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G. D. Whipple and M. D. Gray

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WELFARE EFFECTS OF LOWERED DAIRY PRICE SUPPORT LEVELS

G. D. Whipple and M. D. Gray*

Abstract

A reactive programming simulation model was used to estimate the effects of $.50 and $1.00 reductions in the price support level on milk producers' and consumers' economic surplus. The model solutions indicate that these support level reductions would have reduced the net cost and transfer effects of dairy market regulation in 1981. Milk producers would incur substantial economic surplus losses while milk consumers would receive substantial surplus gains. A support level reduction of $1.00 would have alleviated the need for price support acquisitions in 1981 under long run equilibrium conditions.

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Welfare Effects of Lowered Dairy Price Support Levels

The over-production problem in the U.S. Dairy industry has spawned considerable discussion of the dairy price support program. The Commodity Credit Corporation (CCC) purchased 10.3 percent of total U.S. milk production during the marketing year ending September 30, 1982. October 1, 1982 government inventories of dairy products amounted to 12.1 percent of annual production.

The federal government supports the price of manufacturing milk through the purchase of manufactured products (nonfat dried milk, butter and cheese) by the CCC. The Agricultural Act of 1949 set the price support level at between 75 and 90 percent of parity. From 1977 until April of 1981 the support level was set at between 80 and 90 percent of parity. The April 1981 price support increase was revoked by special legislation. The 1981 farm bill (signed into law in December 1981) set the support level at the previous year's level until September 1982 and related future increases to parity only if support purchases fall below a specified level. A $.50 per cwt. tax was imposed on all milk marketed to defray the cost of the price support program in April 1983. An additional $.50 per cwt. tax was levied in October 1983. This tax is a response to the large CCC expenditures for price support. A reduction in the price support level is an alternative action which would reduce the government cost of the price support program.

A lower support price would reduce government costs of price support but would also affect milk market participants. The objective of this paper is to estimate the impacts of lowered support prices on the welfare of milk consumers and producers in the U.S.

Theoretical Model

Measures of producer's and consumer's surplus have been used frequently to gauge welfare shifts induced by policy changes. Market supply and demand schedules have been used to define areas of surplus and show net welfare effects [Blakely and Riley, Buxton and Hammond, Johnson, and Dahlgran among others]. Although a market demand schedule does not provide an accurate measure of consumer's surplus unless the income elasticity of demand is zero, the measurement error is small if the income elasticity and the portion of the consumer's budget devoted to the product are small. Willig showed that consumer's surplus measured under an ordinary demand curve underestimates the theoretically appropriate compensating variation by $\frac{(N)CS}{2M}$ percent and overestimates the equivalent variation by $\frac{(N)CS}{2M}$ where N is the income elasticity of demand, CS is the consumer's surplus measured under the observed demand curve, and M is the consumer's base income. Empirically, this error has been found to be quite small [Willig].

The perfectly competitive market has been used as a standard by which to compare other equilibria or resource allocations. Dahlgran, Wallace, and Johnson have each used estimates of perfectly competitive equilibrium to gauge the effects of actual or potential agricultural policies. Although perfect competition rarely exists in real world markets, it provides the best standard with which to compare other market equilibria and measure resource reallocations. In this analysis producer's and consumer's surplus measured as deviations of actual or potential market equilibria from the competitive equilibrium are used to assess the welfare effects of lowered support prices.

