# Regulatory Institutions in Agricultural Markets – A Comparative Analysis*

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ABSTRACT

*We have employed a simple model to analyse market regulation in a situation with multifunctional agricultural production, i.e., a public good produced jointly with a private good, and where there is imperfect competition in processing. We have analysed the impact on welfare of two archetype regulatory institutions formed to overcome the market imperfections. The institutions, a Regulatory Marketing Board and a Regulatory Marketing Cooperative, are both represented in the Norwegian agricultural market. Taking into account the cost of public funds, we find that the Board in general ensures the highest social welfare. The Cooperative does not replicate the Board solution unless restricted by a price cap and in combination with a production subsidy. If the restricted Cooperative is able to practise a higher degree of cost sharing than the Board, it may however produce the highest welfare.*

*Key words*: cooperative, marketing board, multifunctionality, oligopsony, trade

# 1 Introduction and motivation

What regulatory institution should the government use in order to regulate agricultural markets? This is the issue of a discussion that has emerged in Norway lately. Whereas the Norwegian Competition Authority concludes in a recent report (Norwegian Competition Authority, 2001) that the regulatory authority should be transferred to a regulatory marketing board, the Ministry of Agriculture maintains the continuation of the important regulatory role of the farmers marketing cooperatives (Ministry of Agriculture, 1999).

In order to determine who is right, it is necessary to clarify the reason why agricultural markets must be regulated in the first place. One reason for intervention is multifunctionality. There seems to be an increasing consensus on the view that agriculture, in addition to the production of food and fibre, is a vital provider of public goods such as food security, landscape values, and rural activity (OECD, 2001).

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When a private good and a public good are produced jointly, the provision of the public good requires some production of the private good. The concept of jointness seems to be of special relevance in three domains (Romstad *et al.*, 2000). These are food security, food safety, and rural concerns, all being associated with aggregate domestic production levels. For food security, the production potential is important in the long run. Brunstad *et al.* (1995) state that a crucial condition for the production potential is that the factors of production (land, labour, agricultural skills, animal and plant material and capital equipment) are present. To a certain degree, the production potential depends upon present domestic production, as this helps to maintain the factors of production.

The private good production associated with world market prices and zero production support may provide a non-optimal volume of the joint non-traded public good. If this is the case, a low transaction cost option to achieve the desired volume of the public good is to simply change the price of the private good (Vatn, 2001, Romstad *et al.*, 2000). Hence, a simple production subsidy could be the most efficient policy to obtain the optimal public good provision. However, important structural characteristics of agricultural markets are that the raw products are bulky and/or perishable, are produced by a large number of spatially dispersed farmers causing costly transportation, and are processed by relatively few firms (Gardner, 1975; Sexton, 1990; Rogers and Sexton, 1994; and Sexton, 2000). Hence, the optimal efficient scale in farming is much smaller than in the food-processing industry.

Natural oligopsony in food processing opens for exploitation of the farmers, and hence a farm-retail price spread causing an economic dead-weight loss. This in itself justifies public intervention (Rogers and Sexton, 1994). In the case of joint production of an agricultural commodity and a public good, the processors will capture only parts of a simple production subsidy aimed at the farmers. Hence, the total dead-weight loss may be considerable, and the need for intervention even stronger.

One way to circumvent the above described market imperfections is to allow farmers to integrate downward; i.e., form farmer owned processing and/or marketing cooperatives. The marketing cooperative ensures that the farmers receive the entire surplus, but does not guarantee efficient production. Alternatively, the Agricultural Ministry may impose regulations by forming a marketing board maintaining control over imports and exports.

Our aim is to carry out a comparative analysis of the two proposed archetype regulatory institutions, a Regulatory Marketing Board and a Regulatory Marketing Cooperative. The article contributes to the existing literature by analysing multifunctionality (joint production) in an imperfect market setting. We show that in this setting, the policy implications from the competitive market (Romstad et al., 2000, and Vatn, 2001) will no longer hold.

Krishna and Thursby (1992) analyse marketing boards with various objectives. We add to their range of board objectives by introducing an open producer owned cooperative maximising the net average revenue product (NARP). Like Krishna and Thursby we find that the Cooperative, like other boards, must be subject to a tax/subsidy policy in order to offset the market distortions created by the Cooperative's behaviour.

Unlike the other analysis, ours introduces a positive shadow cost on public funds. Taking this social cost of taxation into account makes the institutions perform differently, and we are hence able to establish new policy implications regarding which institution to

choose, and under which circumstances. In addition, the analysis highlights the implications of differences in the ability to reimburse production costs directly.

Market interventions in order to increase the production of a public good jointly produced with a private good, necessarily have to affect or 'distort' trade compared to the unregulated solution. Both the regulatory institutions described above fall into the State Trading Enterprises category of institutions that the World Trade Organization (WTO) is critical towards because of their potential to distort trade.[1] In addition, multifunctionality as an argument for agricultural support is controversial and the opponents argue that it has been misused to maintain trade distorting domestic policies (e.g., Bohman *et al.*, 1999). Although multifunctionality may not account for the current level of agricultural production and support in all countries, we feel that it represents a legitimate objective for agricultural support.

# 2 Analysis

The markets and the institutions we set out to analyse are complex, and a number of simplifications are needed in order to elucidate features important to the problem raised. We start by showing that laissez-faire will not necessarily provide a social optimal volume of the non-traded public good produced jointly with an agricultural raw product. This legitimates the use of public intervention.

We continue by modelling a Regulatory Marketing Board and a Regulatory Marketing Cooperative, both established to eliminate the effects of oligopoly market power in processing and to secure a sufficient volume of a specific public good. Based on the model results we evaluate which institution provides the highest social welfare.

## 2.1 The setting

**Production**

A large number of independent farmers may each produce one unit of a raw product, which is a private good. Hence, the total quantity of the private good, $x_p$, is identical to the number of active farmers.

Production is multifunctional in the sense that an essential, non-traded public good, $z$, is produced jointly with the private good. The provision of the public good is associated with the location (country) of production; hence, the public good cannot be traded. To keep the analysis simple, we assume that the joint products are produced in a constant one-to-one relationship (Heady, 1952), i.e. $z = z(x_p)$ where $z(0) = 0$ and $\partial z / \partial x_p = 1$.

[1] State Trading Enterprises are defined as "… governmental and non-governmental enterprises, including marketing boards, which have been granted exclusive or special rights or privileges, including statutory or constitutional powers, in the exercise of which they influence through their purchases or sales the level or direction of imports or exports." (World Trade Organization, 1994). According to Dixit and Josling (1997), the two regulatory institutions we analyse are among those with the highest potential to distort trade.

**Costs**

We assume that all farmers have identical reservation utilities, $u^0$, reflecting their outside opportunity. Without loss of generality, the reservation utility is normalised to zero, i.e., $u^0 = 0$.

The farmers are assumed to have varying levels of production efficiency. Hence, the cost of production (the unit cost) differs between the farms, resulting in an upward sloping, convex inverse market supply curve

$$t(x_p), \quad t'(x_p) > 0, \quad t''(x_p) \geq 0, \quad \forall x_p \geq 0$$

The total cost of supplying quantity $x^p$ is

$$T(x_p) \quad \text{where} \quad T'(x_p) \equiv t(x_p), \quad \forall x_p \geq 0$$

We further assume that farmers' production costs consist of several components and that each component is increasing proportionally when production increases, i.e., the ranking of farmers according to costs is the same for all relevant cost components (e.g., transportation costs, soil quality, size of patches, climate zone, etc.).[2]

**Processing and wholesaling**

The processors face the inverse input supply function $t(x_p)$. The entire quantity of the private good, $x_p$, is used as the only input in the production of a processed commodity in a constant, one-to-one ratio. Thus, we can conveniently use the same notation, $x_p$, for the primary output and the processed output.

The industry is not atomistic in nature. Spatial considerations give rise to scale economics in marketing (collecting, processing, distribution, etc.). Each processor's average processing cost falls until his output reaches the minimum efficient scale in processing. Thereafter, the average cost is constant and equal to zero (Rasmusen, Ramseyer and Wiley, 1991). This means that the industry is a natural oligopsony with farmers facing a limited number of wholesalers, $k$.

**Processed commodity**

The gross consumers' surplus from domestic consumption of the quantity $x_c$ of the processed commodity is $P(x_c)$. The quantity consumed can be produced domestically or imported. Inverse domestic demand, $p(x_c)$ is decreasing in $x_c$,

$$p(x_c) \equiv P'(x_c) > 0, \quad p'(x_c) < 0, \quad \forall x_c > 0$$

**Trade**

The processed commodity may be traded. Hence, domestic production and consumption generally diverge. Net export is defined by $x_e = x_p - x_c$ where $x_c$ denotes domestic

[2] This is largely the case in Norway where the most remote farms are typically smaller, more 'rocky', situated at a higher level or closer to the coast, etc.

consumption and $x_p$ is the quantity of the raw product that is produced and processed domestically.[3]

**Public good**

As explained, the public good, $z$, is not an output in the conventional sense, but rather a by-product from the production of $x_p$. We assume that society's total surplus derived from consumption of the public good is $V(z)$. Based on the assumed one-to-one relationship between the private and public good we have that $V(z(x_p)) \equiv V(x_p)$, and can measure the public good in units of the private good:

$$v(x_p) \equiv V'(x_p) > 0, \quad v'(x_p) < 0, \quad \forall x_p > 0$$

The marginal willingness to pay for the public good is assumed to be decreasing.

**Shadow Cost of Public Funds**

To finance the provision of the public good, public funding for transfers or subsidies is required. In general, lump sum taxation is not feasible and the government must resort to distortionary taxes on income, capital, production, and consumption. According to public finance theory (Atkinson and Stiglitz, 1980) the social cost of raising £1 in public funds is $£(1+\lambda) > £1$. The parameter $\lambda > 0$ is usually called the *shadow cost of public funds* (Laffont and Tirole, 1993).[4] Hence, in order to take full account of the social costs associated with the provision of the public good, all relevant costs and revenues must be multiplied by a factor $(1+\lambda)$.

**Social Welfare**

The public good and the private good are not substitutes. Hence, the social welfare function is additive in the social surplus from the public good, $IS$, and the consumers' net surplus from the processed commodity, $CS$. In our model, which is a partial analysis, social welfare, $W$, is the unweighted sum of the two above mentioned surpluses, the net farmers' surplus, $FS$, the net processors' surplus, $PS$, and the net deficit, $ND$, stemming from the net cost of taxation.

**Small Open Economy**

The country we analyse is a small open economy in terms of world market share for the processed agricultural commodity. Import or export of the processed commodity from this economy has a negligible impact on world market prices. Consequently, the world market price, $p_w$, is treated as exogenous in the model.

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[3] Recall the constant one-to-one technology in processing.

[4] Sandmo (1998) draws attention to the fact that the main justification of imposing distortionary taxes is that they are needed for redistribution. This aspect is absent in a one-consumer economy. He shows how the marginal cost of public funds $(1+\lambda)$ will be the same for all sources of funds in an optimal tax system and under certain assumptions will be less than one. Without optimal taxation, $(1+\lambda)$ will in general differ between different sources of finance. Generally, we can assume $\lambda > 0$ then, but have to evaluate the magnitude of $\lambda$ more thoroughly. As long as $\lambda > 0$, all our results will hold qualitatively.

## 2.2 First Best

The case of a utilitarian government, maximising the unweighted sum of utilities and being able to make lump sum transfers ($\lambda = 0$), provides us with the first best solution (the benchmark).

$$\max_{x_c, x_p} W^* = V\left(x_p\right) + P\left(x_c\right) + p_w\left[x_p - x_c\right] - T\left(x_p\right) \tag{1}$$

The first order conditions for maximum read[5]

$$p\left(x_c\right) = p_w \tag{2}$$

$$t\left(x_p\right) = p_w + v\left(x_p\right) \tag{3}$$

The optimal social welfare in the setting described in section 2.1 is found where the consumers pay world market price for the processed commodity, and the farmers are offered a Pigovian production subsidy (Pigou, 1918) equal to the marginal utility of the public good.

## 2.3 Laissez-Faire

In a situation with no government intervention the first-best solution will not be achieved. The agricultