Recent Changes in the Regional Structure of U.S. Dairy Production

Birgit Huy, Joachim G. Elterich, and Conrado M. Gempesaw II

Gauging the impact of recent policy changes, this article analyzes production characteristics and the impact of the dairy assessment for northeastern dairy farmers as compared to other major production regions. Employing a restricted translog variable profit function, returns to size, shadow prices, supply elasticities for milk and livestock as well as demand elasticities for concentrate were estimated. Northeastern, just as midwestern farmers, were less responsive in milk supply and concentrate demand, more responsive in livestock production, and less efficient than their California and Texas counterparts. The dairy assessment affected profits of northeastern farmers later than those of other regions. Negative shadow prices indicated overinvestment into fixed factors.

Introduction

The past few years have been marked by a definite departure from traditional dairy policies. While previously parity policy and other measures were primarily aimed at sustaining and stabilizing the dairy farmer's income, recent policies are directed at reducing surplus dairy production in light of tremendous and costly oversupply. These policy changes include the dairy assessment, reduced support prices, a marketing assessment, and lately, the herd-buyout program. If effective, these policies will not only reduce milk supply and affect dairy producers but will also affect the agricultural economies of regions highly dependent on milk production. The Northeast is an important dairy production region, producing about 23% of the U.S. milk supply. Since dairy production is so important to the Northeast, an analysis of the impacts of recent policy changes on the dairy production structure of this region as compared to other regions can contribute to an assessment of the present and future competitiveness of Northeast dairy production.

The production structure of the dairy industry has been well researched, with past studies using many conceptual frameworks and methodologies. While such research has been done extensively on the regional or state level (e.g. Grisly and Gitu, Spaulding and Daniels, Hoque and Adelaja, and Elterich and Masud), few have studied regional differences. Recent studies looking at regions include Hammond, Hallberg and Fallert, and Cilley and Blakley. Recently, Dahlgran and Chavas and Klemme analyzed the supply response for the aggregate national dairy industry. This approach ignores the diverse regional characteristics of dairy farms across the nation. Furthermore, none of these studies have analyzed the differential impacts of recent policy changes across regions.

The objectives of the study are as follows:

1. To analyze the major production characteristics of dairy farmers in the Northeast (New England, New York, Ohio, Pennsylvania) as compared to other dairy production regions.
2. To evaluate the impact of recent policy changes on the production structure of northeastern dairy farms as compared to other dairy production regions.

To achieve these objectives, the following characteristics of production were estimated and analyzed for representative dairy farms in selected regions[1] of the U.S. for the period 1981–85: returns to size, shadow prices for quasi-fixed factors, short-run elasticities of product supply and factor demand, and a measure of the regional effect of the dairy assessment on the profitability of dairy farms.

The authors are former graduate research assistant, professor, and assistant professor, respectively, Department of Food and Resource Economics, University of Delaware. The authors acknowledge the helpful comments of the editor and two anonymous reviewers.

[1] "Regions" and states are used interchangeably in this study. However, except for New England, all other so-called "regions" are actually individual states. The New England region includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. The "other" states are New York, Pennsylvania, Ohio, California, Iowa, Tennessee, Texas, and Wisconsin.

Methodology and Data

The regional dairy production in the U.S. can be described by a transformation function

$$(1)\qquad F(Y, X, Z) = 0,$$

where: F = transformation function,
Y = vector of outputs,
X = vector of variable inputs, and
Z = vector of fixed inputs and other exogenous variables.

The transformation function F relates all outputs Y with the chosen levels of variable inputs X, given resource constraints, as represented by the fixed inputs. Duality theory has established the relationship between transformation functions and profit functions that allows using a profit function of certain characteristics in place of the transformation function. The regularity conditions require that the profit function be finite, nonnegative, real valued, continuous, smooth, monotonic, convex in prices, twice differentiable, bounded, and linear homogeneous in all prices (McFadden).

This study employed a restricted translog variable profit function

$$
\begin{aligned}
ln\,\pi = {} & \alpha_0 + \sum_s \alpha_s D_s + \sum_i \beta_i \, ln\, P_i \\
& + \sum_j \chi_i \, ln\, R_j + \sum_z \delta_z \, ln\, Z_z + \tau T \\
& + \frac{1}{2}\Bigg[\sum_i \sum_h \beta_{ih} \, ln\, P_i \, ln\, P_h \\
& + \sum_j \sum_k \chi_{jk} \, ln\, R_j \, ln\, R_k \\
& + \sum_z \sum_t \delta_{zt} \, ln\, Z_z \, ln\, Z_t\Bigg] \\
& + \sum_i \sum_j \epsilon_{ij} \, ln\, P_i \, ln\, R_j \\
(2)\qquad & + \sum_i \sum_z \phi_{iz} \, ln\, P_i \, ln\, Z_z \\
& + \sum_i \sum_s \gamma_{ig} \, ln\, P_i \, D_s \\
& + \sum_i \mu_i \, ln\, P_i T \\
& + \sum_j \sum_z \eta_{jz} \, ln\, R_j \, Z_z \\
& + \sum_j \sum_s \psi_{js} \, ln\, R_j \, D_s \\
& + \sum_j \nu_j \, ln\, R_n \, T \\
& + \sum_z \zeta_z \, ln\, Z_z \, T + \sum_z \sum_s \kappa_{zs} \, ln\, Z_z \, D_s \\
& + \sum_s \omega_s \, TD_s.
\end{aligned}
$$

where: π = normalized expected variable profits (= revenues − cost of variable factors),
D_s = *binary variable for region* s^2,
P_i = vector of normalized output prices,
R_j = vector of normalized input prices,
Z_z = vector of quantities of quasi-fixed inputs and other exogenous variables,
T = binary variable referring to the dairy assessment.

The translogarithmic functional form, originally proposed by Halter, Carter, and Hocking, was developed for the dual form by Christensen, Jorgenson, and Lau. This functional form has the advantage that—by the envelope theorem (Beattie and Taylor)—the first derivatives of the profit function (2) with respect to the normalized product and factor prices represent the product supply and input demand share equations. The share equations are linear in the logarithms of normalized prices and quantities of fixed inputs. This linearity makes empirical estimation easier. The input and output share equations derived using Hotelling's Lemma are

$$
\begin{aligned}
& \frac{\partial\, ln\,\pi}{\partial\, ln\, P_i} = \beta_i + \sum_h B_{ih} \, ln\, P_h + \sum_j \epsilon_{ij} \, lnR_j \\
(3)\qquad & + \sum_z \phi_{iz} \, ln\, Z_z \\
& + \sum_s \gamma_{ig} D_s + \mu_i T,
\end{aligned}
$$

and

$$
\begin{aligned}
(4)\qquad & \frac{\partial\, ln\,\pi}{\partial\, ln\, R_j} = \chi_j + \sum_i \epsilon_{ji} \, lnP_i + \sum_k \chi_{jk} \, ln\, R_k \\
& + \sum_z \eta_{jz} \, lnZ_z + \sum_s \psi_{js} D_s + \nu_j T.
\end{aligned}
$$

Since a cross-partial derivative is invariant with respect to the order of differentiation, symmetry between interaction parameters is imposed. This also reduces the number of parameters to be estimated. To assure linear homogeneity of the profit function, both the profit function (2) and the share equations (3 and 4), were normalized using price of hired labor as the numeraire. When imposing

[2] The regions were divided as follows: The Northeast was comprised of the New England states, New York, Pennsylvania and Ohio. The other regions were Upper Midwest—Wisconsin, Corn Belt—Iowa, Appalachia—Tennessee, Southwest—Texas, and West—California. The Northeast regional dumy was excluded since using all six regional dummies would result into a singular moments matrix.

linear homogeneity, the share equation for the numeraire is dropped in the estimation to avoid singularity in the variance-covariance matrix.

The variables included in the profit function are variable profits, milk and livestock output prices, variable factor prices for dairy concentrate, roughage, hired labor, and miscellaneous inputs, and the real total expenditures[3] for capital and for other quasi-fixed inputs, such as land, family and operator labor, and general farm overhead. These represent the major input costs and output revenues on a specialized dairy farm.[4] In addition, six binary variables were incorporated into the model. One binary variable accounted for the introduction of the dairy assessment in 1983, while the other binary variables distinguished the six regions.

The data set consisted of pooled cross-sectional, time-series data derived from the Firm Enterprise Data System (FEDS), a consistently defined data base in budget form compiled annually by the Economic Research Service/U.S. Department of Agriculture (ERS/USDA). The data set contained information on representative farms for 6 major milk producing regions (20 states) and was available for the time period. This information was aggregated into the nine variables used. The data set, consisting of state budgets, provides information on the unit prices, total revenues and expenditures (Table 1).

The coefficients of the system of one profit and five share equations were estimated simultaneously using Zellner's Iterative Seemingly Unrelated Regression method. This procedure is equivalent to the maximum likelihood procedure and ensures that the parameter estimates are invariant to the numeraire variable selected (Barten). The resulting 89 parameters, of which 44 were significant at the .10 level, and the predicted shares were used to calculate elasticities, returns-to-size estimates, shadow prices, and the impact of the dairy assessment policy. The parameters are not reported here but are available in Huy.

The returns-to-size estimates were calculated using the formula:

$$(5) \qquad RTSZ = \frac{\sum_{j=1}^{n} \frac{R_j \hat{X}_j}{\hat{\pi}}}{\sum_{i=1}^{m} \frac{P_i \hat{Y}_i}{\hat{\pi}}}.$$

The shadow prices, λ_l, for the fixed factors Z_l were obtained using $\lambda_l = \frac{\partial \ln \hat{\pi}}{\partial \ln Z_z} \cdot \frac{\hat{\pi}}{Z_z}$.

$$(6) \qquad \text{where } \frac{\partial \ln \hat{\pi}}{\partial \ln Z_z} = \delta_z + \sum_t \delta_{zt} \ln Z_t + \sum_i \phi_{iz} \ln P_i + \sum_j \eta_{jz} \ln R_j + \delta_z T + \sum_s \kappa_{zs} \ln D_s.$$

Shadow prices were estimated for two quasi-fixed factors: capital, consisting of machinery and equipment capital and livestock capital, and an aggregate of land, family and operator labor and general farm overhead.

Further, the following elasticities were estimated:

1. The own-price supply elasticity for milk, $E_{ii} = \frac{\partial \ln Y_i}{\partial \ln P_i}$, *was estimated using*

$$(7) \qquad E_{ii} = \beta_{ii} \cdot \frac{1}{\hat{SP}_i} + \hat{SP}_i - 1.$$

2. The cross-price elasticity of supply for livestock, $E_{ih} = \frac{\partial \ln Y_h}{\partial \ln P_i}$, *was estimated as*

$$(8) \qquad E_{ih} = \beta_{ih} \frac{1}{\hat{SP}_i} + \hat{SP}_h.$$

3. The elasticity of demand for concentrate feed with respect to the milk price was

$$(9) \qquad E_{ky} = E_{yk} \frac{1}{\hat{SR}_k} + \hat{SP}_y$$

where SP_i and SR_i are the shares of profit associated with output i and input k, respectively.

The binary variable for the dairy assessment was set to zero for 1981 and 1982 and one for 1983, 1984, and 1985, the years farmers were subject to the assessment. The derivative of the dairy assessment variable, called 'T,' was taken with respect to variable profits π^* to obtain the rate of change in profits given a change in the dairy assessment r^*:

$$(10) \qquad r^* = \frac{\partial \ln \hat{\pi}}{\partial T}.$$

Returns to Size

Since Madden's seminal article on economies of size in farming, the estimation of returns to size has been an important topic in the agricultural eco-

[3] Estimated by deflating current expenditures for these items by the general inflation index.

[4] Farms obtaining over 50% of their revenues from the dairy enterprise were considered 'specialized.'

Table 1. Characteristics of Typical Dairy Farms in Different Regions of the U.S., 1985 ($)*

			Products			
State	Price/cwt.	Milk	Milk	Livestock	Total Income	Profits
New England	13.28	15,493	205,747	13,380	219,127	102,500
New York	12.78	11,166	142,701	11,585	154,287	77,231
Ohio	12.87	8,840	113,771	8,353	122,124	64,402
Pennsylvania	13.16	10,369	136,456	8,565	145,021	78,463
California	12.32	91,212	1,123,731	68,149	1,191,880	503,479
Iowa	12.19	8,934	108,905	8,970	117,875	61,067
Tennessee	13.40	10,483	140,472	8,267	148,739	66,686
Texas	13.78	28,152	387,935	23,787	411,721	171,236
Wisconsin	12.30	9,055	111,377	12,103	123,479	72,253

			Variable Inputs			
State	Concentrate Price/cwt.	Expenditures: Concentrate/ cwt. of Milk	Wage Rate/hr	Expenditures: Hired Labor/ cwt. of Milk	Hay Price/tn	Expenditures: Hay/cwt. of Milk
New England	8.40	3.50	4.82	1.46	36.72	0.44
New York	8.16	3.41	4.54	1.27	20.66	0.37
Ohio	7.32	3.53	5.06	0.70	25.42	0.62
Pennsylvania	7.96	3.29	4.59	1.07	27.65	0.41
California	7.42	3.12	6.04	0.98	93.55	2.25
Iowa	7.05	3.35	4.50	0.89	24.88	0.28
Tennessee	8.20	4.15	3.97	0.82	43.71	0.85
Texas	7.46	4.26	4.61	1.18	66.52	1.69
Wisconsin	7.03	2.87	3.76	0.70	28.14	0.55

		Quasi-fixed Inputs		
State	Cost of Equipment, Machinery	Cost of Livestock	Unpaid Labor Allocation	Farm Overhead
	per cwt. of milk			
New England	3.20	0.50	1.54	0.60
New York	3.46	0.53	1.51	0.58
Ohio	3.30	0.52	2.24	0.59
Pennsylvania	3.18	0.51	1.73	0.61
California	1.81	0.55	0.32	0.36
Iowa	3.91	0.56	1.85	0.54
Tennessee	2.88	0.59	1.49	0.54
Texas	2.22	0.84	0.77	0.41
Wisconsin	3.64	0.62	1.64	0.65

*Except as stated. (Source: FEDS)

nomics literature. In a recent summary of the importance of returns-to-size estimates for policy purposes, Stefanou and Madden also concluded that the best data set to use is the cross-sectional, time-series data used in this study. The returns-to-size measures presented in Table 2 must be interpreted with respect to the excellent criticisms and comments provided by Stefanou and Madden.

The returns-to-size estimates for the nine regions were all less than 1.0, indicating that dairy farmers are producing in the decreasing returns-to-size portion of their average cost curves. One could probably conclude that dairy farmers have been overproducing given their respective cost structures in response to past price support policies. In terms of individual regions, dairy farms in the Northeast had similar estimates while Wisconsin had the lowest estimated returns to size. The typically large scale operations in California and Texas had the largest estimated returns to size. Virtually all the regions had increased (i.e., more inefficient) returns-to-size estimates in 1983, the first year of implementation of the dairy assessment act. Despite the assessment's implementation in 1983, dairy producers have not substantially reduced their production levels as indicated by the insignificant changes in returns to size from 1983 to 1985.

Shadow Prices

Regional differences in the production structure of dairy farms can be investigated further through the

Table 2. Returns to Size for Dairy Farms in Selected Regions, 1981–85

Year	State								
	New England	New York	Ohio	Pennsylvania	Wisconsin	Tennessee	Iowa	Texas	California
1981	0.472	0.466	0.491	0.470	0.390	0.568	0.458	0.589	0.566
1982	0.470	0.462	0.466	0.471	0.391	0.560	0.448	0.573	0.559
1983	0.474	0.474	0.474	0.474	0.393	0.570	0.495	0.575	0.572
1984	0.486	0.488	0.489	0.482	0.425	0.563	0.498	0.605	0.571
1985	0.481	0.481	0.466	0.471	0.451	0.540	0.495	0.590	0.584
Mean	0.476	0.474	0.477	0.473	0.410	0.560	0.479	0.586	0.570

analysis of shadow prices. A positive (negative) shadow price gives an indication about the increase (decrease) in profitability of a reallocation of fixed resources. Negative shadow prices for capital, were found for 1982 and 1985 in all northeastern states (Table 3). This confirms that farmers have been overinvesting in capital intensive technology. But the shadow prices for non-capital fixed factors (Table 4) indicate that northeastern farmers were overinvesting (or underutilizing) these factors even more. Except Iowa, the other states exhibit different characteristics from these findings. Tennessee farmers appear to have had the least overinvestment problems. Predominantly negative shadow prices for capital indicate that farmers in California and Texas have overinvested in capital, especially in California where the overinvestment increased between 1981 and 1985. Most of the shadow prices for non-capital fixed factors of farms in California and Texas show increasing and positive values over the years.