The theoretical model used in this analysis incorporates the workings of the market order system and the price support program. Under federal orders, milk is priced according to its use. Class I milk (milk consumed as fluid milk) is paid the Minnesota-Wisconsin manufacturing (M-W) price plus a Class I differential. The Class I differential varies by market order and is generally based on the distance from Eau Claire, Wisconsin. Class II and III milk are paid the M-W price or slightly more. All of the milk shipped into a market order is pooled and producers are paid the average price (blend price) of all milk sold from the pool.[1]

Figure 1 represents a single market for fluid and manufacturing milk with farm level supply curves for Grade A and Grade B milk combined into total milk supply (SM). The farm level derived demand schedules for fluid and manufacturing milk are represented by DF and DM, respectively. Total milk demand in a competitively organized market is the horizontal sum of DF and DM (DF+DM). Perfectly competitive equilibrium would occur where DF+DM equals SM, resulting in the price-quantity vector (PF^c, PM^c, PB^c, QF^c, QM^c, QB^c) where:

PF is the farm level price of fluid milk

PM is the farm level price of manufacturing milk

PB is the farm level price of milk (blend price)

QF is the quantity of fluid milk consumed

QM is the quantity of milk consumed as manufactured products

QB is the quantity of milk produced.

The superscript c indicates the competitive equilibrium values of the variables.

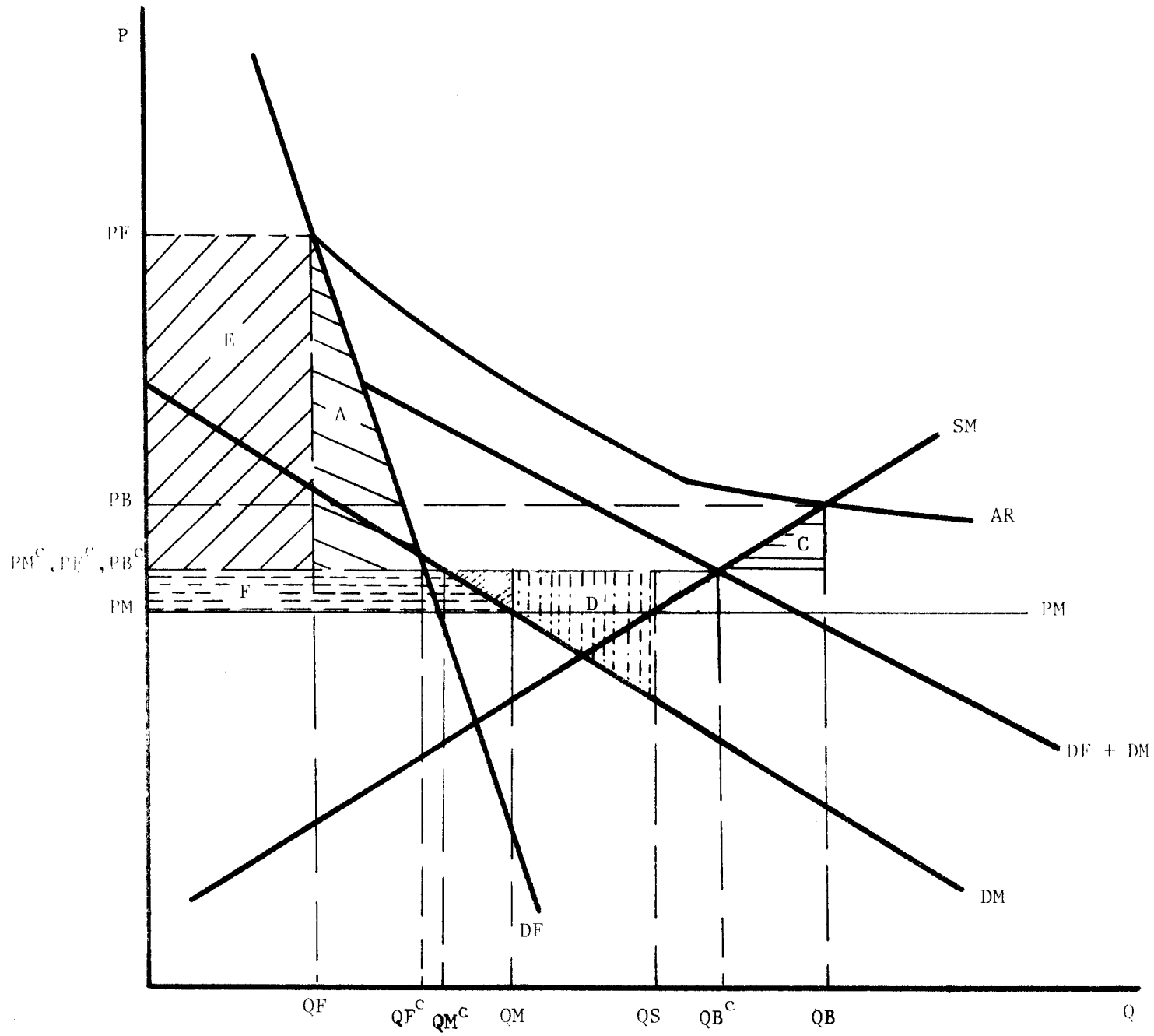

Figure 1. Equilibrium and Welfare Losses and Transfers of a Dairy Market with Classified Pricing, Pooling, and Price Supports.

Under classified pricing and pooling, the producer price depends on how the milk in the pool is used. The higher valued fluid product use is first satisfied while the remainder of the milk is used in manufactured products. The relationship between producer milk price and quantity produced is described by the blend price or average revenue function (AR). The average revenue function is defined as:

$$AR = \frac{PF(QF) + [DM@(QB-QF)]\,[QB-QF]}{QB}$$

for any QB given price PF where

DM@(QB-QF) is the price of manufacturing milk

assuming that (QB-QF) is used in manufactured products.

Under price support the manufacturing milk demand function DM is perfectly elastic at PM reflecting the government's willingness to buy all manufactured milk products offered for sale at prices reflecting PM. This kink in DM results in a kinked AR which approaches PM asymtotically in the limit. It is assumed that Grade B milk is paid the same price as Grade A milk used in manufactured products. Equilibrium with classified pricing, pooling, and price supports is at the intersection of AR and SM resulting in the price-quantity vector (PF,PM,PB,QF,QM,QT) where QS is the total quantity of milk used in manufactured products including that purchased by the CCC for price support. Price support acquisitions equal QS-QM. The economic surplus losses and transfers which result from classified pricing, pooling and price supports are shown in Figure 1. Area A plus Area E is the reduction in consumer's surplus resulting from the supracompetitive pricing of fluid milk: Area E is captured by milk producers as additional revenue and thus represent a transfer from fluid milk consumers to milk producers. Area A is uncaptured, representing a deadweight loss of consumer's surplus. Area C is the resource loss

resulting from the over production of milk under regulation.[2] Area F plus Area B plus Area D is reduction in producer's surplus which results from the subcompetitive pricing of manufactured milk products under regulation. Area F is under the private sector DM and is thus captured by manufactured product consumers. Area F is a transfer from milk producers to manufactured product consumers. Area B plus Area D is uncaptured, thus is a deadweight loss. Area B is the loss of producer's surplus on those products purchased by private sector consumers. Area D is the loss on those products purchased by the government for your support.[3]

An aggregation across all such markets in the U.S. linked by inter-market transfer costs constitutes a farm level model of the U.S. dairy industry. The market and welfare impacts of lower levels of price support can be assessed by comparison of the equilibrium price-quantity vectors and welfare loss and transfer measures at those levels of support.

Empirical Model

The reactive programming technique developed by T. E. Tramel and A. D. Seale was used as the solution algorithm for the simulation model. The reactive algorithm determines interregional market equilibrium given regional supply and demand functions and transfer costs between regions. The interregional model used in this analysis encompassed the continental U.S. which was divided into 21 manufacturing, 21 fluid milk demand, and 21 supply functions. Supply and demand functions used in the model were price dependent and Cobb-Douglas type. They were calculated from calendar year 1981 price and quantity, production and consumption data for each region and long run price elasticities.[4] The price elasticities of demand

for fluid and manufacturing milk were set at -.20 and -.352, respectively. The elasticity of supply was set at 1.19. These elasticity parameters were set based on the estimates of Dahlgran and George and King. Variations in elasticities among regions were non considered. Dahlgran [1980[b]] shows such differences are not significant.

