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Comparative Costs of Dairy Marketing in Norway and the U.S.

1. Introduction

Technical marketing efficiency is an important component of comparative advantage that countries may possess in food marketing. This aspect of marketing efficiency may be affected by size of market(s), technology used, input costs, and institutional factors. With regard to the latter, Norwegian policy makers have asked whether the extensive regulation and monopolization by a single processing cooperative in the Norwegian dairy sector have resulted in technical inefficiency that leads to excessive costs of milk marketing. Excessive marketing costs could have three important impacts; increased prices for domestic consumers, reduced prices for farmers, and reduced competitiveness in international markets. International competitiveness is critical for Norway as it considers or is considered for admission to the European Community and as trade liberalization proceeds under the GATT. The purpose of this anaylsis was to develop and apply a method for comparing marketing costs between countries to provide some insight into relative marketing efficiency between countries.

The issue of relative efficiency in milk markets has been approached with cross country comparisons of milk marketing costs. Comparisons of Norway with Denmark, Sweden and Switzerland, all small countries, by Hoveid (1989a, 1989b) indicated a higher level of efficiency in Denmark, a lower level in Switzerland, while the comparison with Sweden was inconclusive. Here, dairy marketing costs will be compared between the U.S., a large country with a large dairy industry, and Norway. Conclusions on the relative efficiency in these marketing industries should be of some empirical interest as the U.S. marketing system is regulated to lesser extent and in different ways than Norway's. Both industries have been protected from the world market though import controls. A major difference in the industries is that the U.S. has a large number of competing firms in the sector, while the Norwegian sector has virtually no competition.

The methodology developed here should be of general interest, as there are few practical alternatives to cross country comparisons in the evaluation of the performance of such protected sectors. The technique of analysis is a comparison of aggregate dairy marketing margins for a standardized product mix. It involves a weighting process similar to that used in constructing price indexes. The technique should be applicable for cost comparisons for many basic farm foods.

Related comparisons within the European Community were performed by Keane and Pitts (1981) and Haines and Jenkins (1986). Their objective was to explain why the farm milk prices within the EC differed substantially although dairy product prices were fairly similar. As with many of attempts, they ended with an unexplained residual which was attributed to relative marketing inefficiency or missing explanatory factors. This point is well illustrated by the debate between Williams (1987,1988) and Pitts, Haines and Jenkins (1987,1988). Our analysis is aimed at more specific assessment of marketing costs, rather than cross country comparisons of farm and/or retail prices. Moreover, our analytical framework incoporates more relevant explanatory factors.

Before applying the technique, let's examine some of the general dairy industry characteristics that may be relevant in developing our method of analysis and/or evaluating the results.

2. Background

2.1 The Norwegian Industry

Milk production in Norway totals about 1800 billion liters annually (equivalent to 3.968 billion lbs.) which is similar to that produced annually in the state of Iowa, approximately 2.7 percent of total annual U.S. milk production. Milk is produced throughout the country and accounts for the largest share of farm income, about 35 percent in 1988. The dairy herd also produces a large part of the nation's total beef supply. The average size of a dairy farm is small, 11 cows in 1988.

Most milk is consumed domestically as fluid beverage milk, cheese, and butter. There are, however, significant exports of cheese and butter. Approximately 30 percent

of cheese production and 25 percent of butter production are exported. In terms of total milk use, 47.8 percent is used in fluid beverage products, 26.3 percent in cheese and 19.2 percent in butter.

Since the 1930's, almost all milk assembly and processing activities have been performed by a single national cooperative, the National Association of Norwegian Milk Producers/Norwegian Dairies Association. A few private processors purchase milk from the cooperative for production of ice cream and specialty products, but they account for only a very small part of milk use.

Annual interventions and regulation of market prices and quantities are established in a biennial negotiation process between farmer representatives and the government. Prices and subsidies are fixed to achieve a per worker income equivalent to incomes of average industrial wage earners. These are achieved through fixing of wholesale market prices for dairy products and by direct payments to dairy farmers. The direct payments include a general subsidy on milk sales, a quantity determined subsidy, and regional differentials to reflect different production costs. Additionally, milk producers receive subsidies for forage production, animal units, and feeding cattle with grains that are produced by the farm.

A production quota, about 1800 million liters per year during the 1980's is based on estimated total market demand. Quota is allocated to individual farms to determine the quantities on which target prices and subsidies may be received. Milk produced in excess of quotas is priced extremely low, 18 percent of quota price in 1987 and 9 percent in 1988. Consequently, actual production was near the target of 1800 million liters.

Implicit price discrimination is applied with respect to wholesale prices with prices determined in excess of costs for fluid milk other dairy products with low price elasticities. Dairy products with higher elasticities may be priced below costs. This is revenue enhancing price discrimination which can reduce government budgetary costs of income support to farmers. There are also special subsidies to processors for fluid milk which permit lower retail prices than are warranted if all costs are covered.

2.2 The U.S. Industry

Annual farm milk production for the U.S. since 1987 has ranged from 143 to 152 billion lbs. It accounts for a much smaller part of total farm income than in Norway, about 12 to 14 percent. Average herd size is considerably larger than in Norway, 47 in 1988. In 1991, 36.8 percent of the total milk supply was used in fluid products, 31.5 percent in cheese 8.6 in frozen products and the remainder in various other manufactured dairy products.