Elasticities

The estimated elasticities illustrate the supply and demand behavior of regional dairy farms. The own-price supply elasticities for milk (Table 5) indicate that farmers in all northeastern states are extremely unresponsive to milk price changes (0.03 to 0.17). This behavior can be attributed to the lack of alternatives to dairy farming in the region. Over the years, only a minimal increase in responsiveness can be observed. The negative elasticity values (−0.03 to −0.30) for Wisconsin indicate irrational profit maximizing behavior. The estimates for California, Tennessee, and Texas, show a much

Table 3. Shadow Prices (in dollars) for Capital of Dairy Farms in Selected Regions of the U.S., 1981–85

Year	New England	Pennsylvania	Iowa
1981	0.948	0.410	0.477
1982	−0.381	−1.262	0.405
1983	0.148	0.148	0.032
1984	0.296	0.215	−0.008
1985	−1.036	−0.986	0.115
Year	**New York**	**Wisconsin**	**Texas**
1981	0.427	0.077	0.241
1982	−0.258	−1.399	−0.920
1983	0.148	0.193	0.170
1984	0.479	−0.161	−3.849
1985	−1.366	−0.837	−1.302
Year	**Ohio**	**California**	**Tennessee**
1981	−0.700	−1.599	0.171
1982	−1.054	−1.841	−0.521
1983	0.148	−0.911	0.145
1984	−0.197	−1.613	0.153
1985	0.980	−2.130	−0.210

Table 4. Shadow Prices (in dollars) for Fixed Factors other than Capital of Dairy Farms in Selected Regions of the U.S., 1981–85

Year	New England	Pennsylvania	Iowa
1981	−0.341	−0.211	0.083
1982	0.161	0.270	0.375
1983	−0.897	−0.897	−0.642
1984	−0.460	−0.412	−0.033
1985	0.247	0.261	0.394
Year	**New York**	**Wisconsin**	**Texas**
1981	−0.366	−0.280	0.232
1982	−0.021	0.257	0.200
1983	−0.897	−0.887	−0.463
1984	−1.105	−0.474	0.311
1985	0.053	0.034	0.864
Year	**Ohio**	**California**	**Tennessee**
1981	−0.310	1.084	0.442
1982	0.213	0.981	0.911
1983	−0.897	−0.033	−0.193
1984	−0.344	0.588	0.634
1985	0.307	1.092	1.288

less inelastic response (0.47 to 0.88). Apparently, farmers in these states are much more capable of adjusting to milk price changes. Therefore, in the short run, the lowered support price should be much more effective in reducing output in these regions, but may have the opposite effect in Wisconsin. The estimated short-run elasticities in the Northeast are consistent with the elasticities from past studies (.07 to .16) reviewed by Chavas and Klemme. The higher supply response elasticities in California, Texas, and Tennessee reflect the differences in production technologies used in different areas of the country.

The demand for concentrate feed tends to be more elastic (−.56 to −1.0) in the southern and western regions than in the northern parts of the country (−.25 to −.43). The demand elasticity for hired labor has become less inelastic over the

Table 5. Own-Price Elasticities for Milk for Selected Regions of the U.S., 1981–85

Year	New England	Pennsylvania	Iowa
1981	0.064	0.055	−0.017
1982	0.067	0.079	0.036
1983	0.095	0.095	0.193
1984	0.156	0.149	0.212
1985	0.128	0.092	0.183
Year	**New York**	**Wisconsin**	**Texas**
1981	0.028	−0.322	0.748
1982	0.036	−0.295	0.665
1983	0.095	−0.275	0.677
1984	0.159	−0.140	0.884
1985	0.133	−0.029	0.775
Year	**Ohio**	**California**	**Tennessee**
1981	0.158	0.608	0.602
1982	0.060	0.572	0.565
1983	0.095	0.654	0.628
1984	0.171	0.640	0.600
1985	0.061	0.732	0.468

Table 6. Cross-Price Elasticities of Livestock With Respect to the Price of Milk for Selected Regions of the U.S., 1981–85

Year	New England	Pennsylvania	Iowa
1981	−0.631	−0.694	−0.601
1982	−0.787	−0.935	−0.948
1983	−0.927	−0.927	−0.679
1984	−0.888	−1.089	−0.737
1985	−0.880	−1.107	−0.591
Year	New York	Wisconsin	Texas
1981	−0.628	−0.777	0.076
1982	−0.931	−1.004	−0.348
1983	−0.927	−1.116	−0.316
1984	−0.763	−1.007	−0.044
1985	−0.917	−0.848	−0.186
Year	Ohio	California	Tennessee
1981	−0.559	−0.270	−0.083
1982	−1.014	−0.458	−0.313
1983	−0.927	−0.305	−0.213
1984	−0.880	−0.246	−0.440
1985	−0.978	−0.189	−0.811

years. The Northeast shows very inelastic responses while demand is somewhat more elastic in the Pacific, Appalachia and Southern regions. The mid-country regions display unexpected positive elasticities due partly to the lesser reliance of hired labor in lieu of family labor on dairy farms.

