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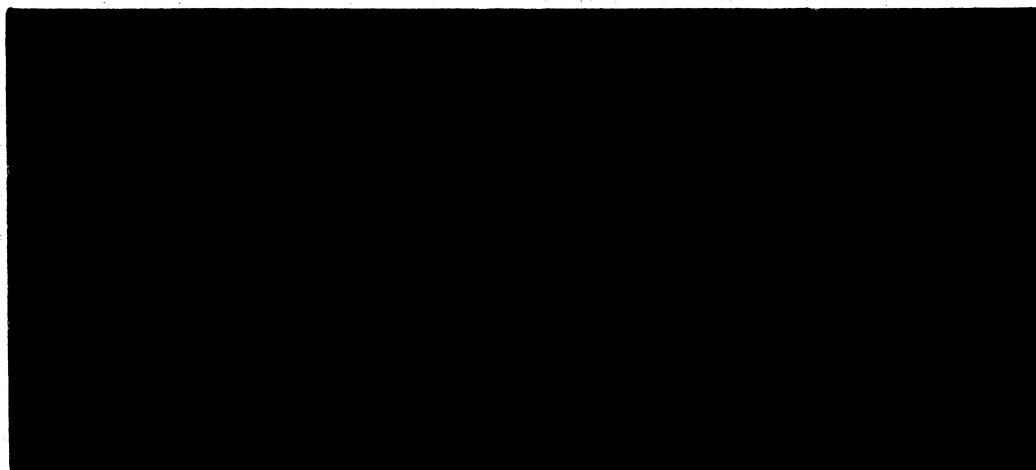
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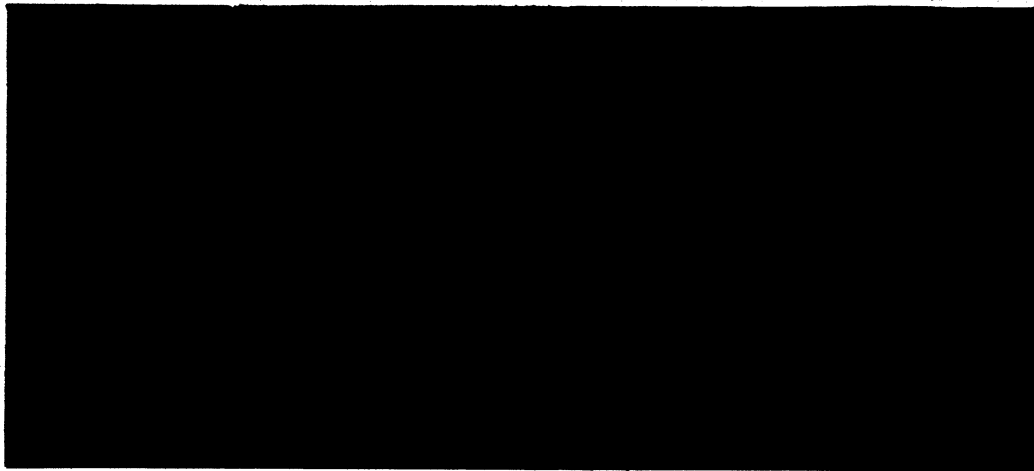
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REGULATION IN A DYNAMIC MARKET: THE U. S. DAIRY INDUSTRY

by

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Regulation in a Dynamic Market: The U. S. Dairy Industry

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# Regulation in a Dynamic Market: The U. S. Dairy Industry

## I. Introduction

Most analyses of Federal dairy programs are completely static (Waugh, Gaumnitz and Reed, Kessel, Ippolito and Masson, Manchester, Buxton). This approach is important because it gives us an indication of the long-run equilibrium or static short-run costs of the government's intervention in the dairy market. However, this single equilibrium approach to measuring the costs and benefits of dairy price supports, marketing orders, import controls, and public storage of manufactured dairy products fails to address the question of the impact of the government's intervention on the dynamics of demand and supply for milk. The purpose of this paper is to analyze the welfare effects of the Federal dairy programs in a dynamic context.

The Federal government has been actively involved in the pricing of farm milk since 1933. Though the dairy program has undergone several changes in its fifty year history, there are basically two sides to the Federal intervention: (1) in grade A fresh fluid milk market areas (defined by demand considerations, not supply) where two-thirds of all dairy farmers supplying the area or the producers of two-thirds of all grade A milk sold to

handlers and processors in the area vote in Federal controls, minimum prices for milk sold f.o.b. at the farm gate are set by an appointed USDA market administrator according to the classified final use of the milk; and (2) in the manufactured milk products market the farm price level of raw grade B and surplus grade A milk is supported indirectly by Commodity Credit Commission (CCC) purchases of butter, cheese, and non-fat powdered milk at announced support prices, the maintenance and disposal of government stocks of these products, and restrictions on imports of most manufactured dairy products.

Opponents of the dairy program (Kessel, Ippolito and Masson, Masson and Eisenstat, Buxton) argue that the competitive nature of milk supply precludes the long-run enhancement of dairy farmers' incomes. Further, the income redistribution effects in the short-run are relatively large, costly in terms of static competitive price equilibrium welfare effects on consumer surplus, producer surplus, government costs, market distortions and resource misallocations between grade A and grade B milk production, and perhaps currently in the direction toward higher income classes and away from lower income classes. Whereas the income gains to farmers dissipate in the long-run, the costs of the program do not, resulting in a large social cost of the program relative to the competi-

tive norm.

Conversely, proponents of the program (Christ) argue that the inelastic demand and supply relations in the dairy sector lead to large inherent instabilities and the support system is necessary to maintain productive capacity and stabilize prices. Further, the seasonality of demand and supply over the year, with variations in demand out of harmony with variations in supply, coupled with the perishability of grade A fresh fluid milk requires greater returns to grade A producers to maintain a steady supply of grade A milk.

It is almost axiomatic that enhanced prices in an imperfectly competitive market structure induce entry and expenditures toward research and development by firms seeking to capture the rents afforded by supra-normal profits. It is even sometimes suggested that there is an optimal degree of short-run imperfection in a market because the increased supply response actually improves consumers' long-run welfare over the competitive norm. This argument has also been applied to agricultural markets and government intervention, for example the proponents of the price support system often assert that such a program is necessary to "protect consumers" from too rapid a flight of farmers from the industry. However, to the authors' knowledge this question has not been empiri-



cally analyzed, and we feel that the United States dairy market affords an excellent opportunity to study this aspect of agricultural policy.

Over the last three decades the U. S. dairy sector has undergone a dramatic dynamic adjustment. Yield per cow has increased steadily, concentrated feed use has intensified and feeding techniques improved, the development and adoption of the herringbone stansion has increased the number of cows that can be kept on a single operation and average herd sizes have increased dramatically, participation in the Federally financed dairy herd improvement association program has increased, and the total number of producing dairy animals in the country has declined to less than half its 1950 size. At the same time, the total number of dairy farms has declined, especially grade B farms, as the dairy program's price distortions induced a transition from grade B to grade A milk production. However, total production and consumption of milk has remained quite stable over the same period, and both per capita fluid milk consumption and per capita manufactured milk products consumption have declined considerably.

Perhaps the most distinguishing feature of the U. S. dairy industry is its dynamic nature. This paper is an attempt to analyze the extent to which the Federal milk

programs have contributed to the size and direction of these supply and demand movements over the period 1950-1980, and the corresponding dynamic welfare effects of the program.

The approach taken in this paper departs in two ways from the analysis of the recent studies by Ippolito and Masson, Alagia, and Buxton on classified pricing in Federal milk marketing orders and by Buxton and Hammond and Manchester on price supports. First, we do not attempt to calculate Harberger triangles as measures of social cost because there is no dynamic counterpart to the Harberger analysis when the level of the demand and supply curves in successive periods depends upon the previous level of consumption or production. Rather, we focus upon the differences in consumer and producer surplus levels that accrue as a result of hypothetically eliminating the government's distortionary impacts on prices and quantities, and on the net costs of operation and administration that the government must finance out of the Federal treasury.

Second, these earlier studies evaluate the static costs of maintaining each of these programs separately, but we feel that the highly related functioning of the two programs warrants analysis of both programs simultaneously. Specifically, this paper explicitly incorporates

the effects of both policies on the supply and demand functions and evaluates the dynamic response of the supply and demand relationships.

The paper is divided into five additional sections. The next section develops a dynamic supply response model for milk, based upon neo-classical economic theory. The second section discusses the demand for milk as an input to the processing and handling sector and the effects on total demand of the import and export restrictions and government purchases of manufactured dairy products. The third section presents the results from the estimation of the dynamic econometric model. The fourth section presents a simulation of prices, quantities, and consumer and producer surplus levels with and without the Federal intervention for the period 1952-1980, and the subperiods 1965-1980 and 1970-1980. A comparison is made between the short-run static results and the results obtained from the dynamic simulations. The last section presents a summary of the major conclusions reached in this study, and an appendix contains the figures and tables referred to in the text.

## II. The Supply of Milk

For the production decisions of a representative dairy farmer, there are no rigid constraints on sales of dairy cattle to slaughter or to other farmers. There are

three basic sources of stock animals from which a firm can increase the size of its dairy herd: (1) retention of existing milk cows that otherwise would have been culled, (2) additions to the herd from the existing heifer stock, and (3) purchases on the open market. Slaughter depletes the aggregate of dairy cows, but one farmer's net purchases come from another's net sales. Since interfirm sales result in no change in the aggregate herd size, additions to the dairy herd in a representative farm formulation are restricted to cows and heifers available from the previous year's carryover stocks.

In the current year the number of milk cows in production must equal the sum of the stock of cows and bred heifers from the previous year less those cows sold to slaughter. Similarly, bred heifers in this year is the difference between the total stock of heifers and those sold to slaughter. Since about 50 percent of all calves are heifers and each producing cow must be bred to continue the annual production process, the stock of heifers in any given year will be closely related to the number of cows this year and in the two previous years.

The productive life of a dairy cow is typically 4 to 5 seasons, where a season usually amounts to 10 months of production then 2 months rest before calving and the start of lactation. A cow is usually bred between 60 to 90 days

after calving, and the gestation period for bovines is approximately 9 months. The closer to calving that a cow can be bred, the greater her average annual yield, though this is limited by the first heat cycle usually not appearing prior to 60 days after calving. A fundamental property of dairy supply response that is due to the biological nature of dairy cattle is that the decision to keep or cull is made a full year prior to the current production period.

Generally, if the net present value of a cow's milk production plus offspring exceeds her value as a cutter or canner, then the profit-maximizing farmer will retain the cow in his producing herd. The number of cows in the current year's producing herd will be a function of lagged real prices and the lagged number of stock animals. In the short-run (within one year) the aggregate herd size is essentially fixed by previous decisions.

Land, capital, and family labor are complementary inputs to milk cows and feeds, and are fixed inputs in the short-run. That is, there is no opportunity to substitute man-hours or capital for cows, grain, or roughage to produce the same quantity of milk. Also, a standard feeding practice is to monitor the cow's concentrated feed ration and permit the dairy animal to eat roughage until full. Therefore, the minimum energy intake for adequate butter-

fat content of the milk is met and the roughage intake of a dairy cow is functionally tied to the concentrated feed ration.

The above considerations imply that the fundamental input choice variable in the current production period is the level of grain and concentrated feeds utilized, while herd size can be varied after a lag of one year. In the long-run all other inputs are also variable, but the critical adjustments are subsumed in the movement of these two inputs.

Letting  $y$  denote yield per cow per year,  $g$  grain and concentrated feeds fed per cow, and  $C$  the number of dairy cows in production in the current year, we have yield per cow as a function of grain fed and the "ability" of the typical dairy animal,  $A$ , and total milk production,  $Q$ , as the product of yield per cow and the number of cows in the producing herd,

$$(1) \quad y = f(g, A) \text{ and } Q = Cy = Cf(g, A) .$$

Total milk production evolves over time in response to three dynamic processes: (1) herd size, (2) grain and concentrated feeds used, and (3) the improvement in the ability of the typical dairy animal through genetic control of the dairy herd.

Because of the limits to the ability of an animal to consume hot feeds, it is evident that there will be diminishing returns to the utilization of grain fed per cow. Beyond certain limits we expect that the marginal productivity of grain will become negative because of the possibility of bloat and other toxicity effects on ruminants of grain and hot feed. In an effort to capture these effects in our yield response formulation, we found the following functional form to give a very good degree of approximation,

$$(2) \quad y = a(A) + b(A)g - cg^2,$$

where  $a(A) = a_1 + a_2A + a_3A^2$  and  $b(A) = b_1 + b_2A$ . To measure the effects of quality improvement of the average dairy animal, we employ the percentage of the dairy herd that was on test in dairy herd improvement associations (DHIA) three years previous to the current production period.

The nature of the milk per cow production function's movement over time is depicted in Figure 1. The curve marked 0 represents an initial level of participation in the DHIA program. As the herd improvement program is adopted by a greater percentage of farmers, both the "natural production level" of an average dairy cow,  $a(A)$ , and the marginal productivity of grain fed,  $b(A) - 2cg$ ,

increase so long as A has not reached the level where there are negative marginal returns to herd improvement. The first effect is manifested by a vertical shift in the yield per cow parabola (curve 1), while the second effect is equivalent to sliding the parabola upwards and to the right through the y-intercept (curve 2).

### III. The Demand for Milk and the Effects of Governmental Intervention

Basically, milk is used by handlers and processors for two purposes -- packaging and sales of fresh whole milk, cream and other perishable soft dairy products, and ~~processing whole milk into manufactured products~~ such as butter, cheese, and non-fat dry milk. The distinction between the local nature of the demand for fresh milk products and the perishability and high transport costs of raw whole milk relative to manufactured products, and the larger national demand and storability of manufactured products is the foundation of the classified pricing system of Federal milk marketing orders.

In any given market area, the milk processing industry tends to be quite concentrated, with the average percentage of Class I milk sales of the largest four processors in 1975 at 75 percent (USDA 1979). The competitive nature of milk supply, concentrated nature of local fresh milk demand, and instability resulting from farmer



cooperatives' attempts to bargain for classified pricing and the tendency for "free riders" to erode the higher Class I price to the level of Class II milk prices led the government to impose price floors in many milk market areas at the request of producers to establish "orderly" marketing conditions.

On January 1, 1980 there were 47 Federal milk marketing orders in the United States. Through these orders the Federal government directly regulates the handling and pricing of nearly 65 percent of all U. S. milk and 80 percent of all grade A milk. Much of the remaining grade A milk in the country is controlled by state regulations very similar to the Federal orders.

Several studies have attempted to estimate the aggregate demand for dairy products, including Rojko, Wilson and Thompson, and Prato. All of these studies report low short-run price elasticities of demand and income elasticities generally close to zero and sometimes negative. We exclude income from our demands on the basis of these earlier results and because tests for an income effect in the demands were insignificant. Further, the functional form we ultimately choose is linear in own price so that a linear income term is theoretically untenable in such a situation. This last consideration results from the Hicksian symmetry conditions implied by the maximization

hypothesis of economic theory requiring prices to lie in a linear subspace if there is an income effect in any of the linear demands.

It is a difficult problem to specify and estimate the effects of imperfectly competitive behavior in demand and/or supply models, especially on an aggregate basis. Rigid behavioral hypotheses about consumer and producer behavior are at best approximations to aggregate behavior, especially in a dynamic context and a linear functional form. Many plausible models can be based on a priori reasoning, but the data base is seldom capable of discerning the "true" specification.

Much can be said for simplicity in such situations since results can be brought forth with relative analytical ease, and tests of the robustness of the model can be employed to ascertain the closeness of the approximation. The approach taken here is to use a rational lag model as a general linear approximation to the unknown structure.

The basic reasons for a dynamic demand response for dairy products include uncertainty of future prices and other factors, habit formation and adjustment lags in consumption behavior, changing demographic characteristics of the population, and asset fixities or adjustment lags in the milk processing sector. We can control for at least some population effects through a per capita

specification, and for some of the effects of the changing demographic makeup through the inclusion of an estimate of the average age of the representative person in the U. S. from age group population data contained in the Economic Report of the President for February 1982, and through a simple trend.

Due to the Federal government's control of both Class I and Class II milk prices, private demand does not equal private supply in any given year, and government purchases of manufactured dairy products must take up the slack to maintain the price controls. Measuring all quantities in milk equivalent units, net government removals, NGR, must satisfy,

$$(3) \quad \text{NGR} = \text{QS} - \text{Q1} - \text{Q2} - \text{NCR} ,$$

where QS is total milk supply, Q1 is domestic fluid milk demand, Q2 is domestic manufactured milk products demand, and NCR is net commercial removals, which consist of net increases in commercial stocks plus net exports of manufactured products.

Commercial exports are largely limited to specialty products unique to the U. S., and commercial imports are generally constrained by a binding quota due to a lower world price than the U. S. price. Commercial inventory changes amount to a very small percentage of total milk

products, and we simply treat net commercial removals as an exogenous variable in the analysis.

The net direct government costs of the dairy program are determined by

$$GEXP = (P2sup - PW)GES + (P2sup - PD)GDS + sEGI + P2supAID ,$$

where GEXP is net government expenditures, P2sup is the Class II support price (vector) at which the government purchases manufactured products, PW is the world price at which government export sales, GES, are made, PD is the domestic price at which government domestic sales, GDS, are made, s is the cost of storage per unit, EGI is the ending stock of government holdings of manufactured dairy products, and AID is the sum of domestic and foreign food aid contributions. However, we assume that the government is efficient at valuing and making direct domestic transfers, so that domestic donations are valued at P2sup. Ending government inventories satisfies the identity,

$$(4) \quad EGI = BGI + NGR - GES - GDS - AID ,$$

where BGI is the level of beginning government stocks. The set of variables directly subject to control by the Federal government is  $(P1min, P2sup, GES, GDS, EGI, AID)$ , where P1min is the average minimum Class I milk price in Federal marketing orders. The objective of the analysis described

in the next two sections is to attempt to uncover the response of the private dairy sector to elimination of the domestic government intervention, excluding import controls, in a dynamic setting.

#### IV. The Empirical Results

The influence of the government programs on market prices without quantity controls breaks the usual simultaneity between market prices and quantities when approached from the perspective that the government price floors are exogenous control parameters that do not absolutely set the actual market price, but have a strong influence on the resulting equilibrium. We exploited this factor in our empirical estimation procedure by reducing the system to a recursive structure with the influence of Federal policy settings entering the model explicitly.

Data on total milk production,  $Q$ , Class I domestic milk consumption,  $Q_1$ , average farm level price for manufacturing (Class II) milk,  $P_2$ , and average farm level price for all milk,  $P$ , were combined to obtain the average price of Class I milk at the farm level,

$$(5) \quad P_1 = (P Q - P_2(Q - Q_1))/Q_1 ,$$

which follows from the definition of  $P$ ,

$$(6) \quad P = (P_1 Q_1 + P_2(Q - Q_1))/Q .$$

Clearly, this price series  $P_1$  will be simultaneously determined with  $Q_1$  by its very construction. Nevertheless, this is a straightforward difficulty to overcome as the following development will show.

The USDA reports the simple average of all minimum Class I prices in Federal market order areas in Federal Milk Order Market Statistics. This average price represents the exogenous control parameter setting for Federally regulated Class I milk in the United States, and is utilized to obtain an estimate of the impact of this aggregated control setting on the average price of Class I milk at the farm level. The resulting ordinary least squares estimation of this relationship is

$$(7) \quad P_1 = .0269 - .251 D(66-80) + 1.062 P_{1min}$$

(.0555)	(.0534)	(.0102)	$R^2 = .9987$
[.484]	[4.71]	[104.6]	DW = 2.01

where  $D(66-80)$  is a structural change variable that has the value 0 for the years 1950-1965 and 1 for the years 1966-1980,  $R^2$  is the coefficient of determination, and DW is the estimated Durbin-Watson statistic. The numbers in parentheses are estimated standard errors, and those in brackets are the absolute values of the estimated t-statistics.

In the Class II farm milk market we employ the announced support price  $P_{2sup}$  as our policy control

parameter. The estimated relationship between the average farm price for Class II milk and the support price is

$$(8) \quad P2 = .0749 + .725 D(73-74) + 1.003 P2_{sup} \quad R^2 = .9952$$

$$\begin{array}{ccc} (.0723) & (.134) & (.0133) \\ [1.03] & [5.41] & [75.37] \end{array} \quad DW = 1.87$$

where  $D(73-74)$  is a qualitative variable that has the value 1 for the years 1973 and 1974 and 0 for all other years to allow for the effects of the OPEC oil embargo, the Russian wheat sale, and other factors such as Water-gate on the economy during those two years on the ability of the USDA to control the output price for Class II milk.

In the estimation procedure for per capita demand for Class I and Class II milk at the farm level, we use the predicted prices from the above two regression equations, deflated by the implicit price deflator for personal consumption expenditures. The estimated relationships are

$$(9) \quad q_{1t} = .153 - .00208 t + .00371 \text{ age}_t + .621 q_{1t-1} - .00364 (P1/IPD)_t$$

$$\begin{array}{cccccc} (.074) & (.000556) & (.00149) & (.115) & (.00174) \\ [2.06] & [3.74] & [2.49] & [5.40] & [2.09] \end{array}$$

$$R^2 = .9941 \quad DW = 1.95$$

$$q_{2t} = -.146 + .00624 \text{ age}_t + .899 q_{2t-1} - .00522 (P2/IPD)_t$$

$$\begin{array}{cccc} (.092) & (.00298) & (.052) & (.00339) \\ [1.60] & [2.09] & [17.2] & [1.54] \end{array}$$

$$R^2 = .9365 \quad DW = 2.05$$

We then take the predicted prices and quantities from the demand estimation and combine them with net government removals and net commercial removals to construct a non-stochastic average farm price for all milk,

$$(10) \quad P^* = (P_1 Q_1 + P_2 (Q_2 + NGR + NCR)) / (Q_1 + Q_2 + NGR + NCR) .$$

A simple regression of P on P\* gave the result

$$(11) \quad \begin{array}{lll} P = & -.00663 & + 1.001 P^* \\ & (.0443) & (.00683) \\ & [.150] & [146.6] \end{array} \quad \begin{array}{l} R^2 = .9987 \\ DW = 1.50 \end{array}$$

The predicted price series from this estimated equation is the variable that we include in our supply equations.

The theoretical development of the yield response model does not produce any short-run operating distinction between grade A and grade B milk producers. The basic interpretation to this approach is that the decision to switch from grade B to grade A production is an investment decision affecting mainly capital and labor for the enhanced sanitary conditions, and does not change the fundamental relationship between yield per cow and feed use. As a result, the short-run marginal cost curve for grade A farmers will be the same as for grade B farmers, even though total operating costs will be slightly higher for grade A farmers.

We estimate aggregate milk production as the product of the size of the producing herd and yield per cow. The



herd size equation we obtain is

$$(12) \quad C_t = \begin{matrix} -2.05 \\ (.720) \\ [2.84] \end{matrix} + \begin{matrix} 1.535 C_{t-1} \\ (.134) \\ [11.49] \end{matrix} - \begin{matrix} .562 C_{t-2} \\ (.131) \\ [4.31] \end{matrix} + \begin{matrix} 1.602 (P/PFF)_{t-1} \\ (.517) \\ [3.10] \end{matrix}$$

$$R^2 = .9974 \quad DW = 1.75$$

The second-order difference equation is stable with roots  $R1 = .932$  and  $R2 = .603$ , so that the dynamic response to price changes is non-negative throughout the adjustment period.

The quadratic yield per cow function developed above produces reduced form equations for feed per cow and yield per cow that are linear in the reduced form parameters. The symmetry restriction implied by the maximization hypothesis for the representative farmer is also linear in the reduced form parameters, and the two equations for feed and yield per cow are exactly identified (overidentified) if we include (exclude) this restriction. The unconstrained feed per cow and yield per cow equations are

$$(13) \quad g_t = \begin{matrix} .972 \\ (.208) \\ [4.678] \end{matrix} + \begin{matrix} .167 A_t \\ (.0058) \\ [28.85] \end{matrix} - \begin{matrix} .600 (P_g/P)_t \\ (.434) \\ [1.384] \end{matrix} + \begin{matrix} .398 u_{t-1} \\ (.168) \\ [2.373] \end{matrix}$$

$$R^2 = .9933 \quad DW = 1.91$$

$$y_t = \begin{matrix} 2.954 \\ (.172) \\ [17.2] \end{matrix} + \begin{matrix} .445 A_t \\ (.0266) \\ [16.73] \end{matrix} - \begin{matrix} .00506 A_t^2 \\ (.00092) \\ [5.473] \end{matrix} - \begin{matrix} 1.73 (P_g/P)_t^2 \\ (.335) \\ [5.158] \end{matrix} + \begin{matrix} .363 u_{t-1} \\ (.170) \\ [2.132] \end{matrix}$$

$$R^2 = .9980 \quad DW = 1.86$$

The symmetry restriction requires that the coefficient on the price variable in the yield equation be one-half the coefficient on the price variable in the feed equation. After transforming the variables for serially correlated residuals, this restriction was imposed through Zellner's seemingly unrelated regression equations estimation method. The resulting constrained model is

$$\begin{aligned}
 (14) \quad g_t^* &= 1.37 + .099 A_t^* - 1.41 (P_g/P)^*_t \\
 &\quad (.166) \quad (.0032)_t \quad (.345) \\
 &\quad [8.26] \quad [31.33] \quad [4.09] \\
 y_t^* &= 2.52 + .467 A_t^* - .00544 A_t^{*2} - .705 (P_g/P)^*_t^2 \\
 &\quad (.213) \quad (.026) \quad (.00092)_t \quad (.176) \\
 &\quad [20.5] \quad [18.03] \quad [5.931] \quad [4.01]
 \end{aligned}$$

and the estimated F-statistic for the asymptotic test of the restriction is  $F(1,51) = 12.925$ . The rejection of the null hypothesis of the symmetry restrictions could be due to several factors, including the approximation of the yield response function to only second order, aggregation across firms, measurement errors, the fact that the serial correlation parameters are estimated for the unconstrained model and are only asymptotically well-behaved under the null hypothesis, or even that dairy farmers do not attempt to maximize net returns over feed costs in the short-run. To mitigate these potential problems we employed the unrestricted equations in our following analysis of the system of equations estimated above.

## V. Analysis of the Dynamic Effects of the Dairy Program

The dynamic response pattern of milk demand and dairy herd size are pictured in Figure 2. An interesting feature of this response is that both demands adjust much more quickly than does supply. For example, after 10 years of adjustment to a price change 99 percent of the effects of the price change have occurred in the Class I market and 80 percent of the effects have occurred in the Class II market, while less than half the total dynamic response of herd size has taken place. However, the total long-run supply response to price changes is much greater than either demand response, as indicated by the price elasticities for each year of the effective sample presented in Table 1. On the demand side, price response followed a downward trend until about 1963, then increased in both markets. On the supply side, short-run yield response has declined monotonically, while short- and long-run herd size and total supply response have increased steadily throughout the period. These properties of the market structure are important in shaping the results that are obtained when we eliminate the influence of the government on domestic milk prices in this dynamic framework.

A recent article by Song and Hallberg suggests that the USDA has not attempted to maximize producer returns in

any period since 1960, and that consumer interests have become more important to the pricing structure of the dairy program in recent years. An interesting question is whether or not their results carry through in the model we have estimated since our elasticities of demand are variable over time while they assumed the same elasticities for each year. We analyzed this question by calculating marginal revenues with respect to prices for the domestic Class I and Class II demands for each year in the period 1952-1980. These results are included in Table 1.

Inspection of the values in Table 1 indicate that for the period from 1952-1970 there is very little difference in the aggregate marginal revenue prices for the two markets, so that our two-market demand system cannot reject the hypothesis that prices were chosen so that their marginal contribution to producer returns are equal and hence short-run farmer incomes were maximized for these years, on average. However, for the ten-year period from 1971-1980 there appears to have developed an increasing divergence between these marginal revenue values, and we conclude that our model is consistent with the results of Song and Hallberg only for the shorter period of 1970-1980.

The short-run market equilibrium with the dairy program is compared to the equilibrium that would prevail if

prices were equal in both markets and total supply equalled total demand in Figure 3. With a Class I price higher than the "competitive" market price and an effective Class II support price, government purchases must be positive for the market to clear. In such a situation, if supply is sufficiently inelastic in the short-run, then government purchases at the support price can lead to a greater total sum of producer and consumer surplus with the program than without it. This implies that the tendency for short-run demand elasticities to increase in recent years, while the short-run supply elasticity has decreased could lead to static losses of total surplus from removing the dairy program in any given year since about 1966 (excluding government costs and overproduction costs).

To estimate the effects on short-run static producer surplus, which we define by the total return over feed costs (excluding roughage), and consumer surplus, which we define as the areas under the milk demand curves and above the relevant prices, we first calculate the surpluses for the status quo as our basis of comparison. These surplus estimates are reported in Table 2. Note from the table that producer surplus has increased dramatically over the 29 year period of the sample, while both consumer surpluses have declined. Because the rents to farmers are

capitalized into the value of a dairy cow, or the price of their land, this does not necessarily imply that profits have risen proportionately, but it does indicate that the short-run input costs of operating a dairy farm did not keep pace with revenues.

If the aggregate dairy market were competitive and there were no government price distortions, the market clearing price would satisfy a third-order polynomial,

$$(15) \quad a_0 + a_1 P + a_2 P^2 + a_3 P^3 = 0,$$

$$\text{where } a_0 = 1.73 C_t P_{gt}^2,$$

$$a_1 = 0,$$

$$a_2 = (-.00641 + .00995 \text{age}_t - .00208t + .621 q_{1t-1} + .899 q_{2t-1}) \text{POP}_t + \text{NCR}_t - (4.64 + .445 A_t - .00505 A_t^2) C_t,$$

$$\text{and } a_3 = -.00886 \text{POP}_t / \text{IPD}_t,$$

$$\text{since } Q1_t = (.153 + .00371 \text{age}_t - .00208t + .621 q_{1t-1} - .00364 P_t / \text{IPD}_t) \text{POP}_t$$

$$Q2_t = (-.146 + .00624 \text{age}_t + .899 q_{2t-1} - .00522 P_t / \text{IPD}_t) \text{POP}_t$$

$$\text{and } Q1_t + Q2_t + \text{NCR} = Q_t = (4.64 + .445 A_t - .00505 A_t^2 - 1.73 P_{gt}^2 / P_t^2) C_t.$$

This polynomial always has one and only one real positive root, and is completely characterized by the sign of the coefficient  $a_2$ , as shown in Figure 4. We calculate the market-clearing price as the largest real root from a Newton-Raphson iterative solution for polynomials.

To analyze the static annual surplus changes resulting from the relative Class I - Class II milk price distortions, we solved for the equilibrium market price for each year from 1952 to 1980, taking the levels of the demand curves to be fixed at their status quo levels. These results are summarized in Table 3. As we would expect a priori, average price is lower in nearly every year, and generally the short-run losers from the dairy program are the Class I consumers, while Class II consumers and producers gain. Also, the inelastic supply response of recent years makes it appear as though the gains to producers and Class II consumers outweigh the losses to Class I consumers, again as we expected a priori. However, these static results can be very misleading if we attempt to interpret them as estimates of the costs of the dairy program because of the dynamic nature of the dairy market and the static nature of the equilibria calculated. At most, they give an indication of the relative size and direction of the initial gains and losses that would have occurred had the dairy program been eliminated in a particular year.

A further shortcoming of the static equilibrium surplus estimates is that they do not account for CCC operating costs or administrative costs of the marketing order program. We estimate these costs for the years

1965-1980, and they are summarized in Table 4. When these costs are incorporated into the static costs of the dairy program we obtain the following estimates for total and average annual static losses due to the Federal milk program for the period 1965-1980:

<u>Discount</u>	<u>Present</u>	<u>Annualized</u>
<u>Rate</u>	<u>Value</u>	<u>Value</u>
(percent)	(billions of 1980 \$)	
0	0.4443	0.0278
5	0.8258	0.0349
10	1.6829	0.0468

Even with our conservative assumption that domestic CCC donations have a marginal social value of the purchase cost to the government, the direct governmental costs of the Federal dairy program are considerable, averaging \$236 million per year during the period 1965-1980. Further, they appear to be rising rapidly, reaching over a billion dollars in the 1980 calendar year, and about \$1.5 billion during the 1980-1981 marketing year.

The static cost estimates are important figures because they indicate the initial level and distribution of welfare gains and losses that would have occurred if the dairy program had been eliminated in a particular year. They also indicate that even in a purely static



sense the elimination of the dairy program is compensatable. However, as the econometric model estimated in the previous sections indicates, the dynamic nature of the demand and supply for milk implies that the level of the demand and supply curves depends upon the previous consumption and output levels. This implies that adjustments to the elimination of the dairy program lead to a different path of gains and losses in intermediate years than in the static case.

Higher (lower) consumption levels of Class I (Class II) milk lead to rightward (leftward) shifts in the demand functions for subsequent years, increasing the short-run gains (losses) from removing the price distortions over time. Similarly, we expect that losses of producer surplus will increase in years following halting intervention because of a lower number of milk cows in response to a lower average price of milk.

An interesting question is whether the leftward supply shifts and rightward demand shifts lead to a higher long-run price path with the competitive structure than with the distortionary structure. We also would like to determine whether or not the cumulative gains in Class I surplus outweigh the cumulative losses in Class II and producer surplus. To study this question we simulated the dairy market equilibria allowing the demand and supply

curves to shift according to the new levels of previous consumption and milk cow numbers for the three periods 1952-80, 1965-80, and 1970-80, assuming a competitive market-clearing price in each year. These results are presented in Tables 5a-5c.

For all three periods the simulation results lead to the same general conclusions. First, the dynamic costs of the dairy program are quite large, exceeding an average of \$1 billion per year by the most conservative estimate without adding the \$200 million in direct administration costs. Second, the annual costs of the program increase from year to year, both because gains to Class I consumers grow faster than losses to producers and because the Class II consumers actually appear to be better off in the long-run without the dairy program because the average price of milk falls below the average Class II price from the status quo after only a few years of adjustment. Third, the downward trend in the average price of milk only lasts a few years after the elimination of the program, and the subsequent upward trend acts to stop the decrease in milk cow numbers, so that there would actually be more cows in the market without the dairy program. Finally, the per capita consumption of both Class I and Class II milk does not decrease nearly as much as in the status quo, indicating that there is a substantial bias in

people's food consumption behavior from the dairy program. This last factor may well be the most important since it indicates that people are turning away from dairy products toward less nutritious beverages and foods because of the price distortions introduced by the government.

## VI. Conclusions

The model results reported in this paper indicate that the costs of the Federal dairy programs are much higher than previous studies suggest. There are several reasons why this model produces more reliable results than those of previous studies. First, we estimate a system of demands and supply that are internally consistent with each other and the nature of the governmental intervention, and are based upon economic theory to generate the welfare estimates. Second, the model explicitly accounts for the effects of the government's policies on the prices and quantities. Third, we allow for dynamic adjustments in the supply and demand relationships. Finally, we analyze both major programs simultaneously, which captures their related structures.

The implications of the results are: (a) the objectives of the dairy program could be achieved through a much less costly set of policy instruments, namely Ramsey pricing (Baumol and Bradford) where the economic distortions are minimized by controlling output and eliminating

the need for burdensome stockholding by the government and costly government purchases; and (b) with the rapidly rising direct costs of the dairy program and the need for the Federal government to become more fiscally responsible, it is indeed clear that the operation of the dairy program requires serious reconsideration, especially in the light of the large social costs implied by the model estimated in this paper.

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## APPENDIX

### Tables and Figures

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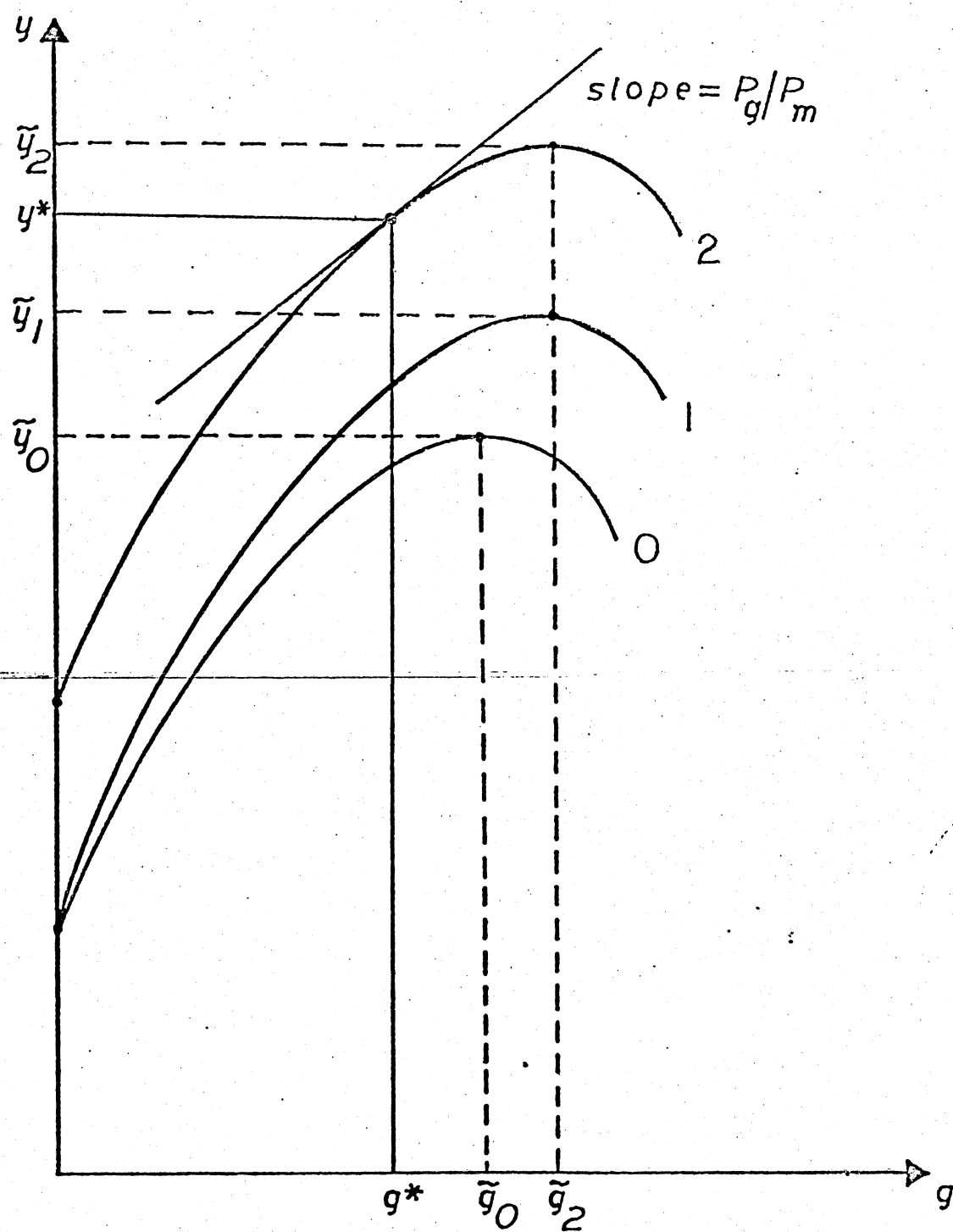
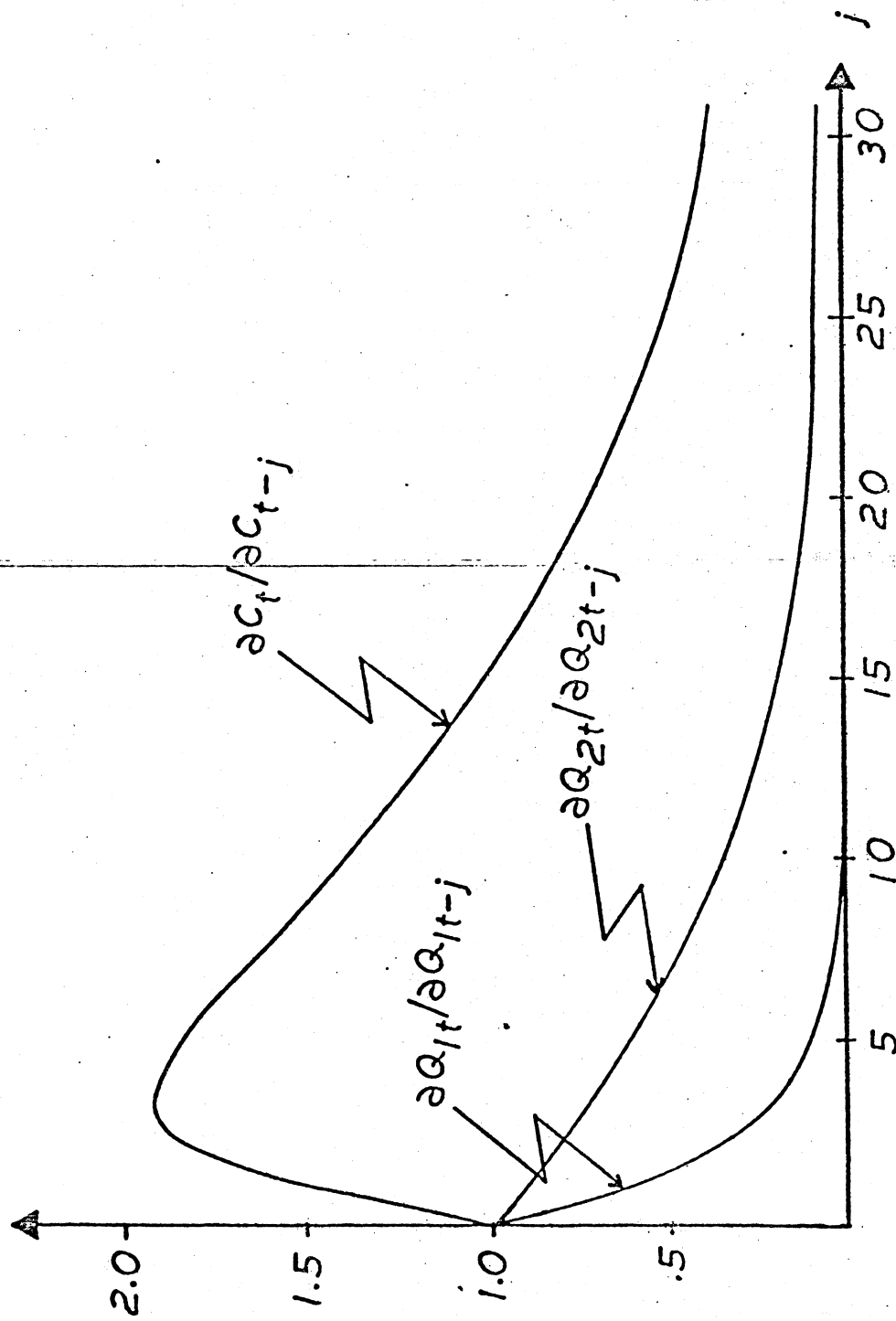
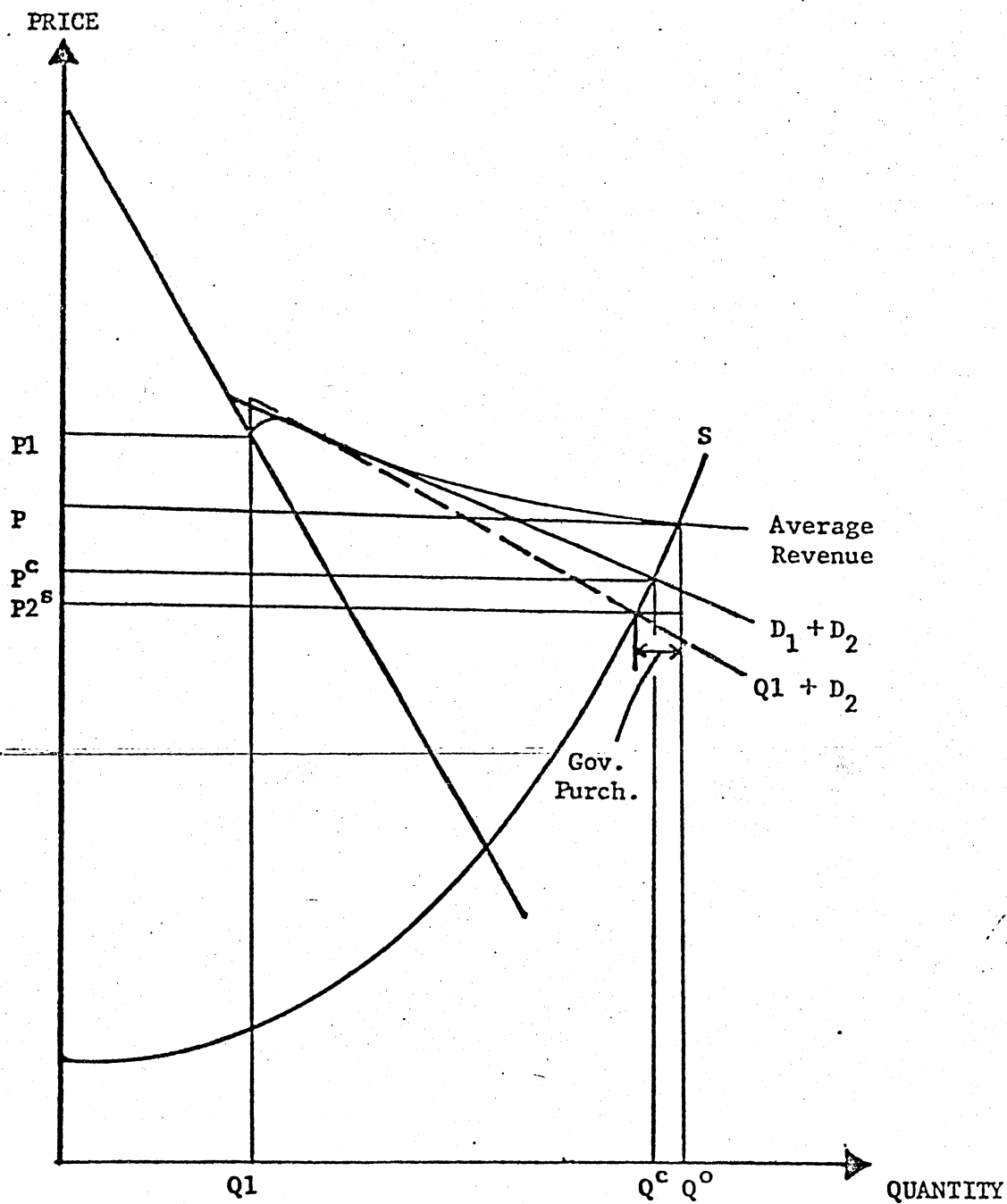


FIGURE 1. Milk production per cow as a function of grain fed.

**FIGURE 2.** Dynamic Response Paths of Farm Milk Demand and Supply.





**FIGURE 3.** Short-run market equilibrium in the U. S. dairy market with and without government intervention.



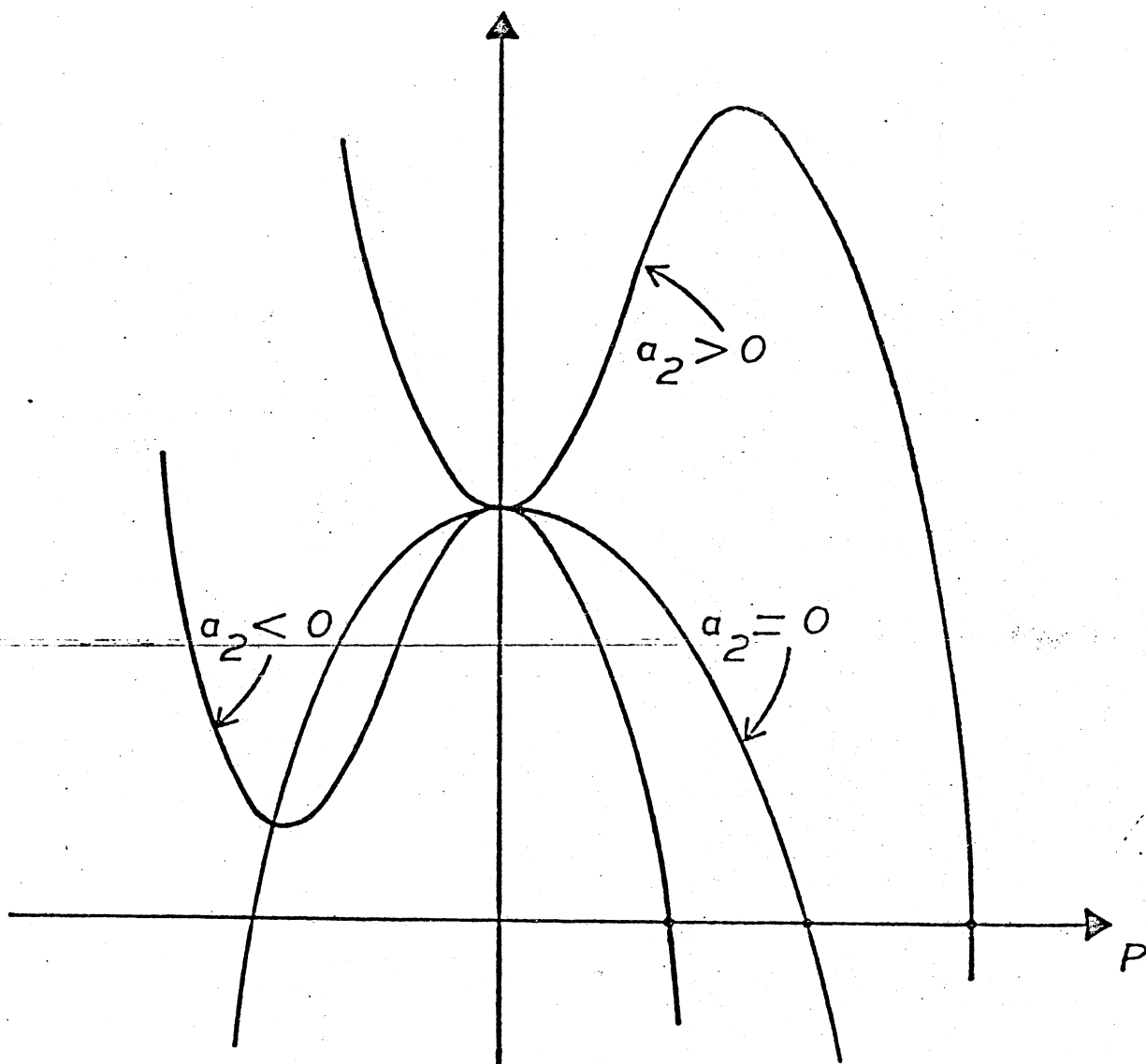


FIGURE 4. Third-order market-clearing milk price polynomial.

TABLE 1.  
ESTIMATED PRICE ELASTICITIES AND MARGINAL REVENUE PRICES.

YEAR	CLASS I MILK				CLASS II MILK				MILK SUPPLY			
	DEMAND ELASTICITY		MARGINAL REVENUE		DEMAND ELASTICITY		MARGINAL REVENUE		YIELD RESPONSE		COWS RESPONSE	
	SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN
1952	-0.0967	-0.2480	49.4511	-0.0930	-0.9207	50.1320	0.3973	0.1190	4.4287	4.8260	0.1190	4.4287
1953	-0.0866	-0.2221	50.9392	-0.0946	-0.9364	48.8229	0.3531	0.1245	4.6301	4.9833	0.1245	4.6301
1954	-0.0816	-0.2092	51.6732	-0.0842	-0.8337	49.1542	0.3883	0.1194	4.4408	4.8292	0.1194	4.4408
1955	-0.0822	-0.2108	52.2741	-0.0788	-0.7798	50.8973	0.3445	0.1116	4.1532	4.4978	0.1116	4.1532
1956	-0.0844	-0.2164	52.6912	-0.0787	-0.7794	52.0718	0.2894	0.1152	4.2867	4.5761	0.1152	4.2867
1957	-0.0827	-0.2120	53.5299	-0.0777	-0.7687	52.4693	0.2791	0.1206	4.4859	4.7650	0.1206	4.4859
1958	-0.0811	-0.2080	53.8928	-0.0739	-0.7314	52.8011	0.2641	0.1232	4.5820	4.8462	0.1232	4.5820
1959	-0.0614	-0.2087	53.7372	-0.0729	-0.7216	52.6001	0.2539	0.1263	4.6973	4.9513	0.1263	4.6973
1960	-0.0833	-0.2135	53.3641	-0.0724	-0.7171	53.5048	0.2389	0.1294	4.8142	5.0531	0.1294	4.8142
1961	-0.0628	-0.2124	53.5011	-0.0783	-0.7756	53.5865	0.2219	0.1309	4.8685	5.0905	0.1309	4.8685
1962	-0.0816	-0.2091	53.1109	-0.0749	-0.7411	53.3650	0.2380	0.1335	4.9645	5.2026	0.1335	4.9645
1963	-0.0808	-0.2071	53.3216	-0.0733	-0.7259	53.7077	0.2501	0.1301	4.8402	5.0903	0.1301	4.8402
1964	-0.0814	-0.2088	53.5944	-0.0742	-0.7344	53.2533	0.2344	0.1321	4.9140	5.1485	0.1321	4.9140
1965	-0.0826	-0.2118	53.4921	-0.0739	-0.7312	54.4203	0.2176	0.1368	5.0878	5.3055	0.1368	5.0878
1966	-0.0879	-0.2254	52.9588	-0.0830	-0.8216	53.8663	0.1817	0.1502	5.5885	5.7702	0.1502	5.5885
1967	-0.0923	-0.2366	52.2937	-0.0878	-0.8688	54.1558	0.1679	0.1672	6.2183	6.3862	0.1672	6.2183
1968	-0.0979	-0.2511	50.7943	-0.0952	-0.9423	50.6142	0.1268	0.1798	6.6866	6.8135	0.1798	6.6866
1969	-0.0997	-0.2556	50.2819	-0.0931	-0.9219	50.9284	0.1216	0.1943	7.2255	7.3471	0.1943	7.2255
1970	-0.1011	-0.2593	49.6320	-0.0956	-0.9465	50.9159	0.1162	0.1987	7.3925	7.5088	0.1987	7.3925
1971	-0.1017	-0.2607	48.9624	-0.0967	-0.9570	51.8488	0.1158	0.2024	7.5302	7.6460	0.2024	7.5302
1972	-0.1027	-0.2633	48.5563	-0.0912	-0.9030	54.6572	0.1142	0.2029	7.5465	7.6607	0.2029	7.5465
1973	-0.1106	-0.2837	48.3177	-0.1097	-1.0861	52.0982	0.1577	0.1979	7.3600	7.5177	0.1979	7.3600
1974	-0.1201	-0.3080	47.1084	-0.1155	-1.1431	52.1059	0.1882	0.2090	7.7739	7.9621	0.2090	7.7739
1975	-0.1153	-0.2955	46.2664	-0.1067	-1.0564	55.5866	0.1807	0.2148	7.9911	8.1719	0.2148	7.9911
1976	-0.1276	-0.3272	45.2837	-0.1117	-1.1053	55.4092	0.1400	0.2165	7.4897	7.6297	0.2165	7.4897
1977	-0.1189	-0.3048	46.1890	-0.1115	-1.1034	57.7079	0.1235	0.2114	8.0541	8.1777	0.2114	8.0541
1978	-0.1193	-0.3059	46.7884	-0.1103	-1.0917	58.9483	0.1006	0.2127	7.8636	7.9642	0.2127	7.8636
1979	-0.1291	-0.3310	44.8577	-0.1142	-1.1299	59.6455	0.0946	0.2120	7.9132	8.0079	0.2120	7.9132
1980	-0.1252	-0.3210	45.5537	-0.1155	-1.1435	61.9185	0.0923	0.2120	7.8837	7.9760	0.2120	7.8837

TABLE 2.  
CALCULATED SURPLUS VALUES FOR ACTUAL PRICES AND QUANTITIES.