Marketing of milk at the farm level in the U.S. is dominated by cooperatives, but not entirely by a single cooperative as in Norway. Almost 80 percent of all milk sold by farmers in the U.S. is marketed through farmer owned cooperatives. Ten regional dairy cooperatives control the sale of more than half of farm milk sales. Cooperatives process about one half of the milk under their control, the remainder is sold to other milk processors. Cooperatives are, nevertheless, the principle producers of the major manufactured dairy products, butter, nonfat dry milk and cheese (Ling et al., 1989). Investor-owned firms (IOF's) account for most of the processing and distribution services for fluid milk, frozen dairy products, and specialty dairy products.

Two federal programs and several state programs influence prices that are paid for milk and dairy products in the U.S. One, the federal dairy price support program fixes an annual minimum target price to be paid to producers of manufacturing milk. Prices are simultaneously established for butter, nonfat dry milk, and cheese that will permit plants to pay the support price. If products cannot be sold in commercial markets at these or higher prices, they can be sold to the government at these purchase prices. Currently, the annual target support price is 10.10 USD per hundredweight with an assessments on producers if price support purchases exceed specified levels.

Second, the Federal Milk Marketing Order program establishes multiple prices (price discrimination) for milk sold to dealers in 38 designated milk marketing regions of the U.S. The program regulates about 70 percent of all milk produced in the U.S. Minimum prices are established according to the use made of the milk. If milk is used in manufactured dairy products, processors pay the price that is paid for non-federal order manufacturing milk. Until the 1990's this price was, frequently, near the

federal manufacturing milk support price. Milk used in fluid form is priced at the manufacturing milk base price plus specified differentials, ranging from 1.20 USD to more than 4.00 USD per hundredweight in each of the federal order markets. Milk used in soft manufactured dairy products is priced at .10 to .15 USD per hundredweight above the base manufacturing milk price. Producers in each of these markets receive a blend price which is a weighted average of the prices charged to handlers in the various uses of milk.

Several states apply classified pricing schemes that operate essentially as the federal milk order program. And, four states fix retail prices for fluid milk products.

3. Estimated Dairy Marketing Spreads for Norway and the U.S.

3.1 The Technique of Analysis

Comparison of gross marketing margins (farm- retail price spreads) between countries, we believe, is a very practical approach to assess food marketing costs and efficiency. In this paper we describe and apply a weighting procedure to measure apparent farm-retail marketing margins, for the entire dairy sector that permits meaningful comparisons of costs and efficiency. Simple comparison of exchange rate adjusted margins would omit many adjustments that are needed for meaningful comparison. For example, milk assembly between countries may differ by density of milk production, size of production units, and topographical characteristics of the market, all of which will influence transportation costs. Product mix is likely to vary from one country to another. Furthermore, each dairy product has different processing and marketing costs. A method of comparison is needed that standardizes the industries of the respective countries with respect to product mix and marketing activities for all dairy products in the dairy food basket.

The model with on which our maragin comparisons are based was developed ad follows: Let marketing costs be defined as the product $w'x$, prices w times quantities x, for all inputs except milk. The input quantities are not directly observable, but the accounting identity can be utilized for cost estimation. Let π denote excess profit beyond the market rate of return to assets, p is a vector of dairy product prices, y is a vector of quantities of dairy products, or a product mix, r is a

vector of prices of milk constituents, m is the quantity of milk, and the vector β distributes this quantity over constituents. Then: $\pi = p'y - w'x - r'\beta m$, and total marketing costs, $C = w'x$, is measured as:

$$C = p'y - r'\beta m - \pi \quad (1)$$

Empirical measures of the components may be difficult to obtain, especially for quantities and the correct measure of profit. Furthermore, it is debatable whether excess profit should be deducted in cost comparisons. From the farmers' point of view, it does not matter whether the milk price is low because of inefficiency or excess profits. However, according to standard methodology for efficiency measurement, excess profits are not a cost component. Because we have no observations on excess profits, we will assume, for the following analysis, that if excess profits exist, they are simply one of the marketing imputs.

Observed milk marketing costs are assumed to arise from cost minimization subject to the technology of milk processing. This assumption is justified by reference to the technology of milk marketing which should have the following structure: First, there is a requirement on milk constituents. The constituents in the products can be found with a matrix of input-output coefficients A.

$$Ay \leq \beta m \quad (2)$$

Second, there is a requirement that certain dairy activities should be performed at certain levels z, in order to convert the milk m to final products y. This requirement is specified in terms of a matrix of I/O coefficients B:

$$B\,(y\ \beta' m)' \leq z \quad (3)$$

This implies that dairy processing services can be computed as a linear combination of the products and the quantities of milk constituents and there is a direct correspondence between z and $(y\ \beta' m)$. Third, for each dairy process j, there are requirements for inputs x not originating from milk. The requirements, in terms of production functions, G_j, are dependent on local parameters , ε, reflecting the geographical environment of marketing, and institutional parameters, δ.

$$z_j \leq G_j(x^j;\varepsilon,\delta) \quad (4)$$

Finally, it is assumed that all non-dairy inputs x are attributed to some non-joint process.

$$x = \Sigma_j x^j \tag{5}$$

As a representation of macro technology, all production functions G_j and the set T are linearly homogeneous, i.e. there are no economies or dis-economies of scale. This means that costs can be considered on a per litre or per cwt basis with no loss of information. The technology assumptions implies a weak separability between the activity levels z and non-dairy inputs, x. This feature facilitates the efficiency comparisons shown later.

The dairy processing industry consists in general of cooperatives and IOFs with different market power in upstream and downstream dairy markets. Across the industry and across countries there may be the common objective of maximizing earnings. However, the objective functions depend on the exploitation of market power and so do the decisions on milk purchases and milk processing, i.e., z. In general, it is not appropriate to measure the relative performance among competitors with different objectives. Therefore, relative efficiency cannot be measured, unambiguously, without controlling for the economic environment in which these decisions are taken. Such control is hardly attainable. But regardless of market power and ownership structure, it is likely that all dairy marketing firms minimize the costs of non-dairy inputs x, subject to the decisions with respect to activity levels, z. Thus, marketing costs can be perceived as the minimum costs of activities, z, for prices, w, environment, ε, and institutions, δ. Formally, optimum input use, x^* can be stated as : $x^* = x^*(w,z,\varepsilon,\delta)$. A measure of the relative technical efficiency of marketing in two different institutional settings, δ^a and δ^b, is found in the ratio:

$$q'x^*(w,z,\varepsilon,\delta^a)/q'x^*(w,z,\varepsilon,\delta^b) \equiv C^a(w,z,\varepsilon)/C^b(w,z,\varepsilon) \tag{6}$$

The left hand side is a quantity index of inputs for given activity levels and geographical environment, which on the right hand side is expressed as a ratio between comparable marketing costs, i.e., costs where all determinants are identical, except the institutional setting.

From equation (6) it can be shown that we do not necessarily need the exact marketing cost in each country, rather, comparable cost observations are needed. These can be computed from one point on each of the cost surfaces $C_i(w,z,\varepsilon)$; $i=a,b$; then adjusting costs for movement along the cost surface to a common point of reference. First, we will concentrate on finding these two points by calculating expressions (1) for each country. Then adjustments to a common point of reference will be made.

3.2 Standardizing Prices for the Margin Estimates

An important issue in the calculation of margins and costs for international comparisons is specification of the most appropriate price measures. We begin with average prices for dairy products which account for most milk use in each of the countries. These prices of milk and milk products are presented in Table 1 for Norway and in Table 2 for the U.S. Because these groups of products account for more than 90 percent of total milk use in each of the countries, they should be fairly representative for the respective industries. For comparability, it is important that prices reflect corresponding points in the market chain. Here, we used retail prices for fluid milk products because these are the commonly reported in both countries and wholesale prices for cheese, butter, and milk powder because these are commonly reported for both countries. Hence, the marketing sector for the analysis is determined by the points of measurement. We also compute the margin for a common unit of farmers' milk. In this case, one kilogram is chosen.

The relative uses of milk in the various dairy products, also listed in the tables, are the weights used in computing the gross retail (wholesale) revenue contributed by each product. The weights are developed to be consistent with standard techniques and yields of dairy processing. They are efficient with respect to milk utilization and they correspond to the actual mix of product groups. Tables 1 and 2 show that a kilogram of milk in Norway generates 4.758 NOK of gross revenue to the marketing system from the various dairy products. In the U.S., a kilogram of milk generates .460 USD in gross revenue.

Prices at both farm and retail must be adjusted in one or both of the countries to reflect unique pricing, cost, or institutional factors. Several are rather straightforward. For example, in Norway there is consumer subsidization for some dairy products by payments to the dairy cooperative marketing agency. These are added to the Norwegian retail (wholesale) prices to obtain the industry value for the products, Table 1.

Table 1. Dairy Product Prices and Gross Marketing Margin, Norway, 1987

Item	Retail, Wholesale or Farm Unit Price NOK	Subsidy NOK	Weights	Value per Kg of Milk NOK
Wholefat milk, ℓ	4.721	1.670	0.131	0.839
Lowfat milk, ℓ	4.640	1.670	0.227	1.432
Cream, 1/2 ℓ	13.419		0.019	0.260
Sour cream light, 250 ml	6.588		0.032	0.213
Yoghurt, 175 ml	3.640		0.051	0.186
Cheese, kg	30.785	5.600	0.031	1.122
"Whey cheese," kg	29.345	5.600	0.009	0.302
Butter, 1/2 kg	9.265		0.026	0.240
Skimmed milk powder, kg	20.950		0.005	0.112
Skimmed milk for feeding, ℓ	0.440		0.120	0.053
GROSS WEIGHTED SALES PER KG OF MILK			1.000	4.758
Farm price of milk, ℓ	3.227	0.372	0.969	2.768
Adj. for farmer service	.302		1.000	.302
Adj. to no exports, kg	0.161		1.000	0.161
Adj. for redistr. rev., kg	0.085		1.000	0.085
ADJUSTED FARM PRICE OF MILK, KG			3.014	
MARGIN per KG			1.000	1.443

Source: Based on data from Norske Melkeprodusenters Landsforbund and from "Manufacturing Statistics," 1987, 1988, 1989, Central Bureau of Statistics for Norway, 1986, 1987, 1988, Oslo, NORWAY.

Table 2. Dairy Product Prices and Gross Marketing Margin, U.S., 1987

Item	Retail, Wholesale or Farm Unit Price USD	Subsidy USD	Weights	Value per Kg of Milk USD
Wholefat milk, 1/2 gal.	1.204	0.000	0.065	0.079
Lowfat milk, 1/2 gal.	1.082	0.000	0.148	0.160
Cream				0.000
Sour cream light				0.000
Yoghurt, 1/16 gal.	0.581		0.032	0.019
Cheese, lbs	1.425	0.000	0.084	0.119
"Whey cheese"				0.000
Butter, 1 lb	1.622		0.042	0.068
Skimmed milk powder, lbs	0.806		0.018	0.015
Skimmed milk for feeding			———	0.000
GROSS WEIGHTED SALES PER KG OF MILK			1.000	0.460
Farm price of milk, 1 lb.	0.125	0.000	2.205	0.276
Adj. for farmer service	0.000		1.000	0.000
Adj. to no exports, kg				0.000
Adj. for redistr. rev., kg	0.001		1.000	0.001
ADJUSTED FARM PRICE OF MILK, KG			0.276	
MARGIN per KG			1.000	0.182

Source : Calculated from data in: "Dairy Market Statistics", Annual Summaries 1986, 1987, and 1988, Agricultural Marketing Service, U.S. Department of Agriculture, Washington, D.C.; "Weights, Measures and Conversion Factors for Agricultural Commodities and Their Products," Agricultural Handbook No. 697, Economic Research Service, U.S. Department of Agriculture, Washington, D.C.; "Federal Milk Order Market Statistics," Selected Issues, 1986 through 1989, Agricultural Marketing Service, U.S. Department of Agriculture; and "Dairy Situation and Outlook Yearbook," 1987, 1988, and 1989, Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Two adjustments of producer milk price are straightforward. First, as noted above, the dairy cooperative in Norway is the conduit for the subsidies received by dairy farmers for milk production from the national treasury. Some are directly transferred as the specified subsidy payments to the farmers. Thus, recorded farm price or marketing costs are not affected by these transactions. There is one exception. An amount of .372 NOK per kg. ("grunntilskudd") is presumably transferred to the farmers, but not as a specified payment. Consequently, the farmers' milk price reflects this payment. For our analysis, it is deducted from the recorded average farm price.

Price adjustment is needed for farmer services that are provided by the cooperatives. The Norwegian dairy cooperatives finances milk collection, milk coolers, breeding services, insurance, etc. These services are not directly charged to the farmer, but are financed with a lower price of milk. It is questionable whether this is a wise policy, but to arrive at a comparable marketing margin, the costs of these services are added to the recorded farm price. For 1987, the cooperative incurred milk collection costs of 324.6 million NOK, farm milk cooler costs of 105.3 mill. NOK, breeding program costs of 95 million NOK, and other services that amount to approximately 60 million NOK. On a per unit basis, they result in a cost of 0.302 NOK/kg. of milk.

Farm to plant transport of milk is subsidized in some regions of the U.S. but the amount is not directly identifiable from published data. Officials from cooperatives in the upper midwestern region of the U.S. dairy industry report costs of milk assembly ranging from .40 USD to .60 USD per cwt., while assembly charges to producers average about .35 USD per cwt. If .15 USD per cwt. is a representative level of subsidization, the U.S. margin would be lowered about .003 USD (.021 NOK) per kg. Because these figures could not be generalized to a national basis, we did not adjust the U.S. milk cost estimate. Nevertheless, it should be kept in mind when the analytical results are discussed.

Buyers of milk from producers in the U.S., largely cooperatives, employ large field staffs to not only service producer members, but to encourage membership in the respective cooperatives. In Norway with producers assigned to plants by region, activities and costs for recruiting members are unnecessary. The value of these cooperative services in the U.S., as estimated in a recent report of the USDA for southern U.S. dairy farmers, was $.008 (.053 NOK) per kg. (Leibrand et al., 1991). Since this is an estimate for only one region of the U.S., it is not included in our margin computations.

It should also be noted that the prices of the upper part of Table 1 for Norway are for only domestically sold products. But Norway markets a considerable part of its production on the world market at lower prices. Hence, there is subsidization in

the form of price discrimination between markets. As the farm price of milk reflects both domestic prices and significant sales at world market prices, the Norwegian farm price is adjusted upwards to reflect domestic marketing, only. The actual method of calculating this adjustment is described below. Clearly, this price discrimination is from a welfare point of view sheer nonsense. But for the industry it has a certain rationale that dairy exports are almost invariably subsidized throughout the world.

There is also the need for an adjustment for differences in price discrimination between products in domestic markets, in both Norway and the U.S. This price discrimination is reflected in the class differentials according to milk use in the U.S. and in the wholesale product pricing strategies in Norway. Exploitation of market power induces rents, presumably reflected in the farmer price. Because the 10 products of Table 1 are substituted for the actual shares of all dairy products, the price discrimination rents (and revenues) will also be different. Thus, further adjustment of the farmer price and the apparent margins is required.

The two last adjustments would be rather difficult, without data on the extent of price discrimination. Fortunately, such data exist. To provide for equal distribution of the price discrimination rents in Norway, there is a redistribution measure -"Riksoppgjøret" - which, in principle, collects all revenue, covers all marketing costs, and distributes the residual to the farmers. In the U.S. the difference between the manufacturing milk price and the fluid use milk price is a measure of this redistribution. Data from this redistribution are used for the price discrimination adjustment. The formal justification for the two adjustments is as follows:

