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**Abstract:**

A milk marketing board (MMB) is a legislatively specified compulsory marketing institution, and a common way to regulate markets for dairy products. MMBs are based on price discrimination. As price discrimination leads to unequal profitability between products, receipts from sales are pooled and farmers receive a single price adjusted for composition and quality. It is well documented that price discrimination through MMBs incurs an efficiency loss to the society.

Earlier contributions, Ippolito and Masson (1978) and Serck-Hansen (1979), point out that a particularly high loss is incurred if export of dairy products is included in the MMB. It proves difficult to find examples where this is the case. MMB countries are either large with a low export share in dairy products (USA and Japan), have economies of scale (Australia) or exports are excluded from the MMB arrangement (Canada). However, we find Norway to be a good example.

Using a numerical model of the Norwegian agricultural sector we show that substantial efficiency gain may be achieved by deregulating the dairy sector, mainly due to the elimination of exports. It is estimated that a transition to cost based pricing may increase the economic surplus by NOK 1.5 billion, which is 26% of the production value. This computed gain from deregulation is far larger than for the other MMB-countries.

*JEL classification: D58,L52, Q13.*

*Keywords:* Dairy policy, milk marketing boards, price discrimination, deregulation, numerical model.

# Efficiency losses in milk marketing boards – the importance of exports*

## 1. Introduction

Following Veeman (1987), a *milk marketing board* (MMB) is a legislatively specified compulsory marketing institution that conducts price discrimination. Since price discrimination leads to unequal profitability between products, receipts from sales are pooled and farmers are paid a single price adjusted for composition and quality. The exact set-up of MMBs and the corresponding pooling arrangements varies between countries. The United States has a pooling arrangement involving fluid and industrial milk through the Federal Milk Marketing Order (US-MMO) system. In Canada[1] and Japan liquid and manufacturing milk prices are pooled regionally. Norway has a special arrangement where the pooling takes place through the Norwegian Agricultural Marketing Board (NAMB). Until 1994 the United Kingdom had MMBs that set prices on milk to the dairies according to end use, and until recently farmers in Australia had to pay a levy that was used to subsidize exports.

It is well documented that price discrimination through MMBs entails an efficiency loss to the society. In table 1 we review the most recent documentation, while appendix 1 offers a broader list of references. Based on an interregional market equilibrium model that was calibrated on U.S. data from 1995, Cox and Chavas (2001) found that eliminating the US-MMOs would lead to a decline in the producer surplus by USD 368 million, and an increase in the consumer surplus by USD 505 million. The efficiency loss of USD 137 million amounts to 0.7 per cent of the production value of milk. Lippert (2001) reviewed the Canadian milk market and evaluated the efficiency loss by the regulation of the Canadian supply of milk to be CAD 200 million, i.e. 4.8 per cent of the production value. According to Freebairn (1992), the levy on milk in Australia generated a relatively small deadweight loss in the domestic market. However, the resulting excess

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[1] The Eastern Agreement on All Milk Pooling and the Western Milk Pooling Agreement. Until the spring of 2003, exports (class 5) had a common pool.

production that was exported involved relatively large deadweight losses. These costs were estimated to be between AUD 25 to AUD 65 million a year, depending on the size of the supply elasticity.[2] For the United Kingdom Anderson (1996) found that eliminating the MMBs, would give an efficiency gain of ecu 298 million. Kawaguchi, Suzuki and Kaiser (1997) studied the Japanese milk markets. According to their analysis the pooled farm price of milk would decrease by 14.7 per cent if markets were deregulated (perfect competition). Unfortunately, they did not report any welfare effects.

[Table 1]

From table 1 we read that the efficiency loss from the US-MMO and from the Australian levy-system seems to be small. The loss from the Canadian MMB is larger. Based on the research of Anderson (1996), the loss from the now abolished British MMBs was more substantial. However, one should be careful when interpreting the results from the various studies. First, the MMBs in the various countries differ both in type and strength. Second, the assumed elasticities of demand and supply affect the results. For example, one reason for the large difference between the loss in consumer surplus from upholding the US-MMO and the UK-MMBs (2.6% versus 12.6%) is that dairy products are assumed to be more elastic in the US study compared to the UK study.

In this paper we focus on another reason for efficiency losses to differ among countries, i.e. that the propensity to export varies. As was reported by Ippolito and Masson (1978) and Serck-Hansen (1979) and more recently by Bergman (1997), exporting MMBs may incur a larger efficiency loss than non-exporting MMBs. The argument is as follows. If exports are allowed, milk production can be taken out of the domestic market to elevate domestic prices. This results in a large deadweight loss because it involves a transfer of money from the home to the foreign country. Naturally, there will also be a welfare loss if a MMB does not export. However, in this case the transfer goes between domestic consumers. Consequently, the welfare loss is limited to pure deadweight losses in domestic consumption. Ceteris paribus, the efficiency gain from abolishing a MMB should therefore be greater in high as compared to low exporting MMBs.

[Table 2]

[2] The pool pricing arrangements provided farmers with price signals in excess of the export parity price in the size of 25% for New South Wales, Western Australia and Queensland, 33% for Victoria and 40% for Tasmania.

In table 2, existing MMB-countries are ranked according to the size of the export share, found in the second column. The third column repeats the efficiency losses from table 1. The United States has a low export share and a low loss, while Canada has a high export share and a moderate loss. As is discussed in section 4.1, a main part of the Canadian export is outside the MMB-system. We therefore lack results on efficiency losses from abolishing MMBs in countries where the export share is large.[3] With this background Norway may serve as a useful case. Exports of dairy products are high and are included in the MMB system.

