for milk sold through stores, and Pr, the price of raw milk.[2] Y is per capita income. E1 through E8 are dummy variables for nine geographic regions. N is the number of plants which provide packaged fluid milk to the market. Q is total consumption of whole milk and is defined as C multiplied by the population in the market. R and D are dummy variables for regulated and recently deregulated markets, respectively. L is the land area of the market.

Because Q is a nonlinear function of C and population (POP) the reduced forms for the endogenous variables C, M, N. and Q are nonlinear in the variables. Since the reduced form equations are inherently nonlinear, ordinary two-stage least squares cannot be used to get consistent estimates of the coefficients in the system.

Procedures for getting consistent estimates for this kind of nonlinear model have been developed by Edgerton (1972) and Kelejian (1971). Basing their methods on these previous studies, Masson and DeBrock regress the endogenous variables in the system on a linear combination of the exogenous variables, including POP.

Masson and DeBrock estimated their system of equations using data from Shaw (1973). Shaw obtained the data for some of the variables from a survey which was part of the Northeast Regional Dairy Marketing Technical Committee Research Project (NEM-40). Conducted in late 1969, NEM-40 is the only study which has collected data on margins, consumption, number of plants, and other variables for individual markets. Masson and DeBrock use data for 69 markets in their study.

Firms Serving a Market Versus Firms Physically Located In a Market

Before Masson and DeBrock's results are examined a note of caution must be given in regard to the interpretation of the estimates. Two of the relationships Masson and DeBrock wanted to consider in their investigation were the effects of retail price controls on the number of plants in a market and on plant capacity. However, the data set Masson and DeBrock used is not able to address these questions directly. Masson and DeBrock treated the observations for the variable N as if they represented the number of plants which were not only selling their output in the market but were also physically located in the market. (The possibility of fluid milk being imported or exported was ignored.)

But the observations on the number of plants actually represent the number of plants which serve a market. Plants which serve a market may include those which ship their product into the market but whose plants are not physically located in the market. Plants physically located in the market are also included in this category (some of which may export to other markets). The distinction between plants serving a market and plants physically located in a market is important. Figure 8 will be used to explain this difference.

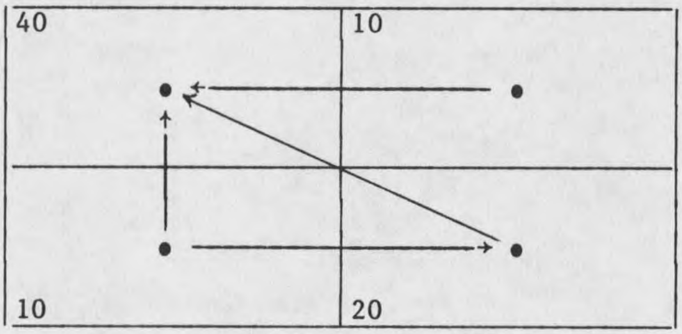

Figure 8. Firms Serving a Market.

Assume the four dots in Figure 8 represent four markets located in a state which regulates the wholesale and retail prices of milk. Furthermore, assume there are ten fluid milk plants physically located in each market. Because prices are regulated, non-price competition may lead plants to ship their product into other markets (indicated by the arrows in Figure 8). This can result in more plants serving a market even though the number of plants physically located in the market has not changed. For example, the market in the upper left hand corner of Figure 8 is being served by plants in each of the other markets. Even though only ten plants are physically located in the market there could be thirty additional plants shipping their product into the market. (The numbers in each rectangle in Figure 8 represent the number of plants serving the market.) In this hypothetical case, retail price controls have increased the number of plants serving a market, but the controls have not increased the number of plants located in a market.

This example points out two problems. First, data on the number of plants serving a market does not provide direct evidence to test the hypothesis that retail price controls increase the number of plants physically located in a market. The number of plants serving a market does not give an exact measurement of how many plants are located in the market. As seen in Figure 8, the number of plants serving a market may increase , but the total number of plants in the state can remain unchanged. Although this does not mean the number of plants serving a market is a useless measure, it does imply that empirical results obtained by using the number of plants serving a market must be interpreted accordingly. Secondly, no strong conclusions can be drawn as to the effects of regulation on plant capacity when the number of plants serving a market is used. Masson and DeBrock claimed to have shown the average daily output per plant in a regulated market was "well below the minimum optimal scale of 40,000 quarts per day."[3] But, as seen in Figure 8, their conclusion that regulation leads to excess capacity could be the result of using the number of plants serving the market as a variable in their system. If a market is served by a large number of plants which are physically located in a different market, it will appear as if the market contains a relatively large number of plants operating at a small scale. Yet it is clear that the scale of the plants physically located outside the market (in another city) cannot be determined by the amount of output they ship into the market they serve. Such an amount would only be a portion of each plant's total output.

Previously, it was argued that the number of plants serving a market is not a precise measure for the number of plants physically located in the market. However, it is possible that observations on the number of plants serving a market may indicate how regulation affects plants physically located in a market. This leads to the subject of trying to determine the relationship between plants serving a market and plants physically located in a market when price controls are in effect. Figure 9 will be used to demonstrate the possible relationships.

		Number of Plants Located in Market		
		+	0	–
Number of Plants Serving a Market	+	1	2	3
	0	4	5	6
	–	7	8	9

Figure 9. Possible Relationships Between the Plant Measures.

The horizontal axis in Figure 9 measures the effect of price controls on the number of plants located in the market. The vertical axis measures the effect of price controls on the number of plants serving a market. A plus sign (+) indicates the number of plants increases under price controls; a minus sign (-) indicates the number of plants decreases. A zero means price controls do not influence the number of plants. As indicated in Figure 9, there are several possible relationships between the two measures of plants in a market. It was mentioned earlier that the number of plants serving a market does not provide a <u>direct</u> test for the effects of price controls on plants physically located in a market. However, it may provide an indirect test. That is, it may be possible that the two measures for number of plants tend to move together. Rectangles 1, 5, and 9 represent this possible relationship. Since the number of plants serving a market consists of plants located in the market and plants that ship into the market (but aren't physically located in the market), a positive correlation between the two measures seems likely. It is expected that as the number of plants located in the market increases (decreases) the number of plants serving the market will increase (decrease). Similarly, if regulation does not affect the number of plants located in a market, then regulations may not affect the number of plants serving a market.

Provided that these two measures move together, the Masson and DeBrock study can offer some insight into the impact of price controls on the number of plants in a market.

Masson and DeBrock's Empirical Results

Masson and DeBrock's estimates for their reduced form and structural equations are reproduced in Tables 1 and 2, respectively. The reduced form equations show retail price regulation has a positive and significant (at the 1% level) effect on the margin (M). The coefficient on the regulation variable indicates regulation increases the margin by 5.19¢ per half gallon, compared to an unregulated market. In Masson and DeBrock's data set, the approximate 5¢ difference meant margins in regulated markets were 20 percent higher and prices 9.5 percent higher than unregulated markets. As Masson and DeBrock mention, finding that regulation increases the price of fluid milk is consistent with the results of Shaw (1973), Manchester (1974), and Bartlett (1965). Together these studies suggest that retail price controls on fluid milk have been binding (to the extent that controls increase the price of milk).