In order to investigate the effect of a change in the milk price on livestock production[5] and its potential effect on the beef market, cross price elasticities for livestock and milk were estimated. The figures in Table 6 indicate that livestock supply is negatively related and fairly responsive to the price of milk and has increased markedly over the years. This increase was particularly pronounced in Ohio and Pennsylvania. In New York and New England, the increase has been less, but nevertheless, by 1985 the supply behavior was nearly elastic. While the development in Wisconsin is similar to that in Pennsylvania, the elasticities in Iowa generally correspond to those in Ohio except for 1985. In Wisconsin and Iowa, the elasticity declined to near the 1981 levels. The development in Tennessee moved in the other direction. From a very inelastic estimate in 1981 the responsiveness increased to −0.81 in 1985. The generally very inelastic values for Texas and California reflect an orientation different from that prevailing in the traditional dairy regions. Dairy farmers in the Southern and Western regions generally gear their production to milk only, and as a result, the milk price will have very little effect on the livestock output and, thus, on the beef market in these areas.

An analysis of cross-price elasticities of demand for concentrate feed with respect to the milk price (Table 7) provides some conclusions about the effect of a price support change on the input market. Like the own-price elasticities for milk, the elasticities for the northeastern states are positive and very small (0.01 to 0.28), implying a minimal change in concentrate demand in the case of a milk price change. Elasticities for Wisconsin show declining negative values, while the demand for concentrate became less inelastic over time in Iowa. The demand for concentrate in California and Tennessee, on the other hand, is nearly elastic, and in Texas, is very elastic with values up to 1.44 in 1984. Obviously, in these states, a change in the milk price will have a greater effect on the concentrate demand, though the greater diversification of agriculture in these regions will likely soften the impact of such a change.

The Dairy Assessment

The dairy assessment—functioning like an excise tax—was introduced in early 1983 as a $.50 charge on every cwt. of milk sold, thus lowering the actual milk price received by an average of $.48 adjusted for the entire year. The objective

[5] Livestock production includes: cull cows, bull calves, and cows sold for breeding and milk production purposes.

Table 7. Demand Elasticities of Concentrate Feed with Respect to the Price of Milk for Selected Regions of the U.S., 1981–85

Year	New England	Pennsylvania	Iowa
1981	0.175	0.118	0.077
1982	0.094	0.070	0.008
1983	0.138	0.138	0.446
1984	0.267	0.273	0.515
1985	0.134	0.117	0.454
Year	New York	Wisconsin	Texas
1981	0.088	−0.837	1.281
1982	0.011	−0.825	1.126
1983	0.138	−0.685	1.151
1984	0.276	−0.276	1.443
1985	0.144	−0.062	1.293
Year	Ohio	California	Tennessee
1981	0.281	0.824	1.068
1982	0.033	0.695	0.989
1983	0.138	0.863	1.090
1984	0.317	0.882	1.078
1985	0.074	0.989	0.849

was to reduce milk output and the cost of maintaining the surplus dairy production. In the following years, the assessment was continued after several court challenges. In 1984, $.50 was charged per cwt. sold. The levy was continued into 1985, which is reflected in the data as an adjusted annual per cwt. payment of $.13.

The estimates with regard to the dairy assessment (Table 8) capture the effect of this policy measure on the variable profits of dairy farmers. The assessment apparently had a lagged effect. Its full impact lagged most in the Northeast, where profits were negatively affected in all states by 1985. This finding corresponds to the development in Wisconsin and Iowa, two other traditional dairy states. In Tennessee, the negative impact was felt immediately in 1983, and continued into 1985. For California and Texas, a negative impact of the assessment can be observed by 1984. In 1985, variable profits were reduced at a rate of 10% (Texas) and 12% (California), which is only a little higher than the results for the northeastern states (between 8% and 10%), but considerably more than in Wisconsin (6%) and Iowa (2%).

