NV

MS 122

UNIVERSITY OF NEVADA, RENO

MARKETING EFFICIENCY OF THE NEVADA DAIRY INDUSTRY

By

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M.S. 122 September, 1980

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Summary and Conclusions

This paper has sought to suggest answers to two questions concerning the efficiency and growth potential of the Nevada dairy industry. First, how does the current milk marketing system in Nevada compare with a most efficient or least cost system? Second, what are the most efficient or least cost marketing systems relative to the projected quantity of milk demanded in 1980, 1985, and 1990?

The study results are clearly dependent upon the costs associated with producing, processing, and shipping milk. The authors believe that the costs used in this study are adequately representative of the industry for testing market efficiency and assessing the impacts of increasing demands in future years.

Regarding the marketing efficiency of the Nevada dairy industry, results indicate that the current marketing system (1977) is only slightly more costly than the most efficient or least cost system. Specifically, total cost of producing, processing, and transporting milk in 1977 is about 1.4 percent higher than the most efficient or least cost system where shipment patterns are not restricted to existing shipment patterns. Because of the small differential between the current and the most efficient system, we conclude that Nevada's marketing system is relatively efficient.

Historically, Nevada milk processing capacity has lagged behind the quantity of milk. With each successive increase in the amount of milk demanded, more milk is shipped into Nevada from out-of-state regions. Should this trend continue, the market share of Nevada processors will dwindle.

With this in mind, we investigated potential adjustments in the dairy industry in view of increasing demands projected to 1980, 1985, and 1990. The results of this analysis suggests increasing processing capacity in western and southern Nevada. These increases in processing capacity should lead to lower unit processing costs due to economies of size in processing milk. These lower processing costs and shorter distances favor increased processing in the future by Nevada processors.

MARKETING EFFICIENCY IN THE NEVADA DAIRY INDUSTRY

Introduction

The fluid milk industry[1] in Nevada, as considered in this paper, is divided into seven regions:

I - Northern California

II - Southern California

III - Western Nevada

IV - Southern Nevada

V - Eastern Nevada

IV - Northern Utah

VII - Southeastern Idaho

Currently, all seven regions produce Class I milk.[2] All regions, except Region V, have fluid milk processing plants. Regions III, IV, and V are the areas of demand for fluid milk as considered in the model. Tables 1 and 2 depict 1977 fluid milk supply and demand for regions considered. The three regions of Nevada currently enteract with out-of-state regions as illustrated in Figure 1. This paper is concerned with the efficiency with which milk is produced an processed in this regional context.

Efficiency, in the general sense, is usually defined as output divided by input. If the output of a particular process is greater per unit of input than that of another process, the first process is considered more efficient than the second. With respect to a marketing system, a measure of efficiency might be the cost of providing a specific level of goods or services. Accordingly, we would say that one marketing system is more efficient than another if the former has a lower cost.

[1]The term "fluid milk" is generally used to designate a milk product processed for consumption in fluid form such as 3.5 percent homogenized milk. It does not include cultured liquid products such as buttermilk.

[2]Class I milk is the term given to unprocessed or producer-level milk that goes to fluid milk products.

Table 1

Regional Fluid Milk Consumption
Selected Years 1977-1990

Consuming Region	1977[a]	1980[b]	1985[b]	1990[b]
		Cwt/year		
N. Nevada	769,797	782,000	864,000	954,000
S. Nevada	1,043,140	1,117,000	1,206,000	1,296,000
E. Nevada	70,753	86,000	90,000	95,000
TOTAL	1,883,690	1,985,000	2,160,000	2,346,000

[a]Nevada Dairy Commission News, Vol. xvii, No. 4, Dec.31, 1977.

[b]Baughman, Garrett, and Ching, Description of the Nevada Dairy Industry, Table 12.

Table 2

Supplies of Class I Milk Potentially Available to
Meet Nevada Demands, 1977

Producing Region	Supply of Milk cwt/year
N. California	1,120,000[a]
S. California	2,128,000[a]
N. Nevada	854,657[b]
S. Nevada	590,170[b]
E. Nevada	18,833[b]
N. Utah	1,437,167[a]
S.E. Idaho	83,200[a]

[a]Milk potentially available to supply Nevada as estimated by the maximum capacities of plants currently shipping to Nevada.

[b]Milk supplied by Nevada producers.

Source: Nevada Dairy Commission News, Vol xvii, No. 4 Dec. 31, 1977.

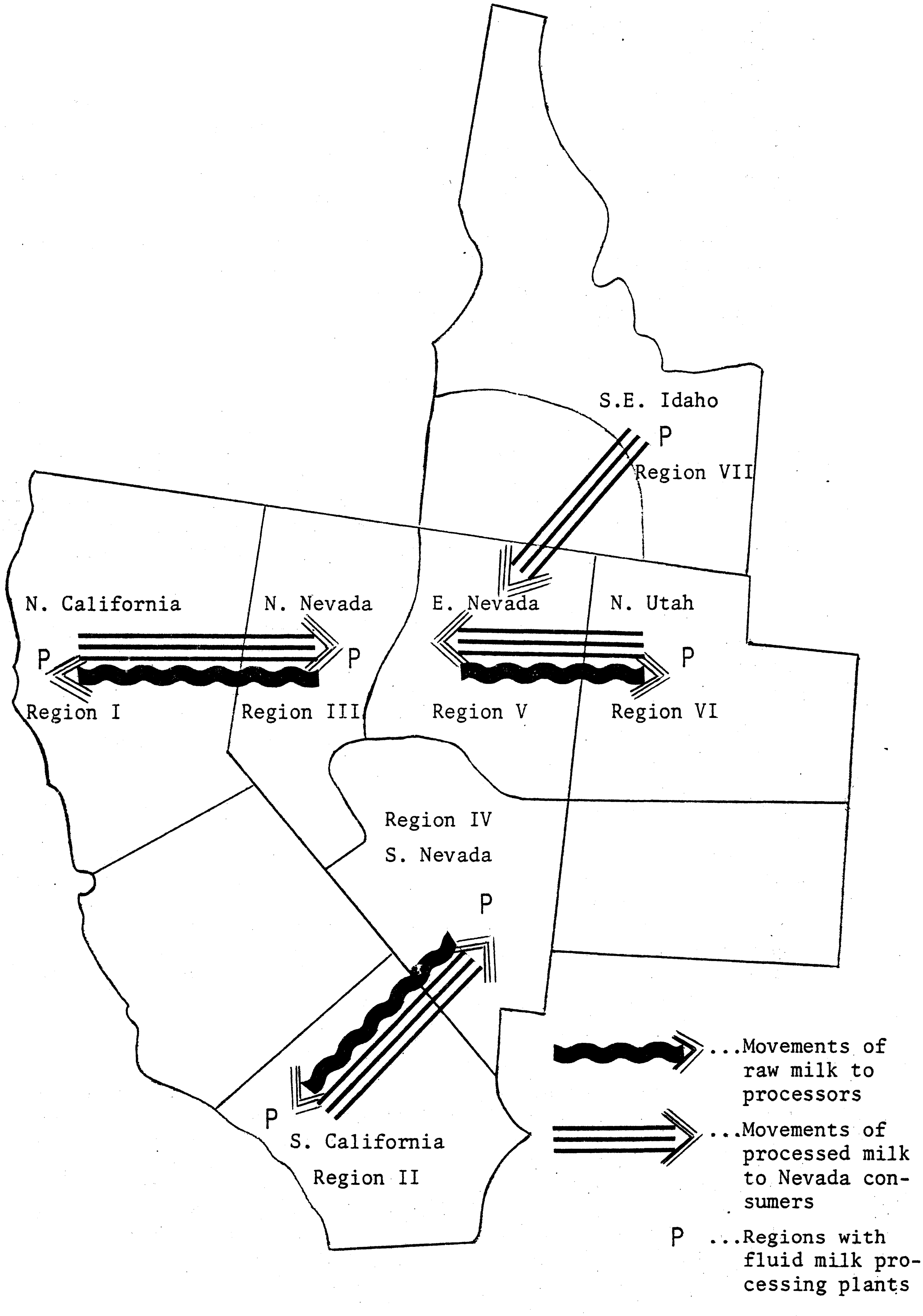

Figure 1

Current Interregional Movement of Raw and Processed Milk

Relative to this concept of marketing efficiency, this report seeks to answer two related questions. First, how efficient is the milk marketing system in Nevada? That is, how does the current milk marketing system in Nevada compare to the "most efficient (lowest cost)" milk marketing system which would provide the same level of milk output?

Second, what are the most efficient marketing systems for the future (1980, 1985, 1990) given projected demands for milk for those years? Analysis of future marketing efficiencies suggests adjustments that can be made in the Nevada Dairy Industry.

Procedure

The analysis is divided into five cases. Case I corresponds to the current (1977) interregional movement of milk at the producer and processor levels. Case II estimates the most efficient (least cost) system of providing fluid milk, using 1977 supply and demand levels, but permitting shipment patterns other than those actually observed in 1977. As the most efficient system, this case provides a benchmark against which Case I is compared.

Cases III, IV, and V, are planning situations. They show the least cost way of producing, processing and distributing milk in Nevada to meet projected fluid milk demands for 1980, 1985, 1990. They are presented to suggest potential adjustments in the Nevada Dairy Industry.

The supplies of and demands for milk (both for processing as well as final consumption) are presented in Appendix B.

Milk Production Costs

Producers of Class I milk in Nevada appear competitive with out-of-state producers (Table 3). The authors recognize that costs from separate studies may not be comparable. However, extreme care was exercised to include the same costs components and to correct for inflation using appropriate indices. Plausible explanations of the lower production costs include lower property taxes, less state imposed costs, less waste regulation, and lower capital investment per farm.

Milk Processing Costs

Fluid milk processing plants in Nevada tend to be smaller and operate at higher per-unit costs than surrounding region competitors. Economies of size can be achieved as processing capacity increases. A 1970 Vermont study found that plants with 559,000, 2,236,000, 4,472,000 cwt per year capacities had costs of \$1.70, \$1.30, and \$1.20 per cwt (Devino, et al.). A similar 1963 Vermont study found that plants with capacities of 33,540, 111,800, 279,500, 559,000 cwt per year had cost respectively of \$2.85, \$1.45, \$1.60 and \$1.45 per cwt (Webster, et al.)

Table 3

Costs of Producing Milk, 1977

Producing Region	Total Feed, Labor, Misc.[f] and Mktg. Cost per cwt	Total Including[f] 10% Return on Inv.
Northern California[a]	8.29	9.12
Southern California[a]	8.39	9.31
Northern Nevada[b]	7.69	9.19
Southern Nevada[b]	7.09	8.48
Eastern Nevada[c]	7.67	9.09
Northern Utah[d]	8.50	9.63
Southeastern Idaho[e]	7.86	9.57

[a]Standard Milk Production Cost Index, North Valley and Southern California, January-February 1978, Bureau of Milk Stabilization, Calif. Dept. of Agriculture.

[b]Milk producer cost survey conducted by Dr. W.O. Champney and R. Murdock, December 1975, inflated to 1977. Division of Agriculture and Resource Economics, University of Nevada, Reno.

[c]Milk producer cost survey conducted by author, June 1978, based on year end 1977.

[d]Phone conversation with Paul Grimshaw, Utah State Univ., July 1978.

[e]Prige, Ray G. and George Gardner, Estimated Costs and Returns For A 50 Cow Dairy Enterprise, Idaho Farm Business Management Series #5, Dept. of Agricultural Economics, University of Idaho, June 1976.

[f]Excludes costs of shipping raw milk which is determined as a part of the solution in the model.

Currently six fluid milk processing plants operate in Nevada. Region III has four plants ranging in approximate maximum processing capacities from 61,490 cwt to 313,040 cwt per year. Region V has no fluid milk processing facilities. Region IV has two plants with a combined annual processing capacity of 804,960 cwt.

Those regions outside Nevada, which currently ship fluid milk into the state, have larger processing capacities than those within the state regions (Table 4). Only those plants which currently process fluid milk for consumption in Nevada are considered in the model.

Table 4
Regional Fluid Milk Processing Capacities, 1978[a]

Region	Current Capacity Gallons	Current Capacity Cwt.	Maximum Capacity Gallons	Maximum Capacity Cwt.
I-N. Calif.	13,000,000	1,118,000	13,000,000	1,118,000
II-S. Calif.	24,232,000	2,083,952	24,700,000	2,124,200
III-N. Nev.	6,497,400	558,776	7,995,000	687,570
IV-S. Nev.	9,360,000	804,960	9,360,000	804,960
V-E. Nev.	none	none	none	none
IV-N. Utah	18,200,000	1,565,200	20,540,000	1,766,440
IIV-SE. Ida.	1,040,000	89,440	1,248,000	107,328

[a]Current as observed during June, 1978. Capacity data from various industry spokesmen.

Model Selection

The problem addressed in this paper deals with minimizing total Nevada marketing costs given the estimated costs of producing, processing and shipping raw and processed milk. Specifically, the problem is to identify the least cost number, size, and location of processing plants in the overall region. We assumed that the quantity and location of milk produced is given, as is the demand for fluid milk. The nature of the problem suggests a mathematical programming model approach. Although the nonlinear models would be most applicable, the authors chose an iterative linear programming model (transhipment model) because it posed fewer computational problems.

Past work has utilized this approach to minimize the cost of providing beef to consumers in California (King and Logan). King's work was concerned with determining the optimum location, number and size of beef processing plants, among various regions in California. Application of the transhipment model has been applied to regional solid waste disposal systems (Ching and Tonks). In this case the objective was to determine the optimum size, number and location of both compacters and incinerators. An application of the transhipment model to the fluid milk industry as presented here, seems equitable.

Assumptions Underlying the Analysis

In each of the five cases, a homogeneous product and mix was assumed. All quantities of milk considered were converted into raw milk hundredweight equivalents. All solutions, supplies, and demand were based on an annual time period.

In Case I, which duplicates the current transhipment pattern (for Benchmark purposes), it was assumed that out-of-state regional supplies of milk are equal to the current output of processing plants within these regions currently providing fluid milk to Nevada. Supplies of raw milk in Case II were equivalent to those used in Case I.

Each subsequent case allowed the supply of raw milk and processing capacity in each region to be equal to the total demanded in all consuming regions. This allows for all milk to be produced or processed in any given region, if optimal. More specifically, it was assumed for Cases III-V, that each region can expand production or processing to meet total demand of all consuming regions.

Mathematical Presentation of the Model

The linear programming transhipment model as used in this paper may be stated mathematically as shown on the following page.

(1) $$\text{Minimize } TC = \sum_{i=1}^{M} \sum_{j=1}^{N} (P_i + t_{ij}) X_{ij} + \sum_{i=M+1}^{W} \sum_{j=N+1}^{V} (C_j + T_{ij}) X_{ij}$$

Subject to:

(2) $$\sum_{j=1}^{V} X_{ij} = S_i \qquad \text{for } i = 1,2,\ldots,N$$

(3) $$\sum_{i=1}^{W} X_{ij} = D_j \qquad \text{for } j = 1,2,\ldots,V$$

(4) $$\sum_{i=1}^{W} S_i = \sum_{j=1}^{V} D_j$$

(5) $$X_{ij} \geq 0 \qquad \text{for } i = 1,2,\ldots,N; \; j = 1,2,\ldots,V$$

where,

M = number of milk producing regions
N = number of milk processing regions
K = number of milk consuming regions
TC = total cost of producing, processing and transporting milk produced within the system
V = N + K
W = M + N
P_i = cost of producing one cwt of milk in region I
t_{ij} = cost of transporting one cwt of milk from producing region I to processing region J
C_i = cost of processing one cwt of fluid milk in processing region I
T_{ij} = cost of transporting one cwt of fluid milk from processing region I to consuming region J
X_{ij} = quantity of milk equivalent shipped from producing region I to processing region J; or, from processing region I to consuming region J
S_i = quantity of milk equivalent supplied by producing region J
D_j = quantity of milk equivalent demanded by consuming region J

Schematic Presentation of the Model

Figure 2 schematically illustrates the model for Cases II-V. In each case the number of milk producing regions (M), the number of milk processing regions (N), and the number of consuming regions (K) is seven.

	Processing Region	Consuming Region	Dummy Consuming Region	S_i
	1 2 3 4 5 6 7	1 2 3 4 5 6 7	8	
Producing Region 1 2 3 4 5 6 7	(A) P_i+t_{ij}	(B) High Cost	High Costs	A_1 A_2 . . . . A_7
Processing Region 1 2 3 4 5 6 7	0 High 0 Costs 0 (C) 0 0 High 0 Costs 0	(D) C_i+T_{ij}	High Costs	A_1 A_2 . . . . A_7
D_j	A_1 . . . . . A_7	D_1 . . . . . D_7	D_8	

Figure 2
Schematic View of Model

The model contains a cost matrix with four quadrants. Quadrant (A) contains the summation of the unit cost of producing milk in each producing region and the unit cost of shipping raw milk from each producing region to each processing region. Quadrant (B) contains sufficiently high costs to preclude entries in their section entering the solution. This prevents milk moving from producing regions directly to consuming regions without being processed. Quadrant (C) consists of zeros along the main diagonal and high costs off the diagonal. The quadrant allows for excess capacity of the processing regions. Finally, quadrant (D) contains the sum of the unit cost of processing fluid milk in each processing region and the unit cost of shipping processed milk from each processing region to each consuming region. A "dummy consuming region" was added as the last column of the cost matrix. This column contained high and uniform unit costs and served to indicate the excess amounts of milk produced in each region.

For Cases II-V, each producing region was assumed capable of supplying enough milk to meet total demand. Each processing region was likewise assumed to be capable of processing enough milk to meet total demand. Each producing and processing region was assigned a capacity sufficient to meet total demand. Also the component for the "dummy consuming region" served to balance supply and demand and thus satisfied the constraint imposed by equation (4) above.

Consideration of Economies of Scale

As discussed earlier, fluid milk processing plants exibit scale economies. The consideration of economies of size is critical to the determination of a least cost solution. Because of the nonlinear function describing economies of size, an iterative approach to minimizing costs was used. An excellent discussion of the procedure used is found in King (King and Logan). The method described has been incorporated into the transhipment algorithm used to solve the problem. The derivation of an appropriate functional relationship between per unit processing costs and plant size is discussed in the section on processing plant costs.

Data Used in the Analysis

Data required for the analysis included current raw milk supplies in each region, costs for transporting both raw and processed milk, and costs of processing fluid milk in each region. Also considered were demands for processed fluid milk, currently (1977) and for specific future time periods (1980, 1985, 1990). All data used in this study have been adjusted to a hundredweight basis. The solutions then, are on hundredweight basis.

Raw Milk Supplies

The current supply of raw milk in each region is shown in Table 2. In Cases I and II, the milk supply in each region was equal to the actual amounts supplied in 1977. Solutions to the model in Cases III-V determined how much milk would be produced in each region. Supplies in Cases III-V were assumed to be equal to the total demanded by all regions. This then allowed for any one region to produce all milk required in the regional system.

Transportation Costs

Production and consumption in each region was assumed to be located at a single point inside the area. Towns represented by these points are given in Table 5. The flow of production and consumption as well as the layout of transportation routes influenced selection of towns. Transportation costs between areas were based on the mileage between the towns.

Costs of shipping raw milk to processors were estimated in a 1969 study by Dhillon. These costs were then adjusted to 1977 levels using a transportation cost index (1977 Agricultural Statistics, p.569). The adjusted raw milk transportation cost function used in this study was:

$$
(5)\quad t_{ij} = \begin{cases} .41 + .0024\, d_{ij}, & \text{for } X_{ij} < 400 \\ .19 + .0030\, d_{ij}, & \text{for } X_{ij} > 400 \end{cases}
$$

where t_{ij} = transportation cost/cwt between producing region I and processing region J (1977).

d_{ij} = the distance from producing region I to processing region J.

Costs of shipping processed milk between processing regions and consuming regions have been estimated by Fletcher. These costs were adjusted using the same index described earlier. The adjusted processed milk transportation cost function used in this study was:

$$
(6)\quad T_{ij} = .223 + .003978 D_{ij}
$$

where: T_{ij} = transportation cost/cwt processed milk between processing region I and consuming region J (1977).

D_{ij} = the distance from processing region I to consuming region J.

Table 5
Distance Between Towns Representing Regions

	Sacramento	Los Angeles	Reno	Las Vegas	Wells	Salt Lake City	Twin Falls
Sacramento	0	380	136	600	478	658	594
Los Angeles		0	469	282	703	721	819
Reno			0	447	342	523	458
Las Vegas				0	421	439	537
Wells					0	181	116
Salt Lake City						0	217

Source: Rand McNally Atlas, 44th Edition.

Processing Costs

As stated earlier, any function relating the per hundredweight cost of processing and amount processed must be sensitive to economies of size. For this paper, two alternative methods of estimating economies of size functions were considered: (1) the "statistical approach," which in this case refers to the use of regression techniques on average annual cost per volume data. We also considered: (2) the "synthetic approach," which involves the determination of the physical input-output relationships for all of the various possible techniques for each production process and the conversion of these relationships into cost terms. A thorough analysis and comparison of both methods is given by Knudtson. Knudtson suggested that the statistical approach is basically useless since it overestimates the economies of size curve.

Numerous studies have suggested the use of the synthetic method of determining the economies of size curve (Devino, et al.; Webster, et al.; King and Logan; Knudtson). Synthetic costs covering the total range of plant sizes observed have been determined by Webster and Devino. Because of the time and cost involved in constructing new synthetic cost estimates, previously estimated costs were used after adjusting for inflation. Where possible, component indices were used to inflate each portion of the costs composing total cost. Appendix A contains the inflated budgets and associated costs. We felt this procedure would adequately reflect economies of size while appropriately estimating current per unit operating costs.

The published costs of processing per unit and the corresponding inflated costs for various processing capacities are shown in Table 6. A nonlinear regression of the inflated costs yielded the following curvilinear function:[1]

(7) $Y_i = 38.622306\ (X_i^{\ -.191892})$

Where:

Y_i = cost per cwt to process fluid milk in region I

X_i = annual volume of fluid milk processed in region I.

These functions when utilized in the transhipment algorithm determined the cost per hundredweight of processing fluid milk while allowing for consideration of economies due to size.

Costs of processing fluid milk per estimated by the previously described function are shown in Table 7 for plants ranging in size from 20,000 to 4,500,000 cwt per year.

[1]The standard error associated with the estimated expotential coefficient is 0.016. This coefficient is significantly different from zero at the 1 percent level of confidence.

Table 6

Milk Processing Costs Per Hundredweight, 1977

Plant Size cwt/year	Cost/cwt Bulletin	Cost/cwt Inflated(1977)[c]	Cost/cwt Estimated[d]
33,540	2.85[a]	5.74	5.23
111,800	1.95[a]	3.99	4.15
279,500	1.60[a]	3.19	3.49
559,000	1.45[a]	2.94	3.05
559,000	1.70[b]	3.05	3.05
2,236,000	1.30[b]	2.41	2.34
4,472,000	1.20[b]	2.14	2.04

[a]Webster and Bradfield, Economies of Size in Fluid Milk Processing Plants, Agricultural Experiment Station Bulletin NO.636, Univ. of Vermont, May 1963, p.32

[b]Devino, Bradfield, Mengel and Webster, Economies of Size in Large Fluid Milk Processing Plants, Agricultural Experiment Station Report MP62, University of Vermont, May 1970, pp. 9-11.

[c]Bulletin values were inflated according to indices found in various issues of the Survey of Current Business prepared by equipment, buildings, services, hourly labor, gas and electricity, and the overall CPI. Inflated operating budgets are shown in Appendix A.

[d]Values estimated using equation (7) in the text.

Table 7
Estimated Costs of Processing Fluid Milk[a]

Annual Plant Capacity (cwt)	Cost Per cwt	Annual Plant Capacity (cwt)	Cost Per cwt
20,000	$5.77	2,300,000	$2.32
100,000	4.24	2,400,000	2.30
200,000	3.71	2,500,000	2.28
300,000	3.43	2,600,000	2.27
400,000	3.25	2,700,000	2.25
500,000	3.11	2,800,000	2.24
600,000	3.01	2,900,000	2.22
700,000	2.92	3,000,000	2.21
800,000	2.84	3,100,000	2.19
900,000	2.78	3,200,000	2.18
1,000,000	2.72	3,300,000	2.17
1,100,000	2.67	3,400,000	2.15
1,200,000	2.63	3,500,000	2.14
1,300,000	2.59	3,600,000	2.13
1,400,000	2.55	3,700,000	2.12
1,500,000	2.52	3,800,000	2.11
1,600,000	2.49	3,900,000	2.10
1,700,000	2.46	4,000,000	2.09
1,800,000	2.43	4,100,000	2.08
1,900,000	2.41	4,200,000	2.07
2,000,000	2.38	4,300,000	2.06
2,100,000	2.36	4,400,000	2.05
2,200,000	2.34	4,500,000	2.04

[a]Estimated using the following function as described earlier,
$Y_i = 38.622306(X_i^{-.191802})$

Results

With estimates of total supplies of milk and total demand for milk (Appendix B), the linear programming transhipment model was used to minimize the cost of producing, processing, and transporting milk from producer to processor and from processor to final consumption. Results for the five cases described previously are presented in Tables 8 through 12.

These results suggest answers to the two questions raised at the beginning of this paper. Specifically, the results of the transhipment analysis provides an assessment on the marketing efficiency of milk in Nevada and on the potential adjustments that might be made in response to increased future demands for milk.

Marketing Efficiency

For Case I, the supply and demand for milk and the processing capacities for each region are those actually observed for 1977 (Table 8). Results of the computer analysis indicate that the minimum costs of providing 1,883,690 cwt of milk to Nevada consumers was $24,051,256 or $12.76 per cwt.

The solution for Case I (Table 8) illustrates the dependency of Nevada on out-of-state processors. In western Nevada, northern California processors provide over 100,000 cwt of milk of 13 percent of the total milk consumed in that region. In southern Nevada, southern California provides over 350,000 cwt of milk or 34 percent of the total milk consumed in that region.

In Case II (Table 9), the final demand for milk is identical to Case I. Shipment patterns, however, were unrestricted and did not have to conform to those observed in 1977. The least cost production, processing and transportation pattern amounted to $23,712,350 or $12.58 per cwt. Thus, if shipment patterns were unconstrained to those observed in 1977, total cost of producing, processing and transportation is less by about $338,900 or 18 cents per cwt.

While it is somewhat arbritrary to indicate whether this difference (Case I vs. Case II) is significant, we should point out that the actual situation in 1977 (Case I) is about 1.4 percent higher in cost than the most efficient situation (Case II). This does not appear to be significant. And as such, we would rate the current milk marketing system in Nevada to be relatively efficient.

Future Adjustments

Cases III-V (Tables 10, 11, and 12) are descriptive of 1980, 1985, and 1990. They serve to indicate the type of adjustments in the Nevada dairy industry in the coming years. Solutions for these three cases are based on projected increases in demand for milk. We emphasize that all costs used in these solutions to Cases III-V are exclusive of inflationary effects.

Table 8
Case I—Actual Interregional Movement of Milk at Producer and Processor Levels in 1977

Quantities of Milk Shipped from Producing to Processing Regions

Producing Regions	Processing Regions I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
			(hundredweights)				
I	853,711						
II		1,938,560		101,726			
III	1,040,000		688,368				
IV				590,170			
V						18,833	
VI						1,437,167	
VII							83,200

Quantities of Milk Shipped from Processing to Consuming Regions

Processing Regions	Consuming Regions I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
			(hundredweights)				
I	938,571		101,429				
II		1,587,316		351,244			
III			668,896				
IV				691,896			
V							
VI					70,634	1,385,366	
VII					119		83,081

Cost of Milk Supplied to Nevada

Producer to Processor	Cost	Processor to Consumer	Cost	Region	Total Cost	Cost per cwt
III to I	$1,007,190	I to III	$350,944			
III to III	6,416,333	III to III	2,112,043	III	$9,886,510	$12.84
II to II	3,414,092	II to IV	1,313,653			
II to IV	1,056,933	IV to IV	2,179,472			
IV to IV	5,246,611			IV	13,210,761	12.66
V to VI	187,012	VI to V	245,100			
VI to VI	520,082	VII to V	603			
VII to VII	1,188			V	953,985	13.48
Total	$17,849,411		$6,201,815		$24,051,256	$12.76

Table 9
Case II--Optimal Interregional Movement of Milk Using Actual Supplies and Capacities Existing in 1977

Quantities of Milk Shipped from Producing to Processing Regions

Producing Regions	I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
				(hundredweights)			
I	853,711						
II		1,938,560		101,726			
III	1,040,000		688,368				
IV				590,170			
V						18,833	
VI						1,437,167	
VII							83,200

Quantities of Milk Shipped from Processing to Consuming Regions

Processing Regions	I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
				(hundredweights)			
I	938,571						
II		1,587,316					
III			769,797				
IV				1,043,140			
V							
VI					70,753	1,385,366	83,081
VII							

Cost of Milk Supplied to Nevada

Producer to Processor	Cost	Processor to Consumer	Cost	Region	Total Cost	Cost per cwt
III to III	$7,390,051	III to III	$2,370,974	III	$9,761,026	$12.68
II to IV	4,706,358	IV to IV	3,045,969			
IV to IV	5,246,611			IV	12,998,938	12.46
V to VI	187,012	VI to V	244,098			
VI to VI	521,277			V	952,386	13.46
Total	$18,051,309		$5,661,041		$23,712,350	$12.58

Table 10
Case III—Optimal Interregional Movement of Milk to Meet
Projected Fluid Milk Demands for 1980