The estimates for the reduced form plant equation show regulation has a positive and significant (1% level) impact on the number of plants serving a market. The estimate in Table 1 implies regulation causes approximately six additional plants to serve a market. With an average of 13.6 plants serving regulated markets in their data set, Masson and DeBrock conclude that about 45 percent of the plants serving a regulated market can be attributed to regulation. Based on this result, it appears retail price controls increase the number of plants serving a market. However, the next section discusses Needy's (1982) results

Table 1. Masson and DeBrock's Reduced Form Estimates.[a]

	Dependent Variables		
	M	N	C
R	5.19	6.08	-3.77
	(4.13)	(2.81)	(2.20)
D	-2.58	6.06	-1.14
	(1.60)	(2.18)	(.517)
POP	.0002	.0027	.00003
	(.651)	(5.24)	(.073)
Y	-.001	.0003	-.0009
	(1.28)	(.212)	(.764)
L	-.0002	-.0003	.0002
	(1.02)	(.918)	(.713)
Pr	1.51	-6.37	-3.98
	(.965)	(2.35)	(1.85)

Source: Masson, Robert T., and Lawrence M. DeBrock, "The Structural Effects of State Regulation of Retail Fluid Milk Prices," The Review of Economics and Statistics 62 (May 1980): 258.

[a]Masson and DeBrock did not report their estimates for the intercept and regional dummy variables.

Table 2. Masson and DeBrock's Structural Estimates.

	Dependent Variables				
	M		N		C
R	5.99R (4.13)	R	4.08 (2.38)	P	.54 (2.50)
D	.919 (.539)	D	2.32 (1.04)	Y	-.0014 (1.29)
N	-.247 (1.37)	Q	.00005 (5.41)	E1	22.3 (7.15)
Q	.0001 (.959)	L	.0001 (.294)	E2	13.78 (5.68)
Pr	-.205 (.202)	Int	7.24 (6.47)	E3	5.14 (1.84)
Int*	27.54 (3.54)			E4	1.59 (.529)
				E5	9.90 (3.46)
				E6	3.66 (1.31)
				E7	3.97 (1.51)
				E8	5.88 (1.68)
				Int	77.29 (5.54)

Source: Robert T. Masson and Lawrence M. DeBrock, "The Structural Effects of State Regulation of Retail Fluid Milk Prices," The Review of Economics and Statistics 62 (May, 1980):259.

*Int denotes intercept.

which indicate price controls do not have an impact as large or as significant as Masson and DeBrock's estimate implies.

Needy's Empirical Results

Upon careful examination Needy found several errors in Masson and DeBrock's data set. Needy noticed errors in Masson and DeBrock's numbers for the price of raw milk (PR) for several markets. Originally, the margin data used by Masson and DeBrock had been estimated by Manchester. Manchester had taken the consumer price (P) and subtracted from it the price of raw milk (PR) to get the margin numbers. Masson and DeBrock, not knowing the PR data was available from Manchester, used the Fluid Milk and Cream Report to get the PR data.[4] However, this source has several gaps in it which Manchester had been able to fill. Masson and DeBrock's estimates for the missing PR number were not equal Manchester's. As a result, when Masson and DeBrock added their PR and M data, they did not get the original price Manchester had used to determine the margin numbers in the first place. This meant Masson and DeBrock's M and PR numbers were incompatible. Needy avoided this problem by obtaining the correct PR data from Manchester.

In addition to using incompatible data, Needy discovered that Masson and DeBrock accidentally dropped nine of the possible 80 observations that could have been used. Masson and DeBrock also dropped the observations for two North Dakota markets. They believed that since North Dakota had been regulated for only 21 months when the observations were made, not enough time had elapsed for regulation to affect the market. Needy argues that it is not clear that 21 months is insufficient time for markets to adjust to regulation. Therefore, he examines the effects of adding the North Dakota observations to the data set. Needy also added the observation on the single Maine market which Masson and DeBrock had missed.

Finally, Needy claims that Masson and DeBrock misclassified four New Jersey markets by categorizing them as deregulated markets. Needy argues that these markets should be classified as regulated markets.[5]

After making the above changes to the data set, Needy re-estimated Masson and DeBrock's system of equations. His results for the reduced form and structural equations are in Tables 3 and 4, respectively. Examining the reduced form margin equation reveals that regulation still has a positive and significant (1% level) effect on the margin. The estimated coefficient of 3.71 is 1.48¢ per half gallon less than Masson and DeBrock's estimate. Needy determined that regulation results in a 15 percent increase in the margin and an approximate 7 percent increase in price.

In the reduced form plant equation the regulation coefficient is positive but not significant. The coefficient (2.95) is less than half the estimate obtained by Masson and DeBrock. The estimates in Table 2 were obtained by including the North Dakota observations. Needy reported that when these two markets were dropped, the coefficient on R was 4.7 and significant at the 1 percent level.[6] This indicates that the estimate for the regulation variable in the reduced form plant equation is sensitive to the classification of North Dakota. This sensitivity suggests that a closer look should be taken at the equation system and data set.

Table 3. Needy's Reduced Form Estimates.[a]

	Dependent Variables		
	M	N	C
R	3.71	2.95	-3.09
	(3.17)	(1.58)	(1.98)
D	1.47	.44	-3.48
	(.654)	(.12)	(1.16)
POP	.0005	.0028	-.00006
	(1.73)	(4.65)	(1.50)
Y	-.0018	.00003	-.0011
	(1.84)	(.02)	(.825)
L	-.00001	.00036	.00004
	(.071)	(3.13)	(.410)
Pr	-.500	-.114	-.357
	(2.10)	(.30)	(1.13)

Source: Charles Needy, "The Structural Effects of State Regulation of Retail Fluid Milk Prices: A Comment," The Review of Economics and Statistics 64 (August 1982): 523.

[a]Needy did not report his estimates for the intercept and regional dummy variables.

Table 4. Needy's Structural Estimates.

	Dependent Variables				
	M		N		C
R	4.63	R	2.53	P	-.68
	(4.21)		(1.92)		(2.15)
D	3.06	D	.12	Y	.0018
	(1.39)		(.14)		(1.41)
N	-.308	Q	.00005	E1	21.05
	(1.89)		(6.02)		(6.51)
Q	.00001	L	.0003	E2	13.58
	(1.39)		(2.50)		(5.16)
Pr	-.137	Int	6.96	E3	3.14
	(.92)		(8.32)		(.86)
Int	30.44			E4	.78
					(.21)
				E5	9.51
					(3.19)
				E6	3.28
					(1.10)
				E7	4.90
					(1.75)
				E8	.44
					(.14)
				Int	86.81
					(4.18)

Source: Needy, Charles, "The Structural Effect of State Regulation of Retail Fluid Milk Prices: A Comment," The Review of Economics and Statistics 64 (August 1982):523.

Structural Versus Reduced Form Estimates

Up to now the discussion regarding Masson and DeBrock and Needy's empirical results has centered on the reduced form equation estimates. The structural estimates, although reported, have been ignored in the discussion. Because this study attempts to estimate the entire effect of resale price controls on the number of firms in a market, the discussion has focused on the reduced form estimates. The reduced form estimates are the appropriate estimates to examine because they measure the total impact of a change in an exogenous variable. Goldberger (1964) has described reduced form coefficients as measuring the total effect on the dependent variable due to a change in an exogenous variable. Reduced form estimates measure the total impact because the effect is determined "after taking account of the interdependencies among the current endogenous variables . . ."[7] Goldberger goes on to say that "a structural coefficient indicates only a direct effect within a single sector of the economy. It is clear that economic hypotheses often refer to reduced form, rather than structural coefficients . . ."[8]

Using Goldberger's argument, this study will focus on the reduced form estimates. This does not imply that the structural estimates are considered unimportant. Structural estimates do provide information. However, for the purposes of this inquiry, the information provided by the reduced form estimates is more useful than the information given by the structural estimates. For the remainder of the discussion on Masson and DeBrock's system of equations, structural estimates are reported but only the reduced form coefficients will be discussed.

Results of Revising Needy's Data Set

Because Needy's changes to Masson and DeBrock's data resulted in substantially different estimates for some coefficients, a careful examination of the data set seemed appropriate. An examination of Needy's data set revealed several errors. For example, for the Minneapolis and St. Paul observations, the combined land area of the two markets was used for each individual observation. The number was not broken into its component parts. Similar errors were found in other observations.[9] It was also noticed that the figures for land area, per capita income, and population differed from the numbers available from the 1970 Census Report. As a result, the numbers for land area, 1969 per capita income and population were replaced with the numbers from the Census Report. In addition, the data on the margin and/or raw milk price was corrected for six markets using data from the 1981 addendum to Manchester's 1974 supplement.[10] Furthermore, both North Dakota observations were included and denoted as regulated markets. Also, the New Jersey markets were categorized as regulated markets.[11]

Table 5 has the estimates of the reduced form equations of Masson and DeBrock's system of equations after the above revisions are made to the data set (structural estimates are in Table 6).[12] The reduced form margin equation shows regulation has a positive and significant (1% level) effect on the margin. The coefficient implies that regulation raises the margin by approximately 3.5¢ per half gallon. This is smaller than Masson and DeBrock's estimate of 5.19¢ and Needy's estimate

Table 5. Reduced Form Estimates.

	Dependent Variables		
	M	N	C
R	3.458	2.58	-2.835
	(2.817)	(1.263)	(-1.717)
D	1.421	1.734	-3.305
	(.635)	(.465)	(-1.099)
POP	.38E-06	.154 E-05	-.9051 E-07
	(1.437)	(3.491)	(-.255)
Y	-.00205	.577 E-03	-.365 E-03
	(-1.838)	(.310)	(-.243)
L	-.170 E-04	.364 E-03	.189 E-04
	(-.214)	(2.746)	(.177)
PR	-.372	-.301	-.424
	(-1.430)	(-.694)	(1.212)
E1	-5.988	-.897	25.872
	(-2.231)	(-.200)	(7.165)
E2	-4.979	.658	17.201
	(-2.071)	(.164)	(5.319)
E3	-6.347	-.6305	7.574
	(-3.100)	(-.185)	(2.750)
E4	-6.280	-2.908	5.188
	(-2.801)	(-.778)	(1.721)
E5	-1.105	-2.401	11.313
	(-.4515)	(-.5885)	(3.382)
E6	-3.546	-6.545	5.898
	(-1.508)	(-1.669)	(1.865)
E7	-2.759	-3.811	7.006
	(-1.102)	(-9126)	(2.08)
E8	-2.099	-5.593	2.230
	(-.836)	(-1.336)	(.661)
Int	45.704	16.35	55.26
	(5.636)	(1.209)	(5.066)
df	65	65	65
$\bar{R}^2$	.328	.3212	.555

Table 6. Structural Estimates.

		Dependent Variables			
	M		N		C
R	4.443	R	2.086	P	−.705
	(4.147)		(1.460)		(−2.153)
D	2.869	D	.762	E1	20.887
	(1.315)		(.230)		(6.329)
N	−2.90	Q	.330 E-07	E2	13.617
	(−1.780)		(4.514)		(5.107)
Q	.105 E-07	L	.00022	E3	3.117
	(1.334)		(1.863)		(.852)
PR	−.110	Int	7.812	E4	.689
	(−.716)		(9.221)		(.182)
Int	29.784	df	75	E5	9.769
	(5.919)	$\bar{R}^2$	.2416		
df	74			E6	3.489
					(1.142)
$\bar{R}^2$	.151			E7	5.274
					(1.865)
				E8	.685
					(.211)
				df	69
				$\bar{R}^2$	.575

of 3.7¢. The estimate of 3.5¢ implies regulation raises margins by about 14 percent and prices by 6.5 percent.

The reduced form plant equation shows regulation has a positive effect on plants serving a market. The coefficient indicates regulation increases the number of plants serving a market by about 2.6 plants. This number is slightly smaller than Needy's estimate of 2.95. However, the estimate of 2.95 plants is not significant (Needy's estimate was also not significant).

Although the coefficient on R is positive it does not imply that if regulation is suddenly imposed that new plants quickly enter the market. Instead of bringing new plants into a market regulation might affect the number of plants in a market by reducing the rate of exit among processing plants. In Table 7 the total number of fluid milk plants and the percentage changes in the number of plants is reported for various years. The observations in Table 7 indicate a general downward trend in the number of plants over time. It is possible that regulation protects plants from the processes that are generating the downward trend. Therefore, when empirical estimates show R has a positive coefficient it does not imply that regulation causes new plants to enter the market. Regulated markets may have more plants because the rate of exit in these markets is less than the rate of exist in unregulated markets.

Table 7. Number of U.S. Fluid Milk Plants.

Year	Total	Decrease from Preceding Reported Year
1950	8,195	--
1955	6,726	18
1960	5,328	21
1965	3,743	30
1970	2,216	41
1975	1,408	36
1979	1,135	19

Source: U.S. Department of Agriculture. Economics and Statistics Service. Fluid Milk Processing Market Structure, by Harold W. Lough. Staff Report. Washington, D.C., April 1981, p. 3.

Second Degree Approximation to Reduced Forms

All the estimates discussed so far have been obtained by using linear approximations to the nonlinear reduced form equations. Tables 8 and 9 have the results of using a different estimation technique. This new procedure involved using a second degree polynomial as an

Table 8. Reduced Form Estimates, Second Degree Polynomial.

	Dependent Variables		
	M	N	C
R	3.492	.0087	-1.620
	(2.772)	(.0048)	(-.966)
D	2.541	.855	-2.99
	(1.174)	(.273)	(-1.04)
POP	.22 E-05	.535 E-04	.217 E-04
	(.181)	(3.044)	(1.34)
Y	-.030)	-.0069)	-.0385)
	(-2.084)	(-.338)	(-2.04)
L	.0034	-.011	-.0048
	(.741)	(-1.586)	(-.773)
Pr	-1.888	1.398	-2.155
	(.457)	(.234)	(-3.917)
E1	-8.262	1.479	29.194
	(-2.792)	(.345)	(7.409)
E2	-7.906	3.542	18.634
	(-3.086)	(.955)	(5.463)
E3	-7.921	-2.369	9.553
	-3.418	(-.7064)	(3.096)
E4	-7.863	-2.840	6.349
	(-3.119)	(-.779)	(1.891)
E5	-3.575	-4.256	12.488
	(-1.362)	(-1.12)	(3.572)
E6	-5.781	-7.639	8.111
	(-2.226)	(-2.033)	(2.346)
E7	-3.041	-6.160	11.401
	(-1.065)	(-1.505)	(3.027)
E8	-3.487	-4.421	2.543
	(-1.378)	(-1.208)	(.755)
POP^2	-.14 E-13	.17 E-12	.50 E-13
	(.089)	(.708)	(.231)
Y^2	-.50 E-06	.19 E-05	.98 E-06
	(-.367)	(1.020)	(.544)
L^2	-.54 E-07	.72 E-07	.15 E-06
	(-1.155)	(1.076)	(2.369)
Pr^2	-.033	-.017	-.019
	(-.547)	(-.192)	(-.240)
POP•Y	.70 E-10	-.74 E-08	-.20 E-08
	(.032)	(-2.304)	(-.680)
POP•PR	-.90 E-07	-.70 E-06	-.31 E-06
	(-.469)	(-2.547)	(1.217)
POP•L	.45 E-09	-.15 E-08	-.21 E-08
	(.842)	(1.977)	(2.928)

Table 8. (cont'd)

	Dependent Variables		
	M	N	C
Y•L	-.15 E-05	-.70 E-06	-.31 E-06
	(1.220)	(.673)	(1.708)
Y•PR	.0011	-.00024	.00094
	(2.47)	(-.382)	(1.609)
L•PR	.36 E-04	.00025	-.00011
	(.276)	(1.290)	(-.606)
Int	112.6	5.793	141.24
	(1.56)	(.055)	(1.477)
df	55	55	55
$\bar{R}^2$	.396	.541	.608

Table 9. Structural Estimates.

	Dependent Variables				
	M		N		C
R	4.077	R	2.118	P	-.319
	(4.141)		(1.477)		(-1.340)
D	2.633	D	.749	Y	-.00043
	(1.217)		(.225)		(-.321)
N	-.179	Q	.33 E-07	E1	21.87
	(-1.834)		(4.450)		(6.603)
Q	.56 E-08	L	.00023	E2	13.733
	(.945)		(1.883)		5.052
Pr	-.063	Int	7.814	E3	6.181
	(-.433)		(9.184)		(1.911)
Int	27.584	df	75	E4	3.735
	(6.342)	$\bar{R}^2$	.237		(1.102)
df	74			E5	9.816
					(3.203)
$\bar{R}^2$	.153			E6	4.073
					(1.316)
				E7	5.243
					(1.817)
				E8	.861
					(.260)
				Int	61.529
					(3.760)
				df	69
				$\bar{R}^2$	.558

approximation to the reduced forms.[13] The purpose of this procedure was to determine if the estimates were sensitive to the method used in estimating the reduced form equations.

In the reduced form margin equation, the coefficient on R is approximately 3.49 and is significant at the one percent level. This estimate is very close to the estimate obtained using a linear approximation to the reduced form equation, which was 3.46. The regulation coefficient in the reduced form plant equation shows a substantial decline compared to the figure in Table 3. Using the second degree polynomial for the reduced form has caused the regulation coefficient to drop to .0087.[14] This is the smallest estimated impact of regulation on plants serving a market yet reported. Such a small estimate indicates that regulation has a very small effect on plants serving a market. The t ratio is not significant.

Removing the Nonlinearity From the System of Equations

One technique of dealing with the nonlinearity in the Masson - DeBrock system involves rewriting the demand equation to get rid of C. Because the nonlinearity in the system results from the identity $Q = C * POP$. The removal of C from the demand equation frees the system of the nonlinear problem. Changing the demand equation to:

$$Q = \gamma_o + \gamma_1 P + \gamma_2 TY + \gamma_3 E1 + \ldots + \gamma_{10} E8 + \varepsilon_1,$$

where TY is the total income, results in a system which is linear in the variables for the reduced form equations. Since the intent of this analysis is to examine the effects of resale price controls on the number of fluid milk plants the exact form of the demand equation is not instrumental to the study.[15] Therefore, the system of equations was re-estimated using the new demand relationship and the same margin and plant equations. The resulting estimates for the reduced form and structural equations are in Tables 10 and 11 respectively.

The reduced formed estimates for the margin equation show regulation still has a positive and significant (1% level) effect on the margin. The coefficient implies that regulation raises the margin by 4.4¢ per half gallon.

The coefficients on R in the reduced form plant equation is positive and indicates that regulation increases the number of plants serving a market by 2.36 plants. The estimate, however, is not significant.

The Effects of Potential Competition on the Masson - DeBrock Model

So far the only change made to the structure of the system has been to alter the demand equation so that the nonlinearity in the system was removed. Next, the effects of adding a new variable to the system will be discussed. The variable is PC, Manchester's measure of potential competition. The potential competition variable will be added to the modified version of Masson and DeBrock's system where the demand equation has been altered to remove the problem of nonlinearity in the reduced forms.

For most of the markets in the NEM-40 study, Manchester (1974) has constructed what he calls a potential competition (PC) variable. This variable is intended to measure the number of firms that could possibly compete in a given market. It includes all plants within 50 miles of

Table 10. Reduced Form Estimates For Linear Model.

	Dependent Variables		
	M	N	C
R	4.14 (3.854)	2.364 (1.252)	.20 E+.07 (.754)
D	1.656 (.729)	1.631 (.435)	-.56 E+06 (-.105)
Pr	-.422 (1.606)	-.262 (-.604)	.17 E+06 (.273)
TY	.60676 E-10 (.913)	.384 E-09 (3.508)	.014 (90.217)
L	.223 E-04 (.295)	.392 E-03 (3.072)	656.75 (3.635)
E1	-5.828 (-2.135)	-1.021 (-2.27)	.93 E+07 (1.467)
E2	-5.265 (-2.154)	.821 (.204)	.11 E+08 (1.960)
E3	-5.973 (-2.881)	-.583 (-.171)	.82 E+07 (1.698)
E4	-5.97 (-2.625)	-2.859 (-.762)	.61 E+07 (1.156)
E5	.016 (.007)	-2.583 (.649)	.11 E+08 (1.932)
E6	-2.618 (-1.12)	-6.769 (-1.756)	.90 E+07 (1.647)
E7	-1.291 (-.533)	-4.192 (-1.05)	.84 E+07 (1.490)
E8	-1.505 (-.594)	-5.835 (-1.397)	.58 E+07 (.973)
Int	40.051 (5.244)	17.271 (1.371)	-.13 E+08 (-.712)
df	66	66	66
$\bar{R}^2$	.304	.313	.997

Table 11. Structural Estimates For Linear Model.

	Dependent Variables				
	M		N		C
R	4.342	R	2.114	P	.11 E+07
	(4.044)		(1.477)		(1.898)
D	2.778	D	.720	TY	.014
	(1.271)		(.217)		(90.447)
N	-.260	Q	.33 E-07	E1	.11 E+08
	(-1.610)		(4.481)		(1.738)
Q	.88 E-08	L	.00023	E2	.12 E+08
	(1.140)		(1.881)		(2.319)
Pr	-.095	Int	7.805	E3	.15 E+08
	(-.619)		(9.185)		(2.255)
Int	29.148	df	75	E4	.13 E+08
	(5.811)				(1.941)
df	74	$\bar{R}^2$	.239	E5	.84 E+07
					(1.471)
$\bar{R}^2$	.145			E6	.13 E+08
					(2.339)
				E7	.68 E+07
					(1.28)
				E8	.71 E+07
					(.99)
				Int	-.66 E+08
					(-2.066)
				df	69
				$\bar{R}^2$	.992

the market center (for firms with more than one plant only the largest plant was counted). Plants located 50 to 250 miles from the market center were included if they had sales of at least one million pounds per month. Because these distant plants experience greater transportation costs they are at a disadvantage in competing for sales. To account for this Manchester reduced the sales of these plants by a factor proportionate to the transportation cost. This method decreased "the market power of distant plants proportionate to the cost of moving the milk from the plant to the market and the volume."[16]

Manchester's PC variable was added to the system because Masson and DeBrock's equation did not account for the possible effects on the market process by plants that could possibly serve the market. Consequently, the PC variable was added to both the plant and margin equations. It was expected that PC would have a negative sign in the margin equation. This expectation was based on the argument that a more competitive environment would have a negative impact on a firm's margin.[17] PC was anticipated to have a positive sign in the plant equation. As the number of potential competitors increased, it was conjectured that some of the plants would actually serve the market.

The results of including PC as an exogenous variable in the system are shown in Tables 12 and 13. The reduced form estimates (Table 12) for the margin equation reveal PC to have a negative sign, as expected. However, the estimate is not significant. R remains positive and significant (1% level) with an estimated coefficient of 4.38 in the margin equation.

In the reduced form plant equation, PC is positive and significant at the one percent level. This implies that potential competition does lead to an increase in the number of firms serving a market. Also, R is positive with an estimate of 3.9. This suggests that regulation causes almost four additional plants to serve a market. The estimate for R is significant at the five percent level. This is the first time R has been reported as having a significant impact on the number of plants serving a market since Masson - DeBrock's results were examined. The previous regressions did not include PC in the equation system. Yet, the estimates in Table 12 indicate that when PC is added to the system,

Table 12. Reduced Form Estimates With Potential Competition.

	Dependent Variables		
	M	N	Q
R	4.383 (3.572)	3.918 (2.153)	.24 E+07 (.855)
PC	-.0067 (-.304)	.124 (3.792)	14054 (.278)
D	1.189 (.443)	8.177 (2.056)	-.41 E+06 (-.067)
Pr	-.384 (1.323)	-.677 (-1.574)	.21 E+06 (.318)
TY	.70 E-10 (.968)	.30 E-09 (2.839)	.014 (84.772)
L	-.64 E-04 (-.207)	.00079 (1.178)	-368.82 (-.51993)
E1	-5.337 (1.473)	-10.89 (-2.026)	.56 E+07 (.670)
E2	-4.756 (-1.316)	-12.753 (-2.379)	.69 E+07 (.832)
E3	-5.687 (-2.246)	-7.274 (-1.937)	.58 E+07 (.999)
E4	-5.882 (-2.464)	-4.994 (-1.410)	.50 E+07 (.918)
E5	.254 (.091)	-8.896 (2.137)	.83 E+07 (1.284)
E6	-2.645 (-1.040)	-9.403 (-2.494)	.63 E+07 (1.083)
E7	-1.537 (-.602)	-2.335 (-.617)	.71 E+07 (1.207)
E8	-1.545 (-.595)	-5.296 (-1.374)	.61 E+07 (1.015)
Int	39.318 (4.742)	26.078 (2.121)	-.11 E+08 (-.586)
df	63	63	63
$\bar{R}^2$	.278	.398	.993

Table 13. Structural Estimates With Potential Competition.

	Dependent Variables				
	M		N		Q
R	4.09 (4.07)	R	.842 (.604)	P	.42 E+06 (.753)
PC	-.0295 (-2.170)	PC	.0613 (4.003)	TY	.014 (98.537)
D	1.781 (.822)	D	1.914 (.61825)	E1	.98 E+07 (1.588)
N	.0397 (.218)	Q	.18 E-07 (2.334)	E2	.12 E+08 (2.518)
Q	.25 E-08 (.36418)	L	.00088 (1.939)	E3	.97 E+07 (1.597)
PR	.0746 (.454)	Int	4.067 (2.919)	E4	.82 E+07 (1.321)
Int	23.295 (4.443)	df	72	E5	.92 E+07 (1.749)
df	71	$\bar{R}^2$	.330	E6	.86 E+07 (1.656)
$\bar{R}^2$	.193			E7	.80 E+07 (1.628)
				E8	.67 E+07 (1.178)
				Int	-.30 E+08 (.993)
				df	67
				$\bar{R}^2$	.993

the estimated coefficient on regulation differs significantly from zero. However, it is possible that PC could have different effects in regulated and non-regulated markets. To allow for this possibility a new variable, PCR, which is PC multiplied by R, was added to the margin and plant structural equations. With PCR in the system the reduced form plant equation estimate for R is negative and not significant. Also, the coefficient on D in the reduced form plant equation, which is significant in Table 12, is not significant with PCR in the system. PC remains positive and significant in the reduced form plant equation as is PCR. The addition of PCR does not change the estimates for the reduced form margin equation substantially. As an additional sensitivity test the data set was broken into two sets. One set contained only regulated markets, the other set contained non-regulated markets. The number of plants for each data set was regressed on TY, L, PR, PC, and the regional dummy variables. For the unregulated markets PC was positive but not significant. In the regulated markets PC was positive and significant at the five percent level. TY was positive and significant at the one percent level in non-regulated markets but not significant in the unregulated markets. Furthermore, the signs and size of the regional dummy variables differed between the two sets.