Two variations of the simulation model were formulated to measure the welfare impacts of various levels of price support. Model I stimulates the market as if it were perfectly competitive (no market orders or price supports and competition within and between regions). It was assumed in Model I that all milk used in manufactured products was Grade B and that the cost of production difference between Grade A and Grade B milk was $.20 per hundred pounds. Model I provides the efficiency baseline against which the welfare impacts of noncompetitive market situations can be measured. Model II simulates the market with classified pricing and pooling and price supports with the price support level as a policy variable. The price mover or base is assumed to be the manufacturing milk price because this is the closest internal model approximation to the M-W price. The fluid milk price is assumed to be the manufacturing milk price plus the Class I differential. The producer blend price is the average revenue derived from the sale of milk for fluid and manufacturing uses. Grades A and B milk are combined in each production region. Thus, the producer price represents an average milk price rather than an average Grade A milk price.

The average U.S. manufacturing milk price was about $12.95 per cwt. in 1981. The welfare effects of alternative price support levels of $12.50 (70 percent of parity for 1981) and $12.00 (67 percent of parity for 1981) are presented in this paper.

To measure the welfare impacts of the reduced support levels a three step analysis was used. 1) The economic surplus losses and transfers resulting from classified pricing, pooling and the price support program were estimated from Model I competitive market estimates and Model II regulated market estimates at the observed level of price support. 2) The surplus losses and transfers which would result from classified pricing and pooling but with lowered levels of support were estimated from Model II, lowered support price estimates and competitive market simulation estimates. 3) The surplus loss and transfer estimates of the observed and lowered support price situations were compared. The difference between the welfare effects of the two policy situations provides an estimate of the welfare effects of a lowered support price.[5]

Results

The reduction of the 1981 support level to $12.50 would have reduced price support acquisitions by 40 percent (from 12,861 million lbs. to 7,716 million lbs.) at long run equilibrium. Reduction to $12.00 would have reduced price support acquisitions to zero in the long run. The welfare implications of lowering the price from its 1981 level of $12.95 to $12.50 and to $12.00 are listed in Tables 1 and 2, respectively. These results indicate that both support price reductions would have decreased the deadweight loss due to the supracompetitive pricing of fluid milk (Figure 1, Area A) and the resource loss due to the over production of milk (Area C). The deadweight loss due to the subcompetitive pricing of manufactured milk products (Area B) would have increased while

Table 1. The Net Welfare Effects Associated with a Reduction of the Support Price from $12.95 to $12.50 Assuming the Existence of the Federal and State Market Orders and the Price Support Program

Region	Change in Economic Surplus[e]						Change of Net Surplus			
	A	B	C	D	E	F	Milk Producers[a]	Fluid Milk Consumer[b]	Manufacturing Milk Consumer[c]	Net Total Effects[d]
	Millions of Dollars									
Northeast	-1.878	-0.107	-13.303		-55.243	61.065	-103.000	57.121	61.172	-16.293
Southeast	-0.693	-0.104	-2.665		-36.515	8.590	-42.240	37.224	8.694	-3.477
Lake States	-0.670	-0.052	-5.746	-59.027	-34.587	92.547	-121.604	35.257	151.625	-66.279
Upper-Midwest	-0.218	-0.084	-0.925		-12.119	62.534	-73.728	12,337	62.593	-1.786
South Central	-0.609	0.779	-3.286		-38.635	9.564	-44.914	39.245	8.785	-3.116
Mountain-Southwest	-0.241	0.006	-1.300		-8.727	3.877	-11.297	8.968	3.871	-1.542
California-Nevada	-0.615	0.065	-2.331		-3.005	21.766	-22.450	3.620	21.686	-2.863
Northwest	-0.185	0.009	-0.414		-8.608	9,930	-18.124	8.793	9.921	-0.590
TOTAL	-5.109	0.512	-29.970	-59.027	-197.439	269.873	-437.342	202.548	328.344	-95.946

[a]Equals the change in areas [E-(F+C)].