Interpret, y, as a vector of products sold in different markets at prices p. Considering that the farm prices depends on y and p, we rewrite (1b) as:

$$r(y,p)'\beta m = p'y - M(w,y,m) \tag{7}$$

In order to obtain an even distribution of discrimination rents, it is necessary and sufficient to collect certain specific redistribution fees, d, from all sellers of dairy products. The redistribution fees are determined satisfy the equation:

$$p'y - d'y - C(w,y,m) = \rho'\beta m \tag{8}$$

for some constant constituent prices ρ for all vectors of dairy products y processed from the quantity of milk, m. That is, the net unit return to milk $\rho'\beta$, is independent of the utilization y. When the redistribution revenue, $d'y$, is returned to sellers according to their milk purchases, they will all be able to pay the farm prices:

$$r(y,p)'\beta = (d'y - \pi)/m + \rho'\beta \qquad (9)$$

Let y^* and p^* denote the actual quantities and corresponding prices by products; let y^N and p^N denote the quantities and prices of Table 1; and let the y^{N*} denote the actual quantities sold domestically. The appropriate margin is:

$$\begin{aligned} M(w,y^N,m) &= p^N'y^N - r(y^N,p^N)'\beta m && \text{using (1b)} \\ &= p^N'y^N - d'y^N - \rho'\beta m + \pi && \text{using (9)} \\ &= p^N'y^N - d'y^N - p^{*\prime}y^* + d'y^* + C(w,y^*,m) + \pi && \text{using (8)} \\ &= p^N'y^N + d'(y^*-y^N) - r(y^*,p^*)'\beta m && \text{using (7),(1a-b)} \\ &= p^N'y^N - [r(y^*,p^*)'\beta m + d'(y^{N*}-y^*) + d'(y^N-y^{N*})] && (10) \end{aligned}$$

The square bracketed term reveals the appropriate farmer milk price. The actual price is adjusted with two terms, $d'(y^*-y^{N*})$ and $d'(y^{N*}-y^N)$ which represent redistribution revenue which would increase the farmer milk price if exports were avoided (the first term), and if the product mix y^N was sold domestically instead of the actual product mix y^{N*} (the second term). The first term is relevant for Norway only. The redistribution fees are public information and these adjustment terms can be calculated.

The gross revenue less the adjusted prices paid to producers per kilogram of milk provides a measure of the gross marketing margins in the respective countries. Tables 1 and 2 contain marketing margins relative to given product mixes. Calculations in the respective currencies of the two countries show a marketing margin of 1.443 NOK per kilogram in Norway and .182 USD per kilogram in the U.S. Except for profits, these are the estimated points on the respective cost surfaces.

3.3 Converting to Standard Monetary Units

The marketing margins calculated above, obviously, are not directly comparable because of different monetary units. Two options are commonly used for comparison; (1) official exchange rates could be used or (2) trade theorists argue that a real exchange rate (PPP) is appropriate. The official exchange rate measures the relative prices of goods available on the world market (before tariffs and taxes). The PPP is a measure of the relative prices of goods in the two countries after tariffs and taxes (Edwards, 1989). Because we want to determine if one country is using more non-dairy inputs in providing a particular marketing service (z,ε), a more specific measure of the relative prices of *non-milk inputs to dairy marketing* is needed. For this purpose we make use of the Törnqvist price index procedure. This index is developed as follows: Assume the cost functions, $c^a(w^a,z^a,\varepsilon^a)$ and $c^b(w^b,z^b,\varepsilon^b)$, for the dairy marketing industries in the U.S. and Norway respectively, with w^a and w^b as non-milk input prices, and z^a and y^b as dairy marketing services performed. A cost function is an aggregator function, and the ratios: $c^a(w^a,y^a)/c^a(w^b,y^a)$ and $c^b(w^a,y^b)/c^b(w^b,y^b)$ are price indexes for non-milk inputs.

Following the proof of theorem 1 of Caves, Christensen and Diewert the geometric mean of these two price indexes when both industries are minimizing costs, are given by the Törnqvist price index, P^T, (Caves et al., 1982). Because miminimizing behavior is a reasonable assumption for the industry, the use of the Törnqvist price index in (11) is an appropriate cost deflator. For estimating purposes, the

$$log\ P^T = \Sigma\ 1/2(s_j^a + s_j^b)[In(w_j^a) - In(w_j^b)] \qquad (11)$$

where s_j^a and s_j^b are the cost-shares of factor j in country a and b, respectively, i.e. $s_j^i = w_j^i x_j^i / \Sigma_k w_k^i x_k^i$ for $i = a, b$.

The structure of this index confirms that neither PPP-rates nor the actual exchange rates are appropriate for comparison of dairy marketing margins. The appropriate conversion factor is an index like P^T based on relative prices for the actual inputs to dairy marketing. These are: labor, fuel and electricity, packing material, additives, machinery and transportation equipment, and structures. The capital costs

consist of three general items: depreciation, maintenance and interest. Detailed relative prices for relevant commodities are not available except for labor. It is, therefore, assumed that fuel, electricity, additives, packing material, machinery and equipment are bought at the world market prices according to the official exchange rate, 6.737 NOK/USD for 1987, while structures and maintenance are bought domestically at national prices according to the PPP-deflator of the Gross Domestic Product, 8.540 NOK/USD (OECD).

The relative price of labor was obtained as follows: The Central Bureau of Statistics of Norway (CBSN, 1987, 1988, 1989) reports the cost of labor in the dairy marketing industry to be 109.88 NOK per hour including taxes for 1987. U.S. labor costs are based on wages reported in the "Survey of Current Business" for food industry workers (USDC, Selected monthly issues for 1987, 1988, 1989). Compensation per year per full-time worker was approximately 23,300 USD. We added 6.64 percent for employer cost of social security, and divided by 40.2 hours per week for 52 weeks, for an estimate of 11.89 USD/hour. The relative price of dairy marketing labor is hence 9.24 NOK/USD in 1987.

Cost shares for Norway are calculated from the following data for the milk processing industry (CBSN, 1987,1988, 1989):

	mill. NOK
Compensation of employees	1170.4
Fuel and electricity	117.5
Packing materials	459.4
Other goods and services	990.7
Gross fixed capital formation ≈depreciation	495.8
Maintenance of fixed assets	238.7
Value of fire insurance:	7427.8

The fire insurance value is a replacement value. One-half of this value is a our estimate of the total real capital in 1987 prices. Multiplying this by the real interest rate of 6.2 percent (the long-term Government bonds of 13.24 percent per annum less inflation during the year 7 percent reported by the OECD (1988), we obtain an estimate of interest cost of 231.7 mill. NOK. Fifty-seven percent of depreciation is

for machinery, the average for the food industry. These assumptions and calculations generate the cost shares for Norway. Lacking U.S. cost shares we assume similar factor proportions. The U.S. cost shares are then calculated from the relative prices of labor, the exchange rate, and the PPP-rate. The assumptions used in calculation of cost shares are somewhat heroic. Fortunately, the results are not very sensitive to the cost shares as they are only used as weights for the three exchange rates employed. A summary of the results is given in Table 3. A Törnqvist index of 8.226 is derived for 1987. Using this conversion factor, we arrive at estimated dairy marketing margins of .182 USD/kg for the U.S. and .175 USD/kg for Norway in 1987, Table 4.

Table 3. Calculation of a Törnqvist Price Index for Non-milk Inputs for the Dairy Marketing Norway Relative to the U.S. 1987.

	Norway			U.S.	
	cost share		price NOK	cost share	price USD
Compensation of employees	.316	.316	109.9	.287	11.87
Fuel and electricity	.032				
Packing materials	.124	.232	6.737	.290	1.000
Depreciation, machinery	.076				
Other goods and services	.267				
Depreciation, buildings	.058	.452	8.540	.435	1.000
Maintenance of fixed assets	.064				
Interest	.063				
Törnqvist Price Index		1.000	8.226	1.000	1.000

Source: Calculated according to formula (11) in the text

3.4 Standardizing for the Processing Activities

The margins above have the formal representation $M^a(w,z^a,\varepsilon^a)$ and $M^b(w,z^b,\varepsilon^b)$. They are calculated with identical prices, but the activity levels and the geographical environments are different. We will now adjust the margins to identical activities. This is rather simple due to the linear homogeneity and input non-jointness of the technology. Let $c_j(w,\varepsilon)$ denote the unit cost of activity z_j. Then cost can be written as:

$$C(w,z,\varepsilon) = \Sigma_j\, C(w,z_j,\varepsilon) = \Sigma_j\, z_j c_j(w,\varepsilon) \qquad (11)$$

And the costs for the vector of activity levels z are found from those of z^a by:

$$C(w,z,\varepsilon^a) = C(w,z^a,\varepsilon^a) + c(w,\varepsilon)'(z - z^a) \qquad (12)$$

We have chosen to compare margins for two sets of activities, one typical American and one typical Norwegian. The processing activities are calculated from the product mix and the composition of the milk. The product mixes are taken according to the weights in Tables 1 and 2. The Norwegian cheese made out of whey is excluded however as it has no U.S. counterpart. With regard to milk composition, U.S. Norwegian milk are fairly identical. The percentages of butterfat and protein in producer milk was 3.75 and 3.14 in Norway (Hoveid 1989b) and 3.71 for butterfat 3.18 for the Upper Midwest in the U.S. for 1992 (Market Administrator, 1994). The recalculated margins with standardized product mixes and activities appear in Table 4. For both product mixes, we show that the Norwegian margins are lower, .172 USD/kg to .182 USD/kg for the U.S. mix or 0.169 USD/kg to .172 USD/kg for the Norwegian mix.

There may be some doubt as to the representativeness of the year 1987. Therefore, the calculations were repeated with data from 1986 and 1988. The results are also presented in Table 4. For all six cases the Norwegian margins are lower. The estimates show the U.S. marketing margins to range from 1.8 to 15.4 percent higher than in Norway.

Table 4. Dairy marketing margins, Norway and the U.S. 1986-88

	Törnqvist Price Index	U.S Margin Based on:		Norwegian Margin Based on:	
		Norway Mix	U.S. Mix	Norway Mix	U.S. Mix
1986 Margin, NOK/kg	8.102	1.475	1.515	1.288	1.310
1986 Margin, USD/kg		0.182	0.187	0.159	0.162
1987 Margin, NOK/kg	8.226	1.415	1.497	1.390	1.443
1987 Margin, USD/kg		0.172	0.182	0.169	0.175
1988 Margin, NOK/kg	8.296	1.534	1.535	1.385	1.374
1988 Margin, USD/kg		0.185	0.185	0.167	0.166

4. Factors That May Account for Margin Differences between Norway and the U.S.

The analysis thus far indicates that the marketing spread for dairy products in the U.S. industry is greater than in Norway. There are, however, several factors, in addition to efficiency differences, that could explain the differences in margins between the two countries. These are discussed in section below.

4.1 Omitted Price Standardization Factors

We have previously noted several price standardization factors for which representative data were unavailable or were not applied to the U.S. margin calculations. These were:

• Transportation subsidies for milk producers. Representative data on buyer subsidization of producer milk hauling for the U.S. is unavailable. However, as noted above, management officials of cooperatives in the Upper Midwestern U.S. assert that .15 USD per hundredweight is a reasonable estimate. This translates into a subsidy or reduced marketing margin of .003 USD or .021 NOK per kg.

• Farmer services provided by the marketing firms. Costs of farmer services for the southeastern region of the U.S. have been estimated to be .008 USD or .053 NOK per kg (Leibrand, 1991).

• Product differentiation. The single Norwegian Milk Marketing Cooperative is not subject to the same competitive pressures and costs of competing for outlets and milk supplies as U.S. dairy marketing firms. U.S. sellers of differentiated consumer products such as milk, ice cream and butter expend substantial sums of money on promotional activities--media advertising, market analysis, packaging design and related activities. Some of the costs of dairy product promotion in the U.S., unlike Norway where they are entirely incorporated into the marketing costs, are assessed directly on producers and are not included in the calculated margin. Since 1983, U.S. milk producers have been assessed .003 USD/kg. or about .021 NOK/kg. of milk sales to fund national dairy promotion and research programs. This factor would increase the U.S. margin if charged as in Norway.

• Ownership rents. Differences in ownership and distribution of profits may also account for differences in estimated costs of dairy marketing in the two countries. IOF's predominate in the U.S. retail distribution system and much of the fluid milk processing industry. Profits are returned to owners of the business through dividends or stock appreciation. Furthermore, U.S. dairy cooperatives often pay ownership rents explicitly to their members in the form of annual patronage refunds. The payments are in most cases proportionate to patronage, but nevertheless separated from the milk cost for the cooperatives. On the other hand, the Norwegian cooperative, by far the major processor of dairy products in Norway, does not explicitly pay ownership rents. All payments to producers are reported as the price of milk, but it includes an unspecified part related to ownership. This part should be isolated as it is a part of marketing cost.

As an indication of stock appreciation in the Norwegian dairy cooperative, Hegrenes, Hoveid and Tjernæs (1991) found the equity in the dairy cooperatives increasing from 1.510 through 1.919 and 1.970 to 2.424 billion NOK from the end of

1985 to the end of 1988. With these equity values and using the official figure for medium term interest 7 percent, we arrive at ownership rents in the range of .07-.09 NOK per litre. The size of real retained earnings are also unclear, as accounting balances at the end of 1985 was relatively low, because of a change in book-keeping procedures prior to a profound restructuring of the cooperatives in 1986. There was however a real increase in equity of 6.6 percent in average per year over the period 1986-88. Calculating over the periods 1985-88 and 1987-88, the real increase is approximately 3 percent. Hence, the ownership payments are considerable lower than 07-.09 NOK per litre, especially in the years 1986 and 1988.

U.S. dairy cooperatives for 1986-88 had 61 percent of their assets financed by debt capital (Richardson et al., 1987, 1989a, 1989b). Also, net earnings of .004 USD per kg. were paid to cooperative owners for those years. Using these figures for cooperatives only, the U.S. margin would be reduced by .0061 USD or .040 NOK per kg.

4.3 Geographical Characteristics of the Markets

If there are economies of scale in milk receiving systems, processing, distribution of products; then costs would be expected to differ if average size of plant or marketing facilities differ. The geographical environment in which the marketing takes place are quite different in the two countries and they are likely to cause differences in plant size and in transportation costs. Features of the Norwegian milk industry are the small farms and mountainous and narrow roads making collection relatively costly. Except for the southern part of the country, many of the milk markets are located in a narrow north-south coastal band. Estimates are that assembly costs are .92 USD/cwt., in Norway and approximately .40 to .60 USD/cwt. or in the U.S. These costs are not included in the margin., but relatively high costs of collection per unit of milk may explain the relative small size of plants in Norway.

Norway has a relatively small average size of plants, approximately 160 plants handling and processing an annual volume of 1,900 mill kg. milk or about 13 million kg per plant. Data for the U.S. on only manufactured dairy product volumes (excludes

any fluid products) indicates a per plant volume of roughly twice the Norwegian volume. There are large transportation requirements between the regions of milk production and the regions of consumption both in the U.S. and in Norway. This interplant transportation requires transport of fluid milk, usually in bulk form, into regions of low supply and the transportation of hard dairy products from regions of too high supply to those of low supply. The first case represents transportation with relatively high unit costs, but relatively small amounts are moved in either country. Hard manufacture products most frequently move long distances, but they are characterized by high volumes of concentrated products. The Norwegian industry reports an average cost for this interregional transport of 0.006 USD/kg. in 1987. In this respect, we might expect that the U.S. industry has a disadvantage, but cost estimates are few. Pratt et al. report costs from a simulation study of the Northeast Dairy Industry (Pratt et al., 1986). They estimated the total transportation costs of .793 USD/cwt. for 1980 or 1.09 USD after adjusting to the price level of 1987 (38 percent inflation as reported by the OECD). These transport costs were estimated for movement of milk from county centers of milk supply to county centers of consumptions, including both farm milk assembly and product distribution costs. After deduction of the farm assembly costs noted above, it appears that distribution costs in the U.S. would range from .007 to .009 USD/kg. more than the Norwegian distribution costs.

One would expect dairy product distribution in Norway to be more costly than in the U.S. The average delivery of the Norwegian industry is only 190 kg. The Norwegian costs of distribution are .12 NOK/kg in 1987. Much of the U.S. distribution is through large volume supermarkets in high density population centers which should result in low per unit costs.