Table 8. Effects of the Dairy Assessment on Variable Profits (in Percent) for Selected States of the U.S., 1983–85

Year	New England	Pennsylvania	Iowa
1983	0.04	0.04	0.02
1984	0.03	0.02	−0.007
1985	−0.09	−0.08	−0.02
Year	New York	Wisconsin	Texas
1983	0.04	0.04	0.05
1984	0.07	0.00	−0.24
1985	−0.10	−0.06	−0.10
Year	Ohio	California	Tennessee
1983	0.04	0.01	−0.042
1984	−0.009	−0.06	−0.079
1985	−0.09	−0.12	−0.128

Summary and Implications

This study examined structural aspects of dairy production for the major milk-producing regions of the United States. For each region, various price elasticities for milk, livestock, and dairy concentrate, and shadow prices for two aggregated fixed factors were estimated and analyzed for 1981–85. In addition, returns-to-size estimates were obtained to compare the relative economic efficiency among regions. Since government policies were considered to have had an influence on regional disparities, the regional effect of the dairy assessment was estimated.

A profit function approach based on duality theory was chosen, given the data base and the purpose and assumptions of the study. The data set consisted of pooled cross-sectional, time-series data containing budget information on representative dairy farms for twenty regions from 1981–85. A restricted dual output, translog variable profit function was formulated that incorporated nine variables and six binary variables to distinguish among six regions and to account for the dairy assessment. The system of one profit function and five share equations was estimated using Zellner's Iterative Seemingly Unrelated Regression method.

Return-to-size estimates indicate that northeastern dairy farmers have been overproducing and operating less efficiently than farmers in California or Texas, but relatively more efficiently than farmers in Wisconsin. Over the study period, the improvement in efficiency was less in the northeastern states (except New York) than in other major milk producing states. In addition, predominantly negative shadow prices for the fixed factors indicate that farmers in all northeastern states have been overinvesting.

Generally, the northeastern farmers were very unresponsive to milk price changes as far as their milk output and their demand for concentrate feed was concerned. This behavior was significantly different from the response pattern shown by farmers in California and Texas, where the own-price elasticities for milk averaged around 0.7, and the cross-price demand elasticity for concentrate in California was generally more elastic reflecting the availability of other income-producing alternatives. The livestock production in dairy farms in the Northeast was negatively related and relatively more responsive to milk price changes. This responsiveness has increased over the years (between 0.25 and 0.42) and has become even elastic in 1985 in Pennsylvania and Ohio. The degree of responsiveness in Ohio and Pennsylvania was similar to that of Wisconsin while the response pattern in New York and New England corresponds more closely to that in Iowa. In contrast, the livestock production in California and Texas was generally very inelastic with respect to milk price changes. Hence, the major impact of milk price changes on the cattle market can be expected in the traditional milk producing regions, while the input market for concentrate would be affected the most in California and Texas.

The dairy assessment program affected the northeastern states, Iowa, and Wisconsin similarly, with a lag of about two years. Texas and Californian producers were affected sooner (after about one year), but in 1985, the negative impact of the assessment was experienced in all regions.

The generally inelastic response of milk supply and concentrate demand to milk price changes in the Northeast can partly be explained by the limited availability of profitable alternatives. This circumstance emphasizes the importance of the future of dairy farming to the Northeast as a whole.

The analysis of the differing regional impact of the dairy assessment highlighted the importance of a regional perspective not only for researchers, but also for policy makers. It was obvious that a federal policy measure had significantly different effects on different regions. Since dairy farming plays an important role in the rural economies of some regions, its decline or prosperity will have substantial multiplier effects and economic as well as social consequences for these regions. In other regions, where dairy farming is less essential for the regional economy since more alternative exists, its survival might not be of such a general economic importance. These differences should be acknowledged. Such an acknowledgment suggests that it might be more appropriate to differentiate regional approaches to address and account for regional disparities instead of a uniform federal approach.

Policy measures should therefore be carefully assessed with regard to their regional impact before their implementation. In this context, the low returns to size and the minimal improvement in efficiency despite the policy change has to be considered in future policy formulations. Production and economic efficiency needs to improve if the dairy industry in the Northeast is to survive in the long run.

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