[b]Equals the change in areas [-(E+A)].

[c]Equals the change in areas [F-(B+D)].

[d]Equals producers' plus fluid and manufactured product consumers' net welfare for each region and the total U.S.

[e]Economic surplus areas correspond to like-labeled areas in Figure 1.

Table 2. The Net Welfare Effect Associated with a Reduction of the Support Price from $12.95 to $12.00 Assuming the Existence of the Federal and State Market Orders and the Price Support Program

Region	Change in Economic Surplus[e]						Change of Net Surplus			
	A	B	C	D	E	F	Milk Producer[a]	Fluid Milk Consumer[b]	Manufacturing Milk Consumer[c]	Net Social Effects[d]
	Millions of Dollars									
Northeast	-4.030	0.907	-18.187		-131.890	156.442	-270.145	136.010	155.485	-21.350
Southeast	-1.501	0.048	-7.691		-87.636	21.388	-101.333	89.134	21.340	-9.141
Lake States	-1.263	0.777	-4.976	-77.160	-82.803	151.027	-228.854	84.066	227.410	-83.622
Upper-Midwest	-0.399	1.008	1.123		-28.981	161.599	-191.703	29.380	161.616	-0.707
South Central	-1.197	0.229	-6.337		-83.125	30.170	-106.958	84.322	29.607	-2.029
Mountain-Southwest	-0.516	0.095	-2.387		-20.838	10.720	-29.171	21.837	10.466	-2.649
California-Nevada	-1.329	0.566	-4.271		-57.251	56.710	-109.690	58.580	56.012	-4.902
Northwest	-0.366	0.770	0.002		-20.595	24.471	-45.068	20.961	24.397	-0.290
TOTAL	-10.601	4.400	-42.724	-77.160	-513.119	612.527	-1082.922	573.720	686.333	-124.690

[a]Equals the change in areas [E-(F+C)].

[b]Equals the change in areas [-(E+A)].

[c]Equals the change in areas [F-(B+D)].

[d]Equals producers' plus fluid and manufactured product consumers' net welfare for each region and the total U.S.

[e]Economic surplus areas corresponding to like-labeled areas in Figure 1.

the resource loss due to government price support acquisitions (Area D) would have decreased with a reduced support price of $12.00 or $12.50.

The analysis indicates that the $12.50 support price would result in a $437.342 million loss in net economic surplus (Table 1) to U.S. milk producers while respective gains of $202.548 million and $328.344 million would accrue to fluid and manufacturing milk consumers. Total net surplus, which represents the total deadweight loss due to regulation, would be reduced $95.946 million by a $12.50 support price. A support price of $12.00 would result in a $1,082.922 million loss in economic surplus to U.S. milk producers and gains of $523.720 million and $686.333 million to fluid and manufacturing milk consumers, respectively. The net social cost of regulation would be reduced $124.690 million (Table 2).

The welfare implications of dairy market regulation (market orders and price supports at observed 1981 levels) during 1981 are listed in Table 3.[6] The reduction of the price support level to $12.00 would shift milk producers from a net economic surplus gain of $954.265 million (Table 3) to net surplus loss of $128.679 million ($1,082.922 million change, Table 2). Manufacturing milk consumers would shift from a position of -$171.629 million net loss to a net gain of $514.136 million ($686.333 million change). Fluid milk consumers' net surplus loss would be substantially reduced. The total deadweight loss due to dairy regulation, listed as net total surplus, would shift from $146.380 million loss to $21.690 million loss ($124.690 million change, Table 2). Similar, but smaller, changes would be induced by a $12.50 support price.