In total, one would expect economies of size in processing and transport to favor the U.S. dairy industry over Norway, but the data available to us are too limited to provide any reasonable estimate of the monetary value.

4.4 Seasonality of Milk Production

Differences in seasonality of milk production could cause differences in dairy marketing costs. High peaks of supply necessitate high capacity of collection and processing, implying excess-capacity in other periods. Large volumes of excess supply necessitate storage which implies costs and probably some loss of quality. Haines and Jenkins found this to be a major factor of explanation for the processing costs in Ireland and the U.K. The seasonality of dairy production in Norway is not pronounced at the national level. The month of highest production is only 111 percent of the average month for 1986 (Hoveid, 1989b). At the regional level there is somewhat greater seasonality: the highest month is 126 percent of average month as an average over regions. U.S. milk production for 1986 through 1989 exhibited slightly less seasonality than Norway. High month production was 109 percent of the average for these three years. Overall, one can not conclude that the seasonality is more pronounced in Norway in the U.S. or that it is sufficiently different to account for differences in marketing costs.

4.5 Regulatory Impacts

Regulation is frequently criticized from two points of view. Regulation requires resources and, thus, it must be paid for from government revenues or charged directly to the regulated industry to be reflected in its costs. Or, as frequently charged, the regulation of prices or granting of monopoly powers eliminates incentives for cost minimization by the firm or firms. The extent of milk market regulation and the level of market dominance by a single cooperative, monopoly in Norway apparently do not lead to higher levels of market costs than in the U.S. One might argue that the more competitive structure of the U.S. industry will lead to additional costs of competing for milk supplies by several milk buyers milk markets and excess transportation because of overlapping of buyer assembly areas.

One regulatory feature that may contribute to higher interplant transport costs for the U.S. is the plant qualification requirements that are imposed under the federal milk order program, particularly, in the upper midwest markets of the U.S. To participate in the pooling provisions of the federal milk market orders, supply plants must ship specified percentages of milk to fluid milk distributors. Many of these supply plants are farmer-owned cooperatives. To provide their members with some of the increased revenues that are generated by sales for fluid uses, some milk must be shipped to fluid milk markets even though it is not needed to meet the fluid needs. Sometimes this milk is shipped back to the original supply plant for processing into manufactured dairy products. In other instances, supply plants are making continuous shipments to qualify for participation in the pool although other plants located nearer the consuming markets could adequately meet the markets needs.[1] Unnecessarily large fluid supply areas for some U.S. fluid markets and very low percentage utilization of milk in fluid uses for these markets are indicative of unnecessary transport costs in U.S. milk marketing.

4.6 Net Impacts on Standardized Margins

The net total of the above factors for which some measures are available, if they are representative of the respective industries, would reduce the U.S. dairy marketing spread by .0141 USD per kg. or .093 NOK per kg. below the Norwegian spread for 1987 and account for a large part of the differences for 1986 and 1988 in Table 4. If appropriate measures of the factors, they indicate that the U.S. and Norway are similar in dairy marketing efficiency as measured by marketing costs.

[1] A study by Stitts and Hammond in 1970 estimated that the actual radius of the supply area exceeded the optimum supply area radius by 170 miles for the New York-New Jersey market, by 240 miles for the Chicago market, by 30 miles for the Minneapolis-St. Paul market, and by 240 miles for the North Texas market (Stitts et al., 1970). No similar study, to our knowledge, has been done since then.

5. Conclusions

This analysis compared marketing margins of the Norwegian and the U.S. dairy marketing industry for the period 1986-88. A standardization of cost components, prices, and product mix was undertaken and appropriate monetary conversions indexes were developed to compare the aggregate marketing costs for milk in the two countries. Formal calculations show U.S. dairy industry marketing margins to range of 1.8 to 15.4 percent higher than the Norwegian industry for similar marketing functions.

In the course of the analysis we examined several factors that may account for cost differences between the U.S. and Norway. Impacts of several marketing activities that were different in the two countries could not be precisely determined because of lack of appropriate data. These include; transport subsidies in the U.S., producer services provided by the marketing firms, assessment of product promotion directly to farmers, and costs of competing for producer milk supplies. Higher transportation costs due to long distances between areas of production and consumption should favor lower costs in Norway. Larger plant sizes and per unit delivery volumes that may generate economics of scale in processing and distribution seem to favor the U.S. Costs of competing for product markets and for milk supplies because of the monopolistically competitive or oligopolistic structure of the U.S. dairy markets are, an additional consideration in the U.S. Unsubstantiated and local market data indicate that these factors in the U.S. may total to about .014 USD/kg which would be sufficient to reduce the U.S. dairy marketing spread below that of Norway for 1987 and eliminate most of the difference for 1986 and 1988.

The importance of the above factors is sufficient to make the comparisons inconclusive. More extensive data and analysis on dairy marketing operations would be required to determine the importance of these explanations. Regardless of some uncertainty about our margin comparisons, the results are relevant for an ongoing discussion of the Norwegian milk market regulation. The costs of the present regulation system in Norway to society have been questioned, in particular, induced inefficiency is feared. However, this analysis, as well as other comparisons with other

countries, Denmark, Sweden and Switzerland (Hoveid, 1989a, 1989b) do not indicate a serious inefficiency in Norwegian milk marketing. And, although the U.S. dairy marketing sector appears to be operating with costs somewhat above the Norwegian sector, one can easily conclude that higher cost is the result of differences in the marketing functions between the two systems.

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