The results obtained by adding PCR and breaking the data set up suggest that the model is sensitive to the way the data is handled. Although the estimates for the margin equation (reduced form) appear to be stable, the plant equation (reduced form) estimates are not. This indicates all previous estimates for the reduced form plant equation are fragile and must be treated accordingly.

Summary of Results from the Masson - DeBrock Model

In the previous results, regulation has consistently been estimated as being positive and significant in the reduced form margin equation, regardless of the estimation technique or the form of the equations. However, the regulation variable in the plant equation has not had such consistent estimates. Generally, the estimated regulation coefficient was not significant at the one percent or five percent levels. But when PC was added to the system, regulation was significant in the plant equation. However, additional tests revealed that the plant estimates are not robust. Although regulation was not frequently significant in the plant equation, the coefficient was always positive. This indicates a possible tendency for regulation to increase the number of plants, but the effect seems to be slight. The next section will continue to examine the influence of resale price controls on the number of plants by estimating a new plant equation.

Single Plant Equation

As mentioned before, all of the previous regression results are based on the plant numbers obtained from Shaw. These observations represent the number of plants serving a market, but they are not the number of plants physically located in the market. Therefore, any estimates which show R to significantly increase N must be interpreted as meaning R increases the number of plants serving a market. It does not imply that regulation has increased the number of firms physically located in the market. To determine if regulation actually increases the number of plants physically located in a market the rest of this chapter focuses on estimating a new equation. The new equation examines the effects of resale price controls on the number of fluid milk plants in regulated states. This approach is different from the preceding analysis in three ways. First, it only considers states, not individual markets. This leads to the second difference, the new data set contains observations on the number of plants physically located in each state. Because states are the geographic areas which are regulated under price controls, to determine if controls increase the number of plants state data should be used. Compared to the Shaw data, observations on the number of plants located in each state provide a more direct test for determining the effects of regulation on the number of plants. Finally, this new approach is based on estimating a single equation. No attempt is made to develop a new system of equations.

The new plant equation is

$$N = \Theta_o + \Theta_1 \text{ FLPROD} + \Theta_2\text{POP} + \Theta_3 R + \varepsilon \qquad (7)$$

In equation (7) N is the number of fluid milk plants in a state. FLPROD is the amount of fluid milk (in millions of pounds) produced by a state. POP is state population, and R is a dummy variable for retail price control. There is at least one variable missing from equation (7). The equation does not account for geographic characteristics of a state such as population dispersion. If the population of a state is primarily located in one region, instead of being evenly dispersed throughout the state, the number of plants could be affected.

Data

The observations on the number of fluid milk plants per state were obtained from the USDA through Harold Lough and A. C. Manchester (see Appendix, Table 19). This data set contains the number of commercially operated fluid milk plants per state for the years 1948, 1967, 1971, and 1980. Population figures came from Census Bureau estimates.[18] Milk production numbers were obtained from the USDA.[19]

Plant Equation Estimates

The estimates of the plant equation (7) are shown in Table 14. (For 1948 data was not available for determining the production of fluid milk per state. As an approximation to FLPROD the total production of raw milk per state was used.) In Table 14, the estimated regulation coefficient is positive for each year. The estimates imply that price controls act to increase the number of plants physically located in a state. However, the estimate for the R coefficient is significant (5% level) only for 1980. The 1980 estimate suggests that price controls caused nine more plants to be located in regulated states.

Table 14. Estimates for Plant Equation.

	1948	1964	1971	1980
R	22.518 (.639)	18.650 (1.254)	12.717 (1.691)	9.320 (2.136)
FLPROD	.0056 (.796)	.033 (3.605)	.216 E-04 (.096)	-.684 E-05 (-.110)
POP	.045 (7.108)	.0095 (2.761)	.0097 (12.684)	.0042 (13.846)
Intercept	22.277 (.907)	-.187 (-.0188)	-1.370 (-.269)	1.183 (.569)
Degrees of Freedom	44	46	44	46
$\bar{R}^2$	.649	.770	.778	.796

An examination of the remaining variables shows that POP is positive and significant (1% level) for each year. FLPROD is positive for 1948, 1964, and 1971, but it is negative for 1980. Only the 1964 estimate of FLPROD is significant (1% level).

Adding Dummy Variables

Table 15 has the results of estimating the plant equation when dummy variables are added to the equation. The new dummy variables fall into two categories, ON and OFF. These dummy variables represent the number of years that have elapsed since a state has either gone on or off retail price controls. For example, setting the variable OFF2 equal to one indicates that a state has been off price controls for two years. Similarly, the dummy variable ON2 would be set equal to one for those states which have been on price controls for two years. The purpose of adding these variables to the plant equation was to provide additional information in determining the effects of price controls on the number of plants. If regulation increases the number of plants located in a state, the ON variables might be able to measure the increase in plants over time. Analogously, the OFF variables may detect the change in the plant numbers after a state has decontrolled milk prices.

The results in Table 15 show R is positive for all years. As in Table 14, R is only significant (5% level) for 1980. The only ON-OFF variable that is significant is OFF1 for 1948. The estimated coefficient of 445.6 is significant at the one percent level. However, such a large coefficient makes the estimate seem questionable.[20] The estimate suggests that one year after the deregulation of milk prices a

Table 15. Plant Equation Estimates with ON-OFF Variables.

	1948	1964	1971	1980
R	41.927 (1.477)	21.272 (1.368)	12.632 (1.554)	9.575 (2.128)
FLPROD	.011	.033	.201 E-04	-.912 E-05
POP	.040 (7.825)	.0096 (2.754)	.0096 (12.101)	.0043 (12.351)
ON2		-23.791 (-.478)		
ON4			2.840 (.113)	
OFF1	445.59 (5.091)		.5982 (.025)	9.115 (.872)
OFF2				1.337 (.128)
OFF3		34.768 (.7133)		
OFF4			2.0524 (.117)	-.904 (-.112)
Intercept	8.726 (.441)	-1.524 (-.148)	-1.5916 (.288)	.723 (.323)
Degrees of Freedom	43	44	41	43
$\bar{R}^2$	.776	.763	.761	.786

state has over 400 more plants than a state that has never gone off controls. With such a large and, therefore, dubious number, the result appears spurious.