Table 3. Welfare Implications Associated with Regulation of the U.S. Dairy Industry (Classified Pricing, Pooling, and Price Supports at the 1981 Observed Level).[f]

Region	Economic Surplus Losses[e]				Economic Surplus Transfers[e]		Net Economic Surplus			
	A	B	C	D	E	F	Milk Producers[a]	Fluid Milk Producer[b]	Manufacturing Milk Producer[c]	Total Net Surplus[d]
	Millions of Dollars									
Northeast	6.765	0.115	21.790		321.500	-24.386	324.096	-328.265	24.501	-28.670
Southeast	1.924	0.108	8.800		130.079	-2.402	123.681	-132.000	-2.510	-10.829
Lake States	1.377	0.131	6.024	77.160	103.880	-48.593	146.449	-105.257	-125.884	-85.692
Upper-Midwest	0.456	0.099	0.964		37.470	-22.775	59.281	-37.926	-22.849	-1.494
South Central	1.765	0.005	8.144		115.215	-1.401	108.472	-116.980	-1.406	-9.914
Mountain-Southwest	0.770	0.000	2.747		46.342	0.000	43.595	-47.112	0.000	-3.517
California-Nevada	2.018	0.009	4.332		127.130	6.924	115.874	-129.148	6.933	-6.341
Northwest	0.445	0.005	0.470		31.886	-1.407	32.823	-32.331	-1.412	-0.920
TOTAL	15.520	0.192	53.271	77.160	913.346	-94.040	-954.265	-929.016	-171.629	146.380

[a] Equals areas [E-(F+C)].

[b] Equals areas [-(E+A)].

[c] Equals areas [F-(B+D)].

[d] Equals areas [A + B + C + D].

[e] Economic surplus areas correspond to like-labeled areas in Figure 1.

[f] Regulated equilibrium compared with simulated competitive equilibrium.

Conclusions

The simulation results listed in Table 3 indicate that milk producers gained economic surplus from dairy market regulation in 1981, while milk consumers suffered an economic surplus loss. The $.50 and $1.00 reductions in the support level would have reduced producers' economic surplus gain 48 percent and 113 percent, respectively. In fact, a $1.00 support level reduction would shift milk producers from a position of net economic surplus gain from dairy market regulation to one of net loss. Milk consumers would gain economic surplus from a reduced support level. The Model II simulations indicate that reduction of the support level to $12.00 would have relieved the need for price support acquisitions in 1981 at long run equilibrium. In the opinion of the authors, the supply response elasticity used in this study reflects a time horizon of four or five years. Although shorter run equilibrium solutions were not examined in this paper, it is certain that the response of producers and consumers to changes in price would be more inelastic than those reflected in the Model II solutions. Thus, over a shorter time horizon, a lowered support price would have less effect on the level of price support acquisitions and on economic surplus shifts and losses than these results indicate.

Footnotes

1. For an explanation of the workings of the classified pricing and pooling provisions of the federal market orders, see Hallberg and King.
2. Area C is represented to reflect a minimum loss of resources. It would be larger if the next best alternative use of the additional resources yielded a marginal revenue product below the competitive milk price.
3. Assumed for Area D is that price support acquisitions are consumed in the U.S. If some or all of the acquisitions were consumed in foreign markets, Area D would be larger, unless sales price exceeded acquisition cost.
4. Production and consumption data were collected from Milk Production Disposition and Income, Ag Prices, and Federal Market Order Statistics.
5. The Model II equilibrium solutions at the observed 1981 price support level were compared with actual 1981 market characteristics to validate the basic simulation model. The regional prices and quantities of milk supply were misestimated most seriously at 1.7 percent and 2.3 percent, respectively. Prices and quantities for fluid and manufactured milk demand were each misestimated by less than 1.0 percent. These results suggest that Model II simulated the observed market characteristics satisfactorily.
6. The estimation error resulting from using ordinary market demand curves to measure areas of consumer surplus was calculated according to Willig's formula for Areas A, E, and F. For each of these areas the error was less than 1.0×10^{-9} percent viewed either regionally or for the total U.S. This indicates that the error from using ordinary market demand curves is negligible.

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