Quantities of Milk Shipped from Producing to Processing Regions

Producing Regions	Processing Regions I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
	(hundredweights)						
I	938,571						
II							
III			782,000				
IV		1,587,316		1,117,000			
V						1,554,447	
VI							
VII							83,200

Quantities of Milk Shipped from Processing to Consuming Regions

Processing Regions	Consuming Regions I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
	(hundredweights)						
I	938,571						
II		1,587,316					
III			782,000				
IV				1,117,000			
V							
VI					86,000	1,385,366	83,081
VII							

Cost of Milk Supplied to Nevada

Producer to Processor	Cost	Processor to Consumer	Cost	Region	Total Cost	Cost per cwt
III to III	$7,507,200	III to III	$2,408,560	III	$9,915,760	$12.68
IV to IV	9,930,130	IV to IV	3,228,130	IV	13,158,260	11.78
V to VI	853,980	VI to V	295,840	V	1,149,820	13.37
Total	$18,291,310		$5,932,530		$24,238,840	$12.20

Table 11
Case IV—Optimal Interregional Movement of Milk to Meet Projected Fluid Milk Demands for 1990

Quantities of Milk Shipped from Producing to Processing Regions

Producing Regions	I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
				(hundredweights)			
I	938,571						
II							
III			864,000				
IV		1,587,316		1,296,000			
V						1,468,447	
VI							
VII							

Quantities of Milk Shipped from Processing to Consuming Regions

Processing Regions	I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
				(hundredweights)			
I	938,571						
II		1,587,316					
III			864,000				
IV				1,206,000	90,000		
V							
VI						1,385,366	83,081
VII							

Cost of Milk Supplied to Nevada

Producer to Processor	Cost	Processor to Consumer	Cost	Region	Total Cost	Cost per cwt
III to III	$8,294,400	III to III	$2,609,280	III	$10,903,680	$12.62
IV to IV	10,721,340	IV to IV	3,388,860	IV	14,110,200	11.70
V to VI	800,100	VI to V	403,200	V	1,203,300	13.37
Total	$19,815,840		$6,401,340		$26,217,180	$12.13

Table 12
Case V—Optimal Interregional Movement of Milk to Meet
Projected Fluid Milk Demands for 2000

Quantities of Milk Shipped from Producing to Processing Regions

Producing Regions	Processing Regions I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
				(hundredweights)			
I	938,571						
II							
III			954,000				
IV		1,587,316		1,392,000			
V						1,468,447	
VI							
VII							

Quantities of Milk Shipped from Processing to Consuming Regions

Processing Regions	Consuming Regions I Sacramento	II L.A.	III Reno	IV Las Vegas	V Wells	VI Salt Lake	VII Twin Falls
				(hundredweights)			
I	938,571						
II		1,587,316					
III			954,000				
IV				1,297,000	95,000		
V							
VI						1,385,366	83,081
VII							

Cost of Milk Supplied to Nevada

Producer to Processor	Cost	Processor to Consumer	Cost	Region	Total Cost	Cost per cwt
III to III	$9,158,400	III to III	$2,833,380	III	$11,991,780	$12.57
IV to IV	11,530,330	IV to IV	3,605,660	IV	15,135,990	11.67
V to VI	844,550	VI to V	422,750	V	1,267,300	13.34
Total	$21,533,280		$6,861,790		$28,395,070	$12.10

As such, they are presented to show only the effects of economies of size to increased demands for milk. The optimals or least cost shipment patterns to meet the demands for 1980, 1985, and 1990 are presented in Tables 10, 11, and 12.

The solutions indicate increased milk production in each region. In both the western and southern regions in Nevada, larger quantities of milk will be processed, considerably more than is currently processed. For example in western Nevada in 1977, the total amount of milk processed was 668,368 cwt. In 1980, 1985, and 1990, the transhipment algorithm indicates processing amounts in western Nevada of 782,000, 864,000, and 954,000 cwt. These constitute increases of 17, 29, and 43 percent for the three years. In southern Nevada, the increase in processing is even more dramatic. They are 51, 61, and 20 percent for 1980, 1985, and 1990.

For 1980, 1985, and 1990, results of the transhipment analysis indicate that eastern Nevada would still not process milk. However, it is of interest that in 1985 and 1990, the final demand for milk in eastern Nevada is met by southern Nevada processors and not from northern Utah.

This analysis suggests that given the increasing demands for milk in the coming years, and the economies in processing that could be enjoyed with larger scale operations, expansion of the dairy industry deserves serious consideration. It is possible that the dependency on out-of-state processors could be lessened without sacrificing efficiency. That is, increased demand for milk in the future is of sufficient magnitude to encourage processing on a larger scale.