Section 2 of this paper surveys the Norwegian dairy policy in more detail. In particular we discuss the market regulation scheme set up by the NAMB. Dairies have to pay a compulsory tax on profitable products, while unprofitable products receive a subsidy. By law, this scheme has to be self-financing, i.e. the collected taxes shall equal the paid subsidies. In section 3.1 we describe a numerical model of the Norwegian agricultural sector, which is used to simulate the current policy with price discrimination through the NAMB (the base solution) in section 3.2. Section 4.1 discusses the case with no export subsidies. Exports are then eliminated. By comparing this case with the base solution, the cost of export is revealed. The last simulation, presented in section 4.2, illustrates a situation with free competition in the dairy industry. Here domestic prices on dairy products equal marginal costs. Thus, Harberger distortions in the domestic markets are eliminated. Our conclusion is that substantial efficiency gains may be achieved by deregulating the dairy sector, mainly due to the elimination of exports. Due to the high cost of producing milk in Norway the efficiency gains are substantially higher than for other MMB-countries.

[3] Of the previous MMB countries, Australia has a large export share (appr. 45 %), and, according to table 1, a low efficiency loss. However, the low efficiency loss is understandable since Australia is a cost effective country in production. According to the International Dairy Federation (2002), the farm gate price was half of the farm gate price in the U.S. For England we lack information on exports.

## 2. The Norwegian dairy policy

The Norwegian dairy market is dominated by a single farmer-owned cooperative. At the farm gate level the market share is 98%, which means that nearly all milk farmers are members of the cooperative. The presence in the downstream industry is also strong, with a competitive fringe serving only 10% of the end market.

As is described carefully in the literature (see e.g. LeVay, 1983), a marketing cooperative tends to maximize the output price paid to the members, subject to a budget constraint, which says that the total payments to the members cannot exceed the net revenues from the domestic market and the export market. The constraint will always be binding. Thus, the behaviour is also known as the zero surplus solution.

The zero surplus solution is a good approach to understand the Norwegian dairy market. To maximize the farm gate price, the cooperative price discriminates between different end uses of milk (e.g. fluid milk, cheese, butter and milk powder) and between different markets (domestic and export). Like a regular monopoly would behave, the cooperative limits output in the high-value market (e.g. fluid milk) and expands output in the low-value market (e.g. butter, milk powder and exports). However, compared to a regular monopoly, milk production will be higher as the net revenue is paid to the members in accordance with supply. Naturally, a problem for the cooperative is to avoid cream skimming from entrants (private dairy companies) in the high-value segment.

Figure 1 illustrates the zero surplus solution with reference to the Norwegian dairy industry. Note that two additional restrictions are taken into account in the figure: 1) price discrimination in the domestic markets is restricted by price caps on the final products, and 2) the products cannot be imported due to prohibitively high import tariffs.[4]

[ Figure 1 ]

In panel a, domestic demand for fluid milk is represented by $D_A$, while $D_B$ in panel b is the demand for other domestic uses of milk (cheese, butter, milk powder, etc.). $D_A$ represents the high-value

[4] The import tariffs, resulting from the Uruguay Round Agreement on Agriculture (GATT, 1994), are in the range of 250-400 per cent. Minimum access opportunities equal to 5 per cent of domestic consumption in the base period, are established at lower tariffs.

market as it is assumed to be less elastic than $D_B$. $MR_A$ and $MR_B$ are the corresponding marginal revenue curves, while $P_E$ in panel c is the export price.

If the cooperative was free to set domestic prices, it would sell $A$ units of milk as fluid milk at a price $P_A$ and $B$ units of milk for other domestic uses at a price $P_B$. However, the cooperative faces price caps $\overline{P}_A$ and $\overline{P}_B$, and is therefore forced to supply $\overline{A}$ and $\overline{B}$ units in the domestic markets. In panel c the stepwise curve labelled *NMRP* is the (constrained) aggregate net marginal revenue product curve. *S,* the farmers' supply curve of milk, includes subsidies paid directly to the farmers. We assume that the cooperative has constant marginal costs in inputs other than milk, for simplicity normalized to zero.

A regular monopoly, subject to the price caps $\overline{P}_A$ and $\overline{P}_B$, would purchase $C$ units of milk from the farmers and sell $\overline{A}$ and $\overline{B}$ in the two domestic markets. To achieve this solution, the monopoly would have to pay the farmers a price equal to the net marginal return ($\overline{P}_B$). The profit, $(\overline{P}_A - \overline{P}_B)\overline{A}$, could then be divided among the share holders, as is usual in investor-owned firms. In contrast to a regular monopoly the cooperative will not maximize profit. Instead, the cooperative will raise the farm gate price until the profit in the domestic markets is just as large as the loss in the export market. In other words, the farmers are paid a price according to the net average revenue product (NARP), which is a weighted average of the net return obtained in different markets. Referring to figure 1, this principle results in a farm gate price, $P_F$, given by the intersection of the farmers' supply curve, *S*, and the solid curve, *NARP*, defined as:

$$NARP = \alpha_A \overline{P}_A + \alpha_B \overline{P}_B + (1-\alpha_A-\alpha_B)\, P_E$$

where $\alpha_i$, $i = A,B$, is the share of total production sold in the $i^{th}$ domestic market.

As figure 1 illustrates, production will be higher in the cooperative compared to the regular monopoly solution ($\overline{C}$ -$C$). This surplus production is exported at a price lower than the marginal costs in production, which incurs the deadweight loss $\delta$ in panel c.[5] The deadweight loss in the domestic markets due to price discrimination is equal to the triangles $\beta$ and $\gamma$ in panels a and b, as the price caps are binding. Observe that under a cooperative, the worse the domestic price

[5] In 1998 approximately 16% of the Norwegian milk production was exported at a loss. As a means to limit the surplus production of milk, a production quota system applies at the farm level, but the total production level still exceeds by far the quantity necessary to supply the domestic market.

discrimination is (the higher the price cap $\overline{P}_A$), the higher is the export, the lower is the consumer surplus and the lower is the total welfare.