YEAR	CONSUMERS SURPLUS.		PRODUCERS
	FLUID MILK	MANFG MILK	SURPLUS
(BILLIONS OF DOLLARS)			
1952	27.0838	19.7174	3.9260
1953	27.4308	18.1271	3.9465
1954	27.8756	17.4189	3.5901
1955	27.6827	17.1139	3.7804
1956	27.5135	17.7016	3.9676
1957	27.4190	18.1614	3.9363
1958	27.4358	18.1581	3.8972
1959	27.1566	18.0147	3.8086
1960	26.5382	17.5754	3.6737
1961	25.9769	17.6792	3.8551
1962	25.6647	17.7901	3.7787
1963	24.9917	17.3671	3.7259
1964	24.6404	17.3276	3.7347
1965	24.3574	16.8861	3.7936
1966	23.7370	17.1287	4.4832
1967	23.1189	16.8704	4.2603
1968	22.3970	17.0600	4.9917
1969	21.3776	15.3176	5.1163
1970	20.8240	15.2987	5.2921
1971	20.1959	15.1862	5.3710
1972	19.5324	15.7054	5.5641
1973	18.6895	16.4943	6.0502
1974	18.0524	15.3814	6.6472
1975	17.6661	15.6174	6.7255
1976	16.3820	17.0081	8.1560
1977	16.1884	16.8427	8.7402
1978	16.5769	18.9296	9.5709
1979	15.4876	18.1271	11.1716
1980	14.7141	18.4548	12.2694

TABLE 3.  
NO GOVERNMENT PRICE DISTORTIONS. STATIC SHORT-RUN EQUILIBRIA.

YEAR	PRICE (\$/CWT)	COWS (MILL.)	YIELD (THOUSANDS OF LBS. PER HEAD)	GRAIN	Q1	Q2	SURPLUS CHANGES			TOT. CHG.
							CS1	CS2	PS	
							(-----BILLIONS OF DOLLARS-----)			
1952	4.6515	21.1616	5.3276	1.0470	0.3537	0.3489	0.7921	-0.5762	-0.1474	0.0684
1953	3.0639	21.1210	5.3442	1.9053	0.3555	0.3379	1.0166	-0.0063	-0.9654	0.0448
1954	3.5324	21.3620	5.4299	1.9764	0.3557	0.3278	1.0463	-0.1044	-0.8859	0.0560
1955	3.2564	21.7307	5.3517	1.9570	0.3533	0.3234	1.3015	-0.0145	-1.3117	-0.0247
1956	3.4317	20.5956	5.7423	2.0662	0.3492	0.3254	1.3063	-0.0854	-1.1856	0.0351
1957	3.5775	19.8552	5.9399	2.1275	0.3450	0.3261	1.2127	-0.1709	-0.9843	0.0574
1958	3.6326	19.4939	6.1610	2.1969	0.3419	0.3223	1.1282	-0.3090	-0.7720	0.0472
1959	3.8643	18.3494	6.4858	2.3128	0.3363	0.3166	0.9646	-0.5001	-0.4361	0.0282
1960	4.5928	16.7652	6.9963	2.4871	0.3268	0.3053	0.5046	-0.9578	0.5042	0.0511
1961	4.1157	16.5128	7.1118	2.5746	0.3229	0.3089	0.8018	-0.4597	-0.2589	0.0832
1962	3.5911	16.8260	7.0765	2.6269	0.3207	0.3103	1.0778	-0.2237	-0.7978	0.0561
1963	3.4101	16.5628	7.2007	2.7452	0.3151	0.3054	1.1667	-0.1315	-1.0365	-0.0012
1964	3.4845	15.8341	7.5416	2.8931	0.3108	0.3027	1.1568	-0.1715	-0.9571	0.0281
1965	3.6683	15.1360	7.9049	3.0402	0.3067	0.2963	1.0853	-0.2447	-0.7987	0.0418
1966	3.5554	14.8544	7.9391	3.1130	0.3035	0.3006	1.4121	0.1457	-1.7470	-0.1890
1967	5.6054	12.9849	8.4333	3.3619	0.2902	0.2856	0.2459	-0.9866	0.7663	0.0257
1968	4.4382	13.0546	9.0252	3.5310	0.2913	0.2951	1.2348	-0.0907	-1.1908	-0.0467
1969	4.1153	12.7860	9.0570	3.6028	0.2860	0.2810	1.5603	0.1545	-1.8017	-0.0867
1970	4.4008	12.2574	9.4066	3.7849	0.2809	0.2797	1.4931	0.1519	-1.7396	-0.0946
1971	4.7250	11.7963	9.7240	3.9573	0.2749	0.2775	1.3565	0.1338	-1.5569	-0.0665
1972	4.7891	11.7653	9.9159	4.0813	0.2701	0.2815	1.3994	0.1422	-1.6671	-0.1254
1973	6.4253	11.6007	9.9340	4.1174	0.2615	0.2858	0.9888	-0.1444	-0.9765	-0.1321
1974	7.3827	11.4393	9.9756	4.2433	0.2587	0.2769	1.1565	-0.1252	-1.2466	-0.2153
1975	7.7371	11.1035	10.1921	4.3398	0.2547	0.2791	0.9444	-0.1485	-0.9812	-0.1852
1976	8.3675	11.0135	10.7036	4.6221	0.2480	0.2917	1.2598	-0.1132	-1.4990	-0.3524
1977	7.8752	10.9216	10.8082	4.7429	0.2470	0.2954	1.3976	0.5605	-2.6556	-0.6974
1978	10.6056	10.5589	11.3847	4.9252	0.2452	0.3052	0.5536	-0.5840	0.0162	-0.0141
1979	10.1004	10.7888	11.2561	4.9163	0.2431	0.3064	1.3880	0.3828	-2.4390	-0.6680
1980	11.6763	10.4938	11.6305	5.1793	0.2366	0.3111	1.0680	0.4002	-2.0515	-0.5832

ANNUALIZED

PRESENT

DISCOUNT

VALUE

VALUE

RATE

(BILLIONS OF 1980 \$)

(BILLIONS OF 1980 \$)

(PERCENT)

-0.0906

-2.8594

0

-0.0411

-2.5620

5

-0.0034

-0.5102

10

**TABLE 4. CCC Support Operation Costs and Federal Marketing Order Administration Costs.**

<u>YEAR</u>	<u>CCC SUPPORT OPERATIONS</u>		<u>MARKETING ORDERS</u>		<u>TOTAL</u>
	<u>NET</u> <u>EXPENDITURES</u> <sup>1</sup>	<u>DONATIONS</u> <sup>2</sup>	<u>NET</u> <u>COSTS</u> <sup>3</sup>	<u>ADMINISTRATION</u> <u>COSTS</u> <sup>4</sup>	<u>NET</u> <u>COSTS</u>
( Millions of Dollars per Callendar Year )					
1965	268.4	117.4	151.0	19.9	170.9
1966	185.4	93.7	91.7	14.5	106.2
1967	356.0	116.9	194.1	15.6	209.7
1968	351.6	208.1	143.5	16.8	106.3
1969	287.2	196.1	91.1	17.4	108.5
1970	356.0	223.0	133.0	19.1	152.1
1971	373.3	215.7	157.6	21.3	178.9
1972	290.9	172.4	118.5	20.8	139.3
1973	123.9	106.5	17.4	20.2	37.6
1974	258.3	132.3	126.0	20.9	146.9
1975	273.9	94.1	179.8	21.7	201.5
1976	291.5	120.1	171.4	24.9	196.3
1977	611.5	209.5	402.0	24.0	426.0
1978	401.2	216.1	185.1	23.4	208.5
1979	507.9	267.3	240.6	23.8	264.4
1980	1453.5	404.5	1049.0	25.2	1074.2

<u>Discount Rate</u>	<u>Present Value</u>	<u>Annualized Value</u>
(Percent)	(Billions of 1980 Dollars)	
0	3.7813	0.2363
5	4.9859	0.2108
10	6.8984	0.1919

<sup>1</sup>CCC expenditures for support operations less proceeds from sales for the calendar year.

<sup>2</sup>CCC domestic donations of butter, cheese, and non-fat dry milk for the calendar year valued at the average support price for each item.

<sup>3</sup>Net expenditures less domestic donations.

<sup>4</sup>Federal marketing order total assessments of producers for administrative costs.

TABLE 5a.

## NO GOVERNMENT PRICE DISTORTIONS, DYNAMIC ADJUSTMENT, 1952-1980.

YEAR	PRICE (\$/CWT)	COWS (MILL.)	YIELD (THOUSANDS OF LBS. PER HEAD)	GRAIN	Q1	Q2	SURPLUS CHANGES			TOT. CHG.
							CS1	CS2	PS	
							-----BILLIONS OF DOLLARS-----			
1952	4.6515	21.1616	5.3276	1.8470	0.3537	0.3489	0.7921	-0.5762	-0.1474	0.0684
1953	3.9204	21.0082	5.3832	1.9129	0.3590	0.3357	1.5925	-0.2296	-0.8913	0.4715
1954	3.7146	20.9081	5.5744	2.0039	0.3614	0.3255	2.0050	-0.3160	-0.6432	1.0457
1955	3.6289	20.6078	5.6570	2.0157	0.3613	0.3171	2.6834	-0.6132	-0.8374	1.2328
1956	3.5362	20.1951	5.8193	2.0817	0.3598	0.3103	3.0942	-1.6441	-1.0729	0.3771
1957	3.4979	19.7834	5.8839	2.1161	0.3573	0.3049	3.2612	-2.4179	-1.1206	-0.2773
1958	3.5557	19.3308	6.1132	2.1866	0.3535	0.2997	3.0744	-2.7080	-0.9167	-0.5503
1959	3.4948	18.7595	6.2705	2.2653	0.3495	0.2956	3.1417	-2.7515	-0.9257	-0.5355
1960	3.5398	18.1075	6.5250	2.3744	0.3449	0.2919	3.4257	-2.4688	-0.7381	0.2186
1961	3.4051	17.4453	6.7132	2.4861	0.3406	0.2894	3.7067	-2.6043	-1.1292	-0.0268
1962	3.4558	16.8241	6.9847	2.6077	0.3357	0.2869	3.6051	-2.7562	-1.0031	-0.1543
1963	3.5786	16.1231	7.3263	2.7703	0.3303	0.2842	3.7448	-2.4038	-0.8521	0.4889
1964	3.7001	15.3438	7.6885	2.9234	0.3245	0.2815	3.4922	-2.4560	-0.7243	0.3118
1965	4.0397	14.5593	8.1113	3.0858	0.3177	0.2773	2.9618	-2.2555	-0.3838	0.3224
1966	4.1465	13.7812	8.2986	3.1888	0.3118	0.2742	2.8399	-2.6927	-1.1254	-0.9782
1967	4.8709	13.1728	8.6571	3.3098	0.3037	0.2682	2.3949	-2.8917	-0.1138	-0.6105
1968	4.2759	12.7664	8.9599	3.5151	0.3005	0.2686	2.7450	-2.9868	-1.4917	-1.7334
1969	4.4535	12.5796	9.2050	3.6377	0.2971	0.2699	3.3713	-1.0223	-1.4008	0.9481
1970	4.3094	12.4821	9.3654	3.7755	0.2946	0.2738	3.7194	-0.4951	-1.8000	1.4242
1971	4.2914	12.4444	9.5294	3.9132	0.2922	0.2790	4.1394	0.2928	-1.9570	2.4753
1972	4.4550	12.4238	9.7705	4.0483	0.2893	0.2849	4.4831	0.5271	-1.9267	3.0835
1973	5.8218	12.3176	9.7164	4.0702	0.2824	0.2860	4.2686	-0.1049	-1.5290	2.6346
1974	6.8696	12.2275	9.7847	4.2055	0.2754	0.2864	3.7457	0.9667	-1.6319	3.0806
1975	6.6432	12.2020	9.7898	4.2600	0.2720	0.2913	3.4539	1.3142	-2.0386	2.9295
1976	6.9608	12.0320	10.2673	4.5308	0.2687	0.2972	4.4827	0.6513	-2.9912	2.1428
1977	6.8692	11.8953	10.4712	4.6737	0.2667	0.3057	4.4483	1.9203	-3.6308	2.7378
1978	7.9153	11.7397	10.9326	4.8083	0.2673	0.3203	4.1349	1.6432	-2.8439	2.9341
1979	9.5094	11.5581	11.1579	4.8913	0.2596	0.3239	3.9003	2.7307	-2.6843	3.9467
1980	10.6889	11.3532	11.4955	5.1441	0.2549	0.3308	3.8343	3.1470	-2.6526	4.3287

DISCOUNT RATE (PERCENT)

PRESENT VALUE

ANNUALIZED VALUE

(BILLIONS OF 1980 \$)

1.1150

0.7218

0.4936

TABLE 5b.  
NO GOVERNMENT PRICE DISTORTIONS, DYNAMIC ADJUSTMENT, 1965-1980.

YEAR	PRICE (\$/CWT)	COWS (MILL.)	YIELD (THOUSANDS OF LBS. PER HEAD)	GRAIN	Q1	Q2	SURPLUS CHANGES			TOT. CHG.
							CS1	CS2	PS	
							(---BILLIONS OF DOLLARS---			
1965	3.6683	15.1360	7.9049	3.0402	0.3067	0.2963	1.0853	-0.2447	-0.7987	0.0418
1966	3.8501	14.3776	8.1390	3.1537	0.3063	0.2931	1.8993	-0.6695	-1.4061	-0.1763
1967	4.5256	13.7643	8.5366	3.2794	0.3018	0.2874	2.0638	-0.8561	-0.4007	0.8069
1968	4.0477	13.3392	8.8545	3.4906	0.3004	0.2873	2.7050	-0.9832	-1.6542	0.0675
1969	4.2354	13.1266	9.1136	3.6158	0.2979	0.2880	3.4948	0.9423	-1.5444	2.8927
1970	4.1414	12.9997	9.2824	3.7569	0.2958	0.2910	3.9077	1.4173	-1.8966	3.4284
1971	4.1478	12.9317	9.4511	3.8964	0.2935	0.2953	4.3478	2.1470	-2.0349	4.4600
1972	4.3069	12.8809	9.6950	4.0320	0.2906	0.3003	4.7029	2.3298	-2.0137	5.0190
1973	5.6750	12.7455	9.6527	4.0572	0.2837	0.3006	4.4875	1.6152	-1.5918	4.5109
1974	6.7322	12.6274	9.7261	4.1944	0.2766	0.3001	3.9515	2.5912	-1.6787	4.8639
1975	6.5284	12.5755	9.7355	4.2501	0.2731	0.3041	3.8369	2.8628	-2.0733	4.6265
1976	6.8176	12.3806	10.2071	4.5194	0.2698	0.3093	4.6637	2.1506	-3.0656	3.7488
1977	6.7513	12.2205	10.4129	4.6626	0.2678	0.3171	4.6222	3.3814	-3.7071	4.2965
1978	7.7083	12.0430	10.8771	4.7959	0.2685	0.3313	4.3364	3.1313	-2.9852	4.4826
1979	9.2672	11.8410	11.1127	4.8803	0.2609	0.3346	4.1201	4.2001	-2.8374	5.4828
1980	10.4439	11.6170	11.4559	5.1343	0.2562	0.3410	4.0584	4.6056	-2.7959	5.8680

DISCOUNT RATE (PERCENT)	PRESENT		ANNUALIZED	
	VALUE	(BILLIONS OF 1980 \$)	VALUE	(BILLIONS OF 1980 \$)
0	54.4207		3.4012	
5	71.1155		3.0060	
10	94.3134		2.6234	

TABLE 5c.

## NO GOVERNMENT PRICE DISTORTIONS, DYNAMIC ADJUSTMENT, 1970-1980.

YEAR	PRICE (\$/CWT)	COWS (MILL.)	YIELD (THOUSANDS OF LBS. PER HEAD)	GRAIN	Q1	Q2	SURPLUS CHANGES			TOT. CHG.
							CS1	CS2	PS	
							(-----BILLIONS OF DOLLARS-----)			
1970	4.4008	12.2574	9.4066	3.7849	0.2809	0.2797	1.4931	0.1519	-1.7396	-0.0946
1971	4.5938	12.1343	9.6709	3.9449	0.2825	0.2827	2.5612	0.7070	-1.6267	1.6415
1972	4.8637	12.0740	9.9443	4.0881	0.2818	0.2861	3.2560	0.6616	-1.4617	2.4558
1973	6.2655	11.9549	9.8824	4.1058	0.2762	0.2849	3.2661	-0.2420	-1.0432	1.9808
1974	7.2769	11.8673	9.9395	4.2360	0.2703	0.2835	2.9226	0.6232	-1.1955	2.3503
1975	6.9758	11.8529	9.9323	4.2870	0.2679	0.2873	2.9848	0.8323	-1.6888	2.1282
1976	7.3198	11.6986	10.4029	4.5574	0.2652	0.2922	3.9020	0.0293	-2.6066	1.3246
1977	7.1882	11.5797	10.5935	4.6977	0.2637	0.3001	3.9475	1.1903	-3.2951	1.8427
1978	8.3426	11.4425	11.0345	4.8319	0.2644	0.3137	3.6337	0.7387	-2.3988	1.9736
1979	9.9627	11.2793	11.2338	4.9105	0.2568	0.3166	3.4180	1.7011	-2.2477	2.8714
1980	11.1012	11.0922	11.5562	5.1595	0.2523	0.3229	3.3929	2.0295	-2.2059	3.1366

## DISCOUNT RATE (PERCENT)

## PRESENT VALUE

## ANNUALIZED VALUE

(PERCENT)	(BILLIONS OF 1980 \$)	VALUE
0	21.6113	1.9646
5	26.7450	1.8825
10	33.4165	1.8032



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