Percentage Changes

The previous analysis has dealt with estimating the plant equation for four separate years. The estimates of these regressions aid in determining whether or not regulation increase or decrease the number of plants located in a state. But it was mentioned previously that regulation may affect plant numbers by reducing the rate of exit among fluid milk plants.[21]

In order to study this question more directly, the plant equation will be changed by expressing the independent variables (except for the dummy variable) in terms of percentage changes. By using percentage changes, the effect of regulation on the percentage change in plants can be estimated. A positive coefficient on R, in a percentage change model, signifies that regulation slows down the rate of exit of milk plants. If the coefficient is negative, then R increases the rate of exit (the percentage change in plant numbers is negative for each year in the data set).

There is also an advantage in using percentage changes in the plant equation. It was previously mentioned that the equation is missing at least one variable. By assuming the variable has not significantly changed over time, it can be argued that the percentage change for it is approximately zero. Consequently, if the plant equation is expressed in terms of percentage changes, the missing variable would drop out.

Percentage changes, therefore, offer a method of getting around the problem of having missing variables in the plant equation.

The results of using percentage changes to estimate the plant equation coefficients are in Table 16. Because calculating the percentage changes involved using sets of observations separated by several years, a problem exists in classifying the regulatory status of some states. Between 1948 and 1964, four states implemented price controls while three states dropped price controls. To avoid problems in categorizing such states, only those states that were always regulated or non-regulated during each time period were included in the data set.

Table 16. Percentage Change Model.

	48-64	64-71	71-80
R	.079 (1.307)	.016 (.273)	.053 (1.27)
PCFL	.15308 (1.450)	.209 E-04 (.012)	.978 E-03 (.187)
PCPOP	-.12038 (.906)	.98995 (2.286)	.587 (5.076)
Intercept	-.51068 (-10.519)	-.50317 (-11.064)	-.54 (-22.93)
$\bar{R}^2$	.035	.055	.377
Degrees of Freedom	35	39	38

For all three time periods in Table 16, the estimate for R is positive. This signifies that regulation has a positive impact on the percentage change in the number of plants. However, none of the estimates are significant. Also, the adjusted multiple correlation coefficient for all three regressions is low relative to previous models.

Table 17 reports the results of adding ON-OFF dummy variables to the percentage change model. The ON variable equaled one for states that began controlling prices during each time period. Similarly, OFF equaled one for states that dropped price controls. States that went on and then off controls during each period were excluded from the data set. In Table 17, R is positive for each year. However, none of the estimates are significant. The ON variable is positive for the two time periods it was used, but it is not significant. Except for 1971-1980, the OFF variable is negative. None of the OFF estimates are significant.

A Nonlinear Model

In addition to using the ON-OFF variables to determine the effect of going on or off price controls, the following nonlinear model was estimated,

$$N = \Theta + \Theta_1 PROD + \Theta_2 POP + \Theta_3(1-e^{\Theta_4 t^*})e^{\Theta_5 \hat{t}} + \varepsilon \qquad (8)$$

This is basically the same equation as (7) except that R has been replaced by a nonlinear term.[22] In the nonlinear term, t* represents the number of years a state has been regulated and $\hat{t}$ is the number of years a state has been deregulated. If a state has never been regulated, t* equals zero and the entire term equals zero. In this form Θ_4 and Θ_5 can be viewed as rates of growth and decay, respectively. If

Table 17. Percentage Changes with ON-OFF Variables.

	48-64	64-71	71-80
R	.076 (1.3163)	.015 (.260)	.052 (1.223)
PCFL	.202 (2.605)	-.21 E-04 (.012)	.002 (.715)
PCPOP	-.100 (-1.152)	.969 (2.273)	.559 (4.781)
ON	.089 (1.069)	.046 (.360)	
OFF	-.012 (-.123)	-.088 (-.858)	.064 1.355
Intercept	-.518 (-13.717)	-.502 (-10.950)	-.535 (-22.590)
df	40	42	43
$\bar{R}^2$	.101	.024	.321

Θ_4 is small in absolute terms (Θ_4 and Θ_5 are expected to be negative) then the impact of regulation builds up over time. A large number indicates regulation affects the number of plants quickly. Similarly, the larger Θ_5 is (in absolute value) the faster the number of plants responds to deregulation.

Table 18 contains the results of estimating equation (8). Unfortunately, the sign of Θ_4 was never estimated to be negative, and the sign of Θ_5 is negative only for 1948 and 1964. The coefficients Θ_4 and Θ_5 were not significant for any of the four years. These results may reflect the sensitivity of the specification in equation (8) to the data. It is possible that if the effects of regulation are not distinct in the data the specification is unable to detect them.

Table 18. Nonlinear Model Estimates.

	1948	1964	1971	1980
PROD	.0058 (.852)	.0069 (2.788)	.0026 (2.448)	.0006 (1.536)
POP	.0424 (6.628)	.0162 (7.629)	.0084 (10.293)	.004 (11.693)
Θ_3	88.566 (.446)	42.478 (2.002)	.27 E+05 (.00025)	.87 E+05 (.73 E-04)
Θ_4	.135 (.144)	.1104 (438)	.27 E-04 (.00025)	.47 E-05 (.73 E-04)
Θ_5	-.055 (-.194)	-.22 E-10 (-.36 E-09)	1.012 (.17774)	.992 (.770)
Intercept	6.107 (.250)	-12.482 (-1.101)	-2.997 (.679)	.278 (.144)
df	42	44	44	44
$\bar{R}^2$	.665	.755	.823	.830

Summary of Plant Equation Estimates

When the plant equation was estimated using levels, the regulation coefficient was positive for each year. The coefficient, however, was only significant for 1980. Except for a questionable OFF1 estimate for 1948, the ON-OFF variables were not significant. In the percentage change plant equation, the estimated R coefficients were positive but not significant. The ON-OFF variables in the percentage change model were also not significant. Finally, the estimates for measuring the effects of regulation over time in the nonlinear model were not significant.

Footnotes

[1]Johnson, p. 3.

[2]The margin is the difference between the raw milk price and the retail price of milk.

[3]Masson and DeBrock, p. 259.

[4]Charles Needy, "The Structural Effects of State Regulation of Retail Fluid Milk Prices: A Comment," The Review of Economics and Statistics, 64 (August 1982):531-532.

[5]Ibid., pp. 530-531.

[6]Needy uses a one tailed statistical test.

[7]Arthur S. Goldberger, Econometric Theory (New York: John Wiley & Sons, Inc., 1964), p. 369.

[8]Ibid.

[9]The other observations are Manchester, N.H.; Alton, Ils.; Camden, N.J.; New York, N.Y.; and Superior, Wis.

[10]The six markets are Burlington, Vt.; Beloit, Wis.; Green Bay, Wis.; Springfield, Mo.; Springfield, Ill.; and Lubbock, Tex. The data was obtained from U.S., Department of Agriculture, Economics and Statistics Service, "Additions and Corrections to Supplement to Market Structure, Institutions and Performance in the Fluid Milk Industry," (Washington, D.C., March 1981).

[11]For the arguments for and against classifying New Jersey as regulated, refer to Masson and DeBrock, "The Structural Effects of State Regulation of Retail Fluid Milk Prices," p. 257, Needy, pp. 530-531, and Charles Masson and Lawrence DeBrock, "The Structural Effects of State Regulation of Retail Fluid Milk Prices: A Reply," The Review of Economics and Statistics 64 (August 1982):535-536.

[12]Of the 83 markets listed by Shaw, 80 were used in estimating the Masson-DeBrock model. The three markets dropped are Northern, New Jersey, Akron, Ohio; and Canton, Ohio.

[13]Cross products involving the dummy variables were not used in the second degree polynomial.

[14]When Mississippi was accidently dropped from the data set, the sign on the regulation coefficient was negative, but the estimate was not significant.

[15]The exact form of the demand equation is not instrumental as long as no new exogenous variables enter the system.

[16]U.S., Department of Agriculture, Economic Research Service, "Market Structure, Institutions, and Performance in the Fluid MIlk Industry," by Alden C. Manchester, Agricultural Economic Report No. 248 (Washington, D.C., January 1974), p. 9.

[17]Potential competition would not have a negative impact on regulated markets since the producer and retail prices are usually regulated together. A separate regression was run where PC was dummied for regulated markets. The estimates did not change appreciable.

[18]Masson and DeBrock, "The structural Effects of State Regulation," 1980, p. 255.

[19]The population data was obtained from the U.S., Department of Commerce, Bureau of the Census, Current Population Reports, for May 1953, June 1971, February 1980, and April 1982.

[20]The amount of fluid milk produced per state was approximated by subtracting the whole milk equivalent used in manufactured dairy products from the amount of raw milk produced per state. Figures on the production of raw milk came from U.S., Department of Agriculture, Agricultural Statistics, 1950, 1966, 1973. The 1980 statistics came from U.S., Department of Agriculture, Statistical Reporting Service, Milk. The adjustment figure for 1980 and 1971 came from U.S., Department of Agriculture, Economics and Statistics Service, Dairy Products Annual Summary. The figures for 1964 came from U.S. Department of Agriculture, Statistical Reporting Service, Production of Manufactured Dairy Products.

[21]For 1948 Massachusetts was the only observation for OFFI.

[22]See footnote 5 in Chapter 1.

[23]FLPROD is not used in equation (8), instead the variable PROD is used. PROD is the total amount of raw milk produced per state.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The topic of this thesis concerned the effects of retail price controls on the number of firms in a market. In an attempt to empirically determine the influence of price controls on the number of plants, the fluid milk industry was examined.

Chapter 2 discussed several theoretical models which pertained to this topic. The consensus of these studies was that retail price controls would result in more and smaller firms. Koutsoyiannis's model, which considered the possibility of firms competing along non-price margins, reached the same conclusion.

However, Chapter 3 presented a new model for resale price controls which also considered non-price competition and its effects on the costs of a firm. This model indicated that without more information regarding a firm's cost function, the effects of retail price controls are indeterminate. Using this model, it is possible to argue that retail price controls can result in the same number and size of firms, fewer and larger firms, or more and smaller firms. But without additional information or more constraining assumptions, it is not possible to predict which of these outcomes will result under resale price controls.

The empirical results of previous studies and the results of this study were presented in Chapter 4. The work of Masson and DeBrock (1980) indicated regulation was binding, i.e. it acted to increase the price in regulated markets. Furthermore, their results showed regulation had a positive and significant impact on the number of plants serving a market. This result supports those arguments which claim price regulation leads to more plants. Needy's (1982) estimates, while reinforcing the conclusion that regulation increased price, did not show regulation to have a significant influence on the number of plants serving a market. When the system of equations used by Masson and DeBrock and Needy was estimated with new observations on some of the independent variables, regulation again failed to have a significant effect on the number of plants serving a market. However, when Manchester's potential competition variable was added to the system regulation had a positive and significant effect on the number of plants serving a market. But additional testing revealed that the estimates obtained for the plant equation were not stable.

The results of estimating the single plant equation suggested in this study indicate that retail price controls on fluid milk, as a rule, did not significantly affect the number of fluid milk plants. Using the Manchester-Lough data, regulation was only significant for 1980. The plant equation was then estimated using percentage changes to measure the impact of regulation on the decline in the number of fluid milk plants. Although all of the regulation estimates were positive, none were significant.

Based on these estimates, it seems appropriate to conclude that retail price regulation has not significantly increased the number of fluid milk plants. If there has been some impact on the number of plants by price regulation, the effect may be too small to measure.

Although the estimated regulation coefficients were positive, they were usually not significant. These estimates suggest that the evidence offered by previous studies, which argued price controls cause more and smaller firms, is not very strong. The percentage change model indicated that regulation tends to slow down the decline in fluid milk plants but again, the estimates were not significant. The introduction to this thesis mentioned that keeping processors in business was one way fluid milk price controls were to stabilize the industry. The results of this study indicate that price controls have not been effective in achieving this goal.

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APPENDIX

APPENDIX

Table 19. Plant Numbers.

	1948	1964	1971	1980
Alabama	84*	30*	25*	19
Alaska	2	4	3	2
Arizona	84	16	10	8
Arkansas	78	27	15	11
California	359*	296*	220*	98
Colorado	120	53	27	20
Connecticut	174	92	38	15
Delaware	28	12	6	3
Florida	70*	54	42	24
Georgia	125*	67*	28	20
Hawaii	4	7	6	5
Idaho	31	26	16	10
Illinois	360	140	74	32
Indiana	283	82	43	23
Iowa	285	103	39	19
Kansas	142	56	35	15
Kentucky	82	57	35	21
Louisiana	80	55*	38*	23
Maine	135*	78*	41*	22*
Maryland	83	31	25	11
Massachusetts	650	211	83	39
Michigan	409	174	60	29
Minnesota	258	121	53	20
Mississippi	58	33*	21	14
Missouri	176	53	33	12
Montana	71*	36*	19*	12*
Nebraska	91	31	17	7
Nevada	18	8*	7*	6*
New Hampshire	165*	62*	26	11
New Jersey	317*	162*	39*	21*
New Mexico	20	14	10	7
New York	666	435	193	109
North Carolina	83	43	31	18
North Dakota	98	45	20*	10*
Ohio	552	216	109	53
Oklahoma	51	27	16	10
Oregon	102*	46	40	24
Pennsylvania	803*	476*	226*	87*
Rhode Island	166*	44	22	10
South Carolina	76	23	19*	11
South Dakota	99	28	8*	5
Tennessee	125	49	28	14
Texas	186	101	61	42

Table 19. Plant Numbers. (continued)

	1948	1964	1971	1980
Utah	38	20	22	10
Vermont	96*	46*	17*	12
Virginia	76*	50*	33*	17
Washington	155	52	34	23
West Virginia	58	38	17	9
Wisconsin	209	160	61	20
Wyoming	38	10	6	3

*denotes regulated states as classified by Johnson (1983).