Price discrimination, exploiting differences in demand elasticities between different end products, means unequal profitability between different lines and local dairies. *NARP* pricing is a way of pooling revenues and costs in such a way that all dairies have the same ability to pay for the farmers' milk. Obviously, this method involves cross-subsidization. As will be shown empirically in section 3.2, domestic products like milk powder and goat cheese are cross-subsidized by fluid milk, while foreign consumers are cross-subsidized by domestic consumers.

A system based on cross-subsidization is threatened by cream skimming from entrants (private dairy companies) preferring to supply the most profitable products or markets and leaving the incumbent (the cooperative) to supply the less profitable products. Until 1997, cream skimming from private dairies was avoided by different kinds of institutional entry barriers.[6] In June 1997 most of the institutional entry barriers were removed.[7] However, at the same time NAMB introduced a milk price equalization scheme (MPES). Dairies (including the cooperative) are now obliged to pay a tax for profitable products, and for unprofitable products they receive a subsidy. By law the scheme is self-financing, i.e. a zero surplus solution where the total taxes collected equal the paid subsidies. Let us use figure 1 to illustrate the main principle in the milk price equalization scheme. Drinking milk is now taxed by ($\overline{P}_A - P_F$), milk for other domestic uses is subsidized by ($P_F - \overline{P}_B$), while exports are subsidized by ($P_F - P_E$). Since all dairies are treated on an equal basis, cream skimming is avoided.

The main objective of the MPES is to strengthen competition in the dairy sector by removing institutional entry restrictions. As such, the scheme is a response to the general criticism that monopolies tend to have low efficiency, and also a response to results of economic research that suggest that cooperatives are less efficient than other organization forms (Porter and Scully, pp. 511-12, 1987). However, the MPES implies no major change in the practice of cross-subsidizing export and some domestic products by imposing a levy on other domestic products,

[6] It was almost impossible for entrants to get milk supplies from farmers since all the existing milk farmers were members of the cooperative and legally unable to change dairy company. Milk supplies from new farmers were also ruled out as a result of a closed quota system. Potential entrants in the dairy sector were therefore obliged to buy milk from the cooperative, which would be their rival in the end market. Another severe barrier to competition was the cooperative's dual role as competitor in the market place on one side, and as administrator of the pool system on the other side.

[7] By repealing the law, which made it difficult for farmers to change dairy company and by introducing tradable production quotas at the farm level, the new scheme makes it easier for entrants to receive supplies from the farmers. The scheme also facilitates competition by moving the administrative responsibility for the pool system from the cooperative to the NAMB.

especially drinking milk. Hence, the issue of welfare losses due to price discrimination and cross-subsidization is just as relevant as before the reform.

## 3. The model

### *3.1 Description*

In order to estimate the efficiency loss due to the Norwegian market policy for dairy products, we use a price endogenous, partial equilibrium model that includes the most important products and factors in the Norwegian agricultural sector. It is a partial equilibrium model in the sense that input prices as well as export prices are determined outside the model and are treated as given. However, domestic linear demand functions for the main agricultural products are included, hence the name price endogenous (see McCarl and Spreen, 1980).

A description of the model is offered in appendix 2.[8] In this section we focus on some important details regarding the model's representation of the dairy sector. Eight dairy products or aggregates are modeled: Cow milk, goat milk, fluid milk, cheese, whey cheese[9], goat cheese, butter and milk powder. Cow milk and goat milk are delivered from milk farms to dairies.[10] The remaining products are aggregates delivered from dairies to wholesale or retail dealers. Cow and goat milk are converted into dairy products by six different dairy processes or model dairies. The model dairies are characterized by fixed conversion coefficients for milk into each product. The conversion coefficients and processing costs for each model dairy are presented in table 3. Note that four of the model dairies have butter as a by-product.

[Table 3]

The domestic demand functions are linearized to go through the price/quantity combination of the base year (1998) using the following demand elasticities: cheese and whey cheese (0.5), butter (1.0), milk powder (1.0) and fluid milk (0.3). These elasticities correspond to the common assumption that the demand for fluid milk is less elastic than the demand for butter, milk powder

[8] The model is designed to perform policy analyses, and has as such been used by the Norwegian Ministry of Finance and the Norwegian Ministry of Agriculture. A detailed description of an earlier version of the model is given in Brunstad et al. (1995a). For a description of the current version, see Gaasland et al. (2001).
[9] Whey cheese is a traditional Norwegian product made by boiling down milk and whey.
[10] At the farm level, milk production is represented by about 75 model farms of varying size (from 6 to 200 cows) and location (9 production regions), each characterized by fixed input and output coefficients.

and cheese, and are roughly in line with several existing studies. Cross-price effects are neglected as we use broad product aggregates which hardly are close substitutes in consumption, except for cheese and whey cheese.

*3.2 The base solution: The milk price equalization scheme (MPES)*

Using the model, we have simulated the actual agricultural policy in Norway by implementing the actual system of subsidies and import barriers in the base year 1998,[11] and by implementing the MPES. As was explained in section 2, the MPES means price discrimination between different uses of milk and between different markets. The taxes and subsidies in the scheme are listed in the first column of table 4.

[Table 4]

We see that the "price-inelastic-processes" (fluid milk and whey cheese) are heavily taxed, while the "price-elastic-processes" (milk powder and export of cheese) are heavily subsidized. From the discussion connected to figure 1, it is understood that this system encourages milk production beyond the regular monopoly outcome under price caps.

In the simulation perfect competition is assumed to prevail in all sectors. As for the dairy sector the justification is that today dairies are free to compete in both ends of the market. Even if the cooperative dominates the market, it meets a fierce competitive fringe. The results from this simulation, which is called the base solution, is presented in the second column of table 5.

[Table 5]

Observe that the level of support given to Norwegian agriculture is extremely high (NOK 15.2 billion or USD 2.0 billion).[12] Since agriculture employs about 59,700 man years, the support per

[11] At the farm level, the Norwegian agricultural policy is based on different kinds of subsidies. First, there are substantial budget transfers in the form of deficiency payments (general and regionally differentiated), acreage and headage payments, disaster payments, transport subsidies, structural adjustment measures etc. Second, support is also given in the form of tariffs. Third, a system of tradable production quotas gives regional protection. It should also be noted that the subsidies favor small farms in scarcely populated areas. Consequently, the Norwegian agricultural policy is to a large extent directed at rural employment and protection of the family farm. For a recent description of the Norwegian agricultural policy, see OECD (pp. 182-187, 2003.b).

[12] The actual agricultural support in 1998 was approximately NOK 20 billion (USD 2.6 billion).

man year is about NOK 250,000 (USD 32,500). Apart from grain, Norway is self-sufficient or has a surplus in agricultural products. In particular, there are large exports of both cheese and butter.

## 4. Deregulation

### *4.1 No export subsidies*

Export prices are way below production costs, in spite of substantial subsidies at the farm level.[13] Consequently, when export subsidies are abolished, the dumping of dairy products stops. This is shown in the column marked as "No export" in table 5. In order to make the comparison between the various experiments easier, domestic MPES-rates are set such that prices on domestic dairy products are unchanged. Domestic consumption is then unaltered. The 292.4 million litres (17.5%) decline in milk production compared to the base solution is solely due to the elimination of exports.

The MPES-system goes in surplus. If this surplus is allocated to the milk producers, producer surplus will increase by NOK 0.7 billion (1.2-0.5=0.7) compared to the base solution. The overall increase in economic surplus is NOK 1.0 billion, of which NOK 0.7 billion is due to higher producer surplus, while NOK 0.3 billion can be explained by a lower budget support, mainly because of lower milk production and fewer farms. In 1998 the production value of milk was NOK 5.7 billion. Consequently, the NOK 1 billion efficiency gain amounts to 17.5 per cent of the production value.

Schluep (1999) has performed an identical experiment for the Canadian dairy sector. According to her research,[14] eliminating export subsidies leads to an increase in economic surplus equal to 0.7 per cent of the production value. The reason for this small efficiency loss is twofold: First, a major part of the Canadian export is excluded from the Canadian pooling arrangements.[15] Second, the cost of the marginal milk production is substantially lower in Canada compared to Norway.

[13] For example, the average revenue from the cheese export process is NOK 24.40, while the costs are NOK 58.25.
[14] Schluep (1999), p. 105.
[15] Class Ve is not included.

*4.2 Internal deregulation*

In this section, we focus on additional efficiency losses caused by Harberger distortions in the domestic markets. For this purpose all MPES-rates are set to zero. Consequently, we obtain prices which equal marginal costs. Import restrictions are maintained, which means that the focus is on internal deregulation. At the farm level, we assume that subsidies are unaltered. The exact framing and accomplishment of the deregulation is beyond the scope of this paper, but removal of the MPES is a basic condition.

The results of the experiment are presented under "Internal deregulation" in table 5 and in table 6. As we observe from table 6, not only export is cross-subsidized in the base solution but in particular also domestically sold milk powder, since the deregulation means an increase in the domestic price of this product by as much as 68.9%. Furthermore, in the base solution whey cheese and fluid milk are overpriced by 56.2% and 19.8% respectively. Naturally, the consumption of whey cheese and fluid milk increases as a result of the transition to cost-based pricing, while the consumption of milk powder decreases.

[Table 6]

As a result of the deregulation, economic surplus increases by NOK 1.5 billion, i.e. 26.3% of the production value of milk. Consumers and taxpayers are the main gainers. As a result of lower domestic prices on fluid milk and whey cheese, and despite higher prices on milk powder, the consumer surplus increases by 1.3 billion NOK (23.2% of production value). The taxpayers gain NOK 0.4 billion, mainly because of lower milk production and fewer farms, and thereby lower total subsidies to the milk farmers. The producer surplus decreases by NOK 0.2 billion because of the decline in milk production.

An objection to our model simulation is that deregulation will hardly lead to free competition and cost-based pricing. Although institutional entry barriers have been removed, there are many kinds of technical and strategic entry barriers, which may continue to hamper competition, such as economies of scale, sunk costs and transport costs.[16] The industry norm is, as noted by Sexton (1990) and Tennbakk (1995), that cooperatives coexist with other firms in

[16] Since the introduction of the MPES, three private dairies have expanded their production rapidly. However, they still have low market shares, especially at the farm gate level (about 2%). The highest market share is in the wholesale market for cheese (about 10%). Other entrants have tried to enter the market, but have failed.

markets that are structural oligopolies or oligopsonies. Thus, the estimate in this section should be interpreted as the maximum gain by deregulating the dairy sector.

## 5. Concluding remarks

A marketing board is a well known instrument for regulating the markets for dairy products. Since it is based on price discrimination, it causes economic losses. Our findings suggest that a deregulation of the Norwegian dairy industry could increase the economic surplus by as much as 26.3% of the milk production value. This computed gain is far larger than for the other countries reviewed in table 1. The main reasons are that exports are included in the Norwegian MMB, and that production costs of milk are very high in Norway. In addition, there is some evidence that the Norwegian MMB-regulation is stronger than in other countries, based on the following reasoning: A measure of the strength of a country's regulation may be the estimated effect on the price of fluid milk from a deregulation, since fluid milk is regarded as the most inelastic product and therefore most exposed for taxation. For the U.S. this indicator is 13.9% (Cox and Chavas (2001), p. 101), compared to 19.8% for Norway (table 6).

In the literature many arguments in favour of MMBs or marketing cooperations are offered. In a recent article by Bouamra-Mechemache et al. (2001), the possibility of introducing a MMB in the EU is discussed. Their argument is that, as long as the total milk production is kept unchanged by the quota system, a MMB is an effective way of transferring money from consumers to farmers. The reason is according to Bouamra-Mechemache et al. (2001, p. 9) that "the welfare cost of price discrimination policy could be as low as, or lower than fully decoupled payments when the opportunity cost of public funds is taken into considerations." However, this argument is not valid if transfers are used to promote exports.

When evaluating the regulations, there is always the question whether there are social benefits to outweigh the substantial costs of the current policies. There are several alleged benefits of regulation, spanning from the original objectives in the 1930s, namely to raise and stabilize milk prices and offset monopsony power, to current objectives related to rural employment and farm incomes. However, under the present market conditions it is hardly probable that these benefits justify government interventions of the magnitude we have described for Norway. The regulations may have been relevant at the time when they were passed, i.e. during the depression in the 1930s, but they are now out of date due to technological development and structural change. For example, farmers' bargaining power towards dairy companies has increased due to lower transportation

costs and better conservation methods. The rationale for price stabilizing interventions in the market is also weakened, partly because farm level production has become more predictable, and partly because technology makes it easier to deliver milk products in time (storage) and space (trade). Regarding rural employment, it might be argued that deregulation will have a negative effect on agricultural employment in rural areas, estimated to be 4,000 man-years (-10.2%).[17] However, it is well established that the most efficient way to achieve rural employment is by means of general income support to all inhabitants or general wage subsidies to all industries in a particular region (see e.g. Winters 1989-1990), and not by support confined to a single industry. If the authorities still want to pay specific support to agriculture, production neutral support is more efficient than price support of the kind used in the Norwegian dairy sector.

So why does an arrangement that is not desirable neither for economic nor for social reasons continue to exist? One answer is that MMBs serve as a useful instrument for farmers, and through lobbying they have been able to maintain this institution. However, discrimination between foreign and domestic products is a violation of basic WTO-principles. In the Uruguay Round it was agreed that by the end of the year 2000 export of cheese and butter should be reduced by 36% as of the situation in 1992. If future WTO-rounds continue to stress reduction or phase out of export and domestic subsidies, the harm from MMB arrangements such as the Norwegian NAMB will be reduced.

[17] See Brunstad, Gaasland and Vårdal (1995b) for a more detailed discussion of issues regarding rural employment.

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**Appendix 1. Efficiency loss in MMBs**

| *Country* | *Description* | *Welfare Loss* |
|---|---|---|
| (i) Canada | | |
| Schmitz (Barichello) | Abolishing fluid and industrial milk regulation<br>1980 | CAD 214 million annual welfare gain<br>CAD 955 million annual loss in producer surplus<br>CAD 980 million annual gain in consumer surplus<br>CAD 303 million annual gain for taxpayers |
| Lippert | Abolishing fluid and industrial milk regulation<br>2000 | CAD 200 million annual welfare gain<br>CAD 987 million annual transfer from consumer to producers |
| (ii)USA | | |
| Dardis/Bedore | Eliminating MMO<br>1985 | USD 343-608 million annual welfare gain |
| Helmberger/Chen | Long run impact of eliminating MMO<br>1990 | Decrease in producer surplus: USD 444 million<br>Increase in consumer surplus for fluid milk:<br>USD 1 billion<br>Decrease in consumer surplus for manufactured milk:<br>USD 648 million |
| Cox/Chavas | Eliminating MMO<br>1995 | USD 137 million annual welfare gain<br>USD 368 million (2.3%) decrease in producer surplus<br>USD 505 million (0.9%) increase in consumer surplus |
| (iii) Japan | | |
| Kawaguchi et al. | Deregulation | 14.7 % decrease in the milk price |
| (iv) Australia | | |
| Freebairn | Abolishing the levy system<br>1988/1989 | Estimated welfare gain: AUD 25-65 million |
| (v) United Kingdom | | |
| Anderson | Eliminating MMB<br>1994 | Ecu 89 mill. (2.54%) decrease in producer surplus<br>Ecu 387 mill. (2.61%) increase in consumer surplus |

## Appendix 2. The model

For given input costs, demand functions and support systems the model computes market clearing prices and quantities. Prices of goods produced outside the agricultural sector or abroad are taken as given. As the model assumes full mobility of labour and capital, it must be interpreted as a long run model.

The model includes the most important products produced by the Norwegian agricultural sector, in all 13 final and 8 intermediary products. Most products in the model are aggregates. Primary inputs are: land (three different grades), labour (family members and hired), capital (machinery, buildings, livestock and ditches) and other inputs (fertilizers, fuel, seeds, etc.). The prices of inputs are determined outside the model and treated as given.

On the supply side the model has about 1000 model farms with fixed coefficients (Leontief technology), covering 19 different production activities in 6 scales and 9 regions. The regional division reflects differences in climatic conditions, support systems and available land. The products from the model farms go through processing plants before they are offered on the market. The processing plants are partly modelled as pure cost mark-ups (meat, eggs and fruit), and partly as production processes of the same type as the model farms (milk and grains). Imports take place at given world market prices inclusive of tariffs and transport costs. Domestic and foreign products are assumed to be perfect substitutes.

The domestic demand for final products is represented by linear demand functions. These demand functions are based on existing studies of demand elasticities, and are linearized to go through the observed price and quantity combination in the base year (1998). Between the meat products there are cross-price effects, while cross-price effects are neglected for all other products for which the model only assumes own-price effects. The demand for intermediary products are derived from the demand for the final products for which they are inputs. Exports take place at given world market prices.

Domestic demand for final products is divided among 5 separate demand regions, which have their own demand functions. Each demand region consists of one or several production regions. If products are transported from one region to another, transport costs are incurred. For imports and exports transport costs are incurred from the port of entry and to the port of shipment respectively.

In principle restrictions can be placed on all variables in the model. The restrictions that we include, can be divided into two groups:

(1) *Scarcity restrictions:* upper limits for the endowment of land, for each grade of land in each region.

(2) *Political restrictions:* lower limits for land use and employment in each region, for groups of regions (central regions and remote areas), or for the country as a whole; maximum or minimum quantities for domestic production, imports or exports; maximum prices.

Different types of objective functions are used, depending on the market structure. When assuming perfect competition, total economic surplus (consumer surplus, producer surplus and importer surplus) of the agricultural sector is maximized. The maximization is performed subject to demand and supply relationships and the imposed restrictions. Which restrictions we apply depends on the respective scenario. The solution to the model is found as the prices and quantities that give equilibrium in each market. No restrictions must be violated, and no model farm or processing plant that is active, must be run at a loss.

The model reports figures like production, use of inputs, domestic consumption and prices, import and export, support and economic surplus measured as the sum of consumer, producer and importer surplus. A more technical description of the model is given in Brunstad et al. (1995a).

## Appendix 3. Subsidies and taxes given by the NAMB

The taxes and subsidies in table 4 equal the difference between revenues and costs of the various dairy processes in table 3. In principle, these rates equal the official rates given by the NAMB. However, there are some differences. First, the rates of NAMB are tied to products rather than processes. Second, NAMB uses more disaggregated products and markets than in our model. Third, transportation costs are rebated separately. Fourth, the rates are measured at a higher level of the vertical chain than in the model. In this appendix we compare the official rates with the rates reported in table 4.

NAMB comprises two arrangements:

1) The milk price equalization scheme (MPES) that taxes some products and gives subsidies to others. Furthermore, MPES grants subsidies for transportation of milk from farms to dairies and from dairies to retailers.
2) A marketing fee is collected on all milk delivered to dairies. In 1998 this fee was NOK 0.23 per liter farm milk, and it was used to finance exports of cheese and butter, to subsidize transportation, to cover administrative expenses and to finance a program for school milk.

### A.3.1 Official tax and subsidy rates

In table A.1 the MPES-rates are adapted to our level of aggregation. The second column reports the official tax and subsidy rates given by the MPES. A negative entry means a subsidy. The third column reports how much farm milk is needed to produce one unit of the product. Then, weighted by the commodity shares in the fourth column, the fifth column gives the tax and subsidy rate for the various products in the model.

In the table there are altogether eight product aggregates. The first six refer to domestic sales, while the last two are for exports. Notice that exports are financed both through the MPES and the marketing fee.

[Table A.1]

Multiplying the bold marked product rates in table A.1 with the coefficients in table 3, we obtain tax and subsidy rates on a process level, reported in the second column of table A.2. Transportation subsidies are written into the third column, and net rates are found in the fourth column.

[Table A.2]

### A.3.2 The tax and subsidy rates used in the model

The official MPES rates are based on a farm gate price of NOK 3.893 per liter.[18] In reality, the farm gate price is lower (NOK 3.40 per liter). The wedge is due to:

(i) the milk marketing fee,

(ii) the loss in the dairy sector which is passed on to the farmers, and

(iii) additional costs covered by the farmers.

In 1998 the marketing fee was NOK 0.23 per litre farm milk. The remaining NOK 0.263 is costs attributable to (ii) and (iii). To take account of the wedge, the MPES rates are adjusted by multiplying NOK 0.493 with the respective farm milk requirement of each process, given in the first line of table 3. For the milk process this amounts to NOK 0.493x1.013 = NOK 0.50. This adjustment is written into the third column of table A.3. The fourth column gives the adjusted MPES rates.

[Table A.3]

We also have to make some individual corrections. As for exports the MPES-rates are based on prices at a higher level of the vertical chain than in our model. With regard to goat cheese the MPES-rates are based on the farm gate price of goat milk, while our model treats goat milk as a separate product. Finally, whey cheese is based on a separate arrangement for subsidizing whey. When taking this into account, we obtain the model rates in the last column.

[18] See Omsetningsrådets Sekretariat (1998), p. 34.

Table 1: Efficiency loss in MMBs

| | Research | Production value *(million)* | Loss in consumers' surplus *(per cent of production value)* | Gain in producers' surplus *(per cent of production value)* | Efficiency loss *(per cent of production value)* |
|---|---|---|---|---|---|
| *Existing MMBs* | | | | | |
| Canada | Lippert (2001) | CAD 4,187[1] | - | - | 4.8 |
| United States | Cox/Chavas (2001) | USD 19,613[2] | 2.6 | 1.9 | 0.7 |
| *Previous MMBs* | | | | | |
| Australia | Freebairn (1992) | | | | 1.4-3.8[3] |
| United Kingdom | Anderson (1996) | Ecu 3,064[4] | 12.6 | 2.9 | 9.7 |

[1]Lippert (2001), p. 9 and p. 57
[2]Cox and Chavas (2001), p. 98 and p. 102
[3]Freebairn (1992), pp. 35-37
[4]Anderson (1996), p. 64, p. 145 and pp. 151-152

Table 2: Export share in dairy products and efficiency losses in existing MMBs

| | Export share[1] *Per cent; 1999* | Efficiency loss *Per cent of production value* |
|---|---|---|
| Norway | 15.0 | |
| Canada | 10.0 | 4.8 |
| United States | 3.9 | 0.7 |
| Japan | 0.0 | |

[1]International Dairy Federation (2002), country reports pp.22-44 and table 21
[2]OECD (1996)

Table 3: Production processes in the dairy sector

| Product | Process | | | | | |
|---|---|---|---|---|---|---|
| | Fluid milk | Cheese dom. | Cheese export | Whey cheese | Goat cheese | Milk powder |
| Cow milk (litre) | -1.031 | -10.061 | -11.122 | -12.260 | | -12.340 |
| Goat milk (litre) | | | | | -8.690 | |
| Fluid milk (litre) | 1.000 | | | | | |
| Cheese, domestic (kg) | | 1.000 | | 1.000 | | |
| Cheese, export (kg) | | | 1.000 | | | |
| Whey cheese (kg) | | | | 0.529 | | |
| Goat cheese (kg) | | | | | 1.000 | |
| Milk powder (kg) | | | | | | 1.000 |
| Butter (kg) | 0.006 | 0.194 | 0.177 | | | 0.586 |
| Processing costs[1] (NOK) | 3.07 | 19.50 | 20.43 | 18.50 | 15.88 | 14.71 |

[1]These costs are scaled to balance total revenues and costs. The scaling factor constitutes 1.5% of the input value (25 million NOK) of farm milk. This factor can be interpreted as the costs which are left out at the process level, like administration costs in the milk price equalization scheme.

Table 4: Tax (+) and subsidies (-) in the Norwegian MMB

| Process | Tax/Subsidy (NOK per process unit) | % of production value |
|---|---|---|
| Fluid milk | 1.70 | 20.6% |
| Cheese, domestic | -2.44 | 4.8% |
| Cheese, export | -31.99 | 131.2% |
| Whey cheese | 10.72 | 15.1% |
| Goat cheese | -1.63 | 3.3% |
| Milk powder | -18.39 | 48.1% |
| Butter, export *) | -10.90 | 80.7% |

*) NOK per product unit

Table 5: Production, trade, support, economic surplus and main input levels in the Norwegian agriculture

| | Base solution | | No export | | Internal deregulation | |
|---|---|---|---|---|---|---|
| *Production (P) and net imports (I):* (million kilos) | P | I | P | I | P | I |
| Cow milk [*)] | 1671.5 | | 1379.1 | | 1308.1 | |
| Fluid milk [*)] | 635.4 | | 635.4 | | 677.1 | |
| Cheese | 75.7 | -25.1 | 50.7 | | 50.4 | |
| Whey cheese | 11.8 | -3.3 | 8.5 | | 10.9 | |
| Milk powder | 14.5 | | 14.5 | | 4.7 | |
| Butter | 22.3 | -10.2 | 19.0 | | 12.6 | |
| Goat milk [*)] | 22.2 | | 22.2 | | 21.8 | |
| Goat cheese | 2.6 | | 2.6 | | 2.5 | |
| Meat | 233.0 | 1.0 | 233.5 | 1.0 | 233.6 | 1.0 |
| Coarse grains | 1021.3 | 135.0 | 928.1 | 135.0 | 904.7 | 135.0 |
| Wheat | 210.5 | 263.0 | 209.9 | 263.7 | 209.3 | 264.3 |
| Potatoes | 298.0 | | 299.1 | | 299.0 | |
| Eggs | 43.8 | 0.7 | 43.8 | 0.7 | 43.8 | 0.7 |
| *Employment:* (1000 man-years) | 59.7 | | 56.4 | | 55.1 | |
| Remote areas | 40.1 | | 36.3 | | 35.1 | |
| Central area | 19.6 | | 20.1 | | 20.0 | |
| *Land use:* (million hectares) | 8.5 | | 7.9 | | 7.8 | |
| *Economic surplus:* (billion NOK) | 14.4 | | 15.4 | | 15.9 | |
| + Consumers' surplus | 21.9 | | 21.9 | | 23.2 | |
| + Producers' surplus | 0.8 | | 0.3 | | 0.6 | |
| + Surplus MPES | 0.0 | | 1.2 | | 0.0 | |
| + Tariff revenues | 0.3 | | 0.3 | | 0.3 | |
| - Taxpayers' expenses | 8.6 | | 8.3 | | 8.2 | |
| *Support:* (billion NOK) | 15.2 | | 15.0 | | 13.8 | |
| Budget support | 8.6 | | 8.3 | | 8.2 | |
| Border measures | 6.6 | | 6.7 | | 5.6 | |

[*)] Million litres

Table 6: Wholesale prices (NOK per kg or litre)

| Product | Domestic wholesale prices | | |
|---|---|---|---|
| | Base solution | Internal deregulation | Percentage change |
| Fluid milk | 8.14 | 6.53 | - 19.8% |
| Cheese | 46.60 | 47.37 | + 1.6% |
| Whey cheese | 45.95 | 20.12 | - 56.2% |
| Goat cheese | 49.36 | 51.13 | + 3.5% |
| Milk powder | 24.18 | 40.83 | +68.9% |
| Butter | 24.04 | 23.32 | - 3.0% |

Table A.1: The rates in the MPES

| | Rate (R) *NOK per liter Raw milk* | Conversion (C) *Liter raw milk per product unit* | Share (S) | RxSxC *NOK per product unit* |
|---|---|---|---|---|
| Fluid milk aggregate | | | | |
| Yoghurt | 0.958 | 0.895 | 0.043 | 0.0369 |
| Drinking milk | 1.602 | 1.098 | 0.820 | 1.4424 |
| Chokomilk | -0.036 | 1.168 | 0.022 | -0.0009 |
| Milk for industrial use | -0.914 | 1.142 | 0.058 | -0.0605 |
| Full cream | 7.732[1] | 1.036 | 0.057 | 0.4566 |
| | | | | **1.8745** |
| Cheese aggregate, domestic | | | | |
| Cottage cheese | 0.093[2] | 6.379 | 0.22 | 0.1305 |
| Cheese for consumption | -0.097 | 11.122 | 0.53 | -0.5718 |
| Cheese for industrial use | -0.389 | 11.040 | 0.25 | -1.0736 |
| | | | | **-1.5149** |
| Whey cheese | 2.631[3] | 7.87[4] | | **20.706** |
| Goat cheese | 0.284 | 8.690 | | **2.47** |
| Milk powder | -0.854 | 12.340 | | **-10.5384** |
| Butter | -8.591[5] | 2.238[6] | | **-19.2267** |
| Export of cheese | | | | |
| Brand name (MPES) | -1.333 | 11.122 | 0.607 | -9.000 |
| Bulk | | | | |
| (i) MPES | -0.389 | 11.040 | 0.393 | -1.688 |
| (ii) Marketing fee | -2.223 | | | -9.645 |
| | | | | **-20.333** |
| Export of butter (Marketing fee) | | | | **-6.15** |

[1]NOK per liter cream
[2]Average of the rates for consumption and industrial use
[3]NOK per liter whey
[4]Liter whey per kilo whey cheese
[5]NOK per liter cream
[6]Liter cream per kilo butter
Sources:
Gaasland et al. (2001), pp. 22-25.
Omsetningsrådet (1998), p. 10.
Omsetningsrådets Sekretariat (1998), p. 14 and p. 34.

Table A.2: Subsidy and tax rates in the MPES. Process level

| | MPES-gross rates<br>*NOK per process unit* | Transport,a.s.o.<br>*NOK per process unit* | MPES-net rates<br>*NOK per process unit* |
|---|---|---|---|
| Processes: | | | |
| Fluid milk | 1.76 | -0.60 | 1.16 |
| Cheese, domestic | -5.25 | -2.01 | -7.26 |
| Whey cheese | 9.44 | -2.45 | 6.99 |
| Goat cheese | 2.47 | -2.47 | 0.00 |
| Milk powder | -21.81 | -2.72 | -24.53 |
| Cheese, export | -23.73 | -1.98 | -25.71 |

Sources: Gaasland et al. (2001), pp. 22-25

Table A.3: The MPES rates used in the model

| | MPES-net rates | Marketing fee and deficit | Adjusted MPES-rates | Model rates |
|---|---|---|---|---|
| Domestic Sale | | | | |
| Milk process | 1.16 | 0.50 | 1.66 | 1.70 |
| Cheese process | -7.26 | 4.96 | -2.30 | -2.44 |
| Whey cheese process | 6.99 | 6.04 | 13.03 | 10.72 |
| Goat cheese process | 0.00 | 2.63 | 2.63 | -1.63 |
| Milk powder process | -24.53 | 6.08 | -18.45 | -18.39 |
| Export | | | | |
| Cheese process | -25.71 | 4.28 | -21.43 | -31.99 |
| Butter | -6.15 | | -6.15 | -10.90 |

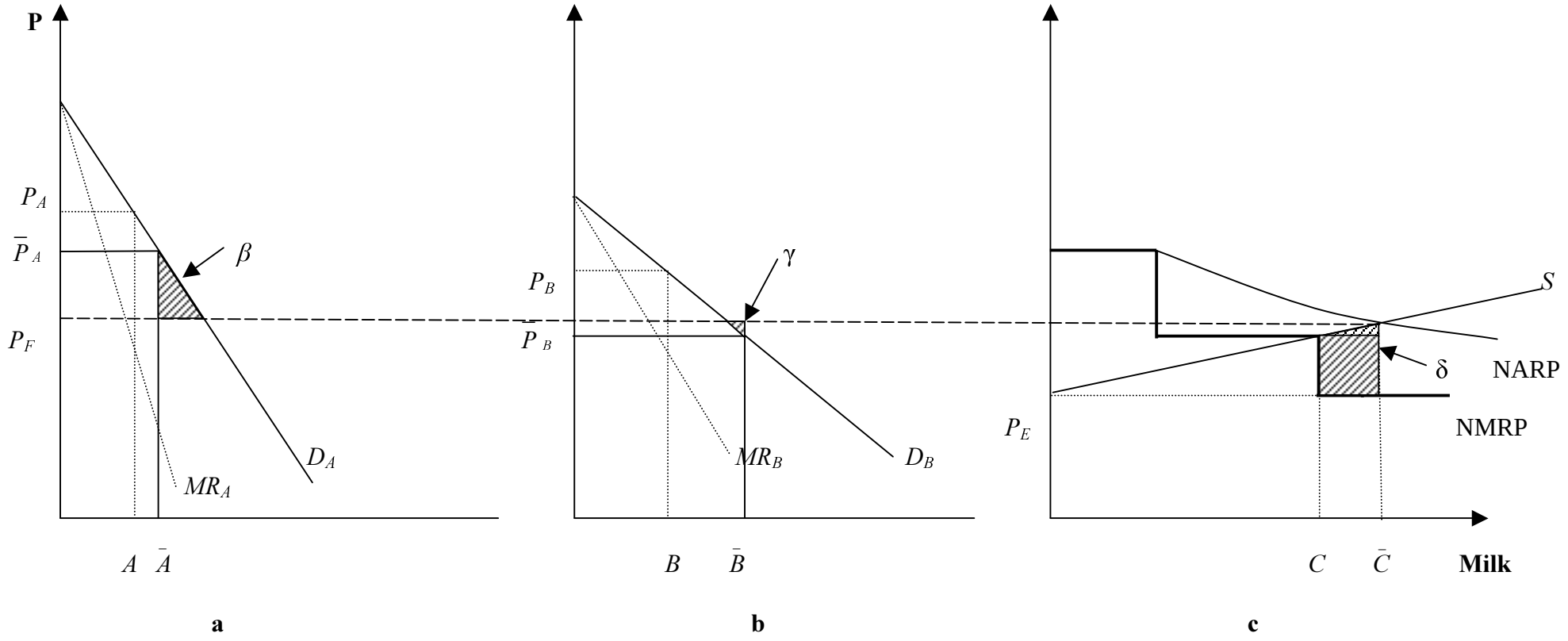


Figure 1. Methods of revenue sharing: a regular monopoly versus a cooperative