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APPENDIX

Table A-1
Fluid Milk Processing Cost by Plant Size
Inflated to 1977

Budget Item	Annual Processing Capacity (cwt.)[a]			
	33,540	111,800	279,500	559,000
Building	$12,975	$17,125	$34,807	$58,364
Equipment	43,926	69,406	101,141	205,620
Utilities	12,350	37,270	44,850	68,422
Supplies	43,985	144,271	361,500	719,266
Labor	63,320	148,766	308,684	520,242
Insurance	3,229	4,960	9,246	15,951
Admin.	12,815	24,105	30,404	55,484
Total	$192,780	$445,903	$890,632	$1,643,349
Per cwt.	$5.74	$3.99	$3.19	$2.94

Budget Item	Annual Processing Capacity (cwt.)[b]		
	559,000	2,236,000	4,472,000
Equipment	$249,280	$557,700	$831,344
Building	36,272	58,331	82,178
Case/Pallet	20,813	136,172	287,745
Direct labor	430,300	1,081,982	1,593,244
Indirect labor	61,646	135,246	177,364
Utilities	60,076	303,971	495,708
Insurance	18,122	55,554	45,211
Taxes	9,498	15,561	21,572
Product loss	34,798	139,199	278,397
Supplies	96,855	268,684	521,771
Containers	678,948	2,617,388	5,234,778
Miscellaneous	10,319	21,528	25,306
Total	$1,706,380	$5,391,316	$9,594,788
Per cwt.	$3.05	$2.41	$2.14

[a]Inflated costs of 1963 Vermont study. (Webster)

[b]Inflated costs of 1970 Vermont study. (DeVino)

Table B-1

Cost Matrix Format of Case I

Producing	Processing Regions							Consuming Regions							
Regions	1	2	3	4	5	6	7	1	2	3	4	5	6	7	S_i
1															853,711
2															2,040,286
3															854,657
4				P_i+t_{ij}							High Cost				590,170
5															18,833
6															1,437,167
7															83,200
1															1,040,000
2															1,938,560
3				Zeros on main diagonal											668,368
4											C_j+T_{ij}				691,896
5				High costs off diagonal											0
6															1,456,000
7															83,200
D_i	1,040,000	1,938,560	668,368	691,896	0	1,456,000	83,200	938,571	1,587,316	769,797	1,043,140	70,753	1,385,366	83,081	

Table B-2

Cost Matrix Format of Case II

Producing Regions	Processing Regions 1	2	3	4	5	6	7	Consuming Regions 1	2	3	4	5	6	7	S_i
1															853,711
2															2,040,286
3															854,657
4			P_i+t_{ij}								High Cost				590,170
5															18,833
6															1,437,167
7															83,200
1															5,878,024
2															5,878,024
3				Zeros on main diagonal											
4											C_j+T_{ij}				5,878,024
5				High costs off diagonal											0
6															5,878,024
7															5,878,024
D_i	5,878,204	5,878,204	5,878,204	5,878,204	0	5,878,204	5,878,204	938,571	1,587,316	769,797	1,043,140	70,753	1,385,366	83,081	

Table B-3

Cost Matrix Format of Case III

Producing	Processing Regions							Consuming Regions							
Regions	1	2	3	4	5	6	7	1	2	3	4	5	6	7	S_i
1															5,979,334
2															5,979,334
3															5,979,334
4				P_i+t_{ij}							High Cost				5,979,334
5															5,979,334
6															5,979,334
7															5,979,334
1															5,979,334
2															5,979,334
3				Zeros on main diagonal											5,979,334
4											C_j+T_{ij}				5,979,334
5				High costs off diagonal											5,979,334
6															5,979,334
7															5,979,334
D_i	5,979,334	5,979,334	5,979,334	5,979,334	5,979,334	5,979,334	5,979,334	938,571	1,587,316	782,000	1,117,000	86,000	1,385,366	83,081	

Table B-4

Cost Matrix Format of Case IV

Producing Regions	Processing Regions 1	2	3	4	5	6	7	Consuming Regions 1	2	3	4	5	6	7	S_i
1															6,154,334
2															6,154,334
3															6,154,334
4				P_i+t_{ij}							High Cost				6,154,334
5															6,154,334
6															6,154,334
7															6,154,334
1															6,154,334
2															6,154,334
3				Zeros on main diagonal											6,154,334
4											C_j+T_{ij}				6,154,334
5				High costs off diagonal											6,154,334
6															6,154,334
7															6,154,334
D_i	6,154,334	6,154,334	6,154,334	6,154,334	6,154,334	6,154,334	6,154,334	938,571	1,587,316	864,000	1,206,000	90,000	1,385,366	83,081	

Table B-5

Cost Matrix Format of Case V

Producing Regions	Processing Regions 1	2	3	4	5	6	7	Consuming Regions 1	2	3	4	5	6	7	S_i
1															6,340,334
2															6,340,334
3															6,340,334
4				P_i+t_{ij}							High Cost				6,340,334
5															6,340,334
6															6,340,334
7															6,340,334
1															6,340,334
2															6,340,334
3				Zeros on main diagonal											6,340,334
4											C_j+T_{ij}				6,340,334
5				High costs off diagonal											6,340,334
6															6,340,334
7															6,340,334
D_i	6,340,334	6,340,334	6,340,334	6,340,334	6,340,334	6,340,334	6,340,334	938,571	1,587,316	954,000	1,297,000	95,000	1,385,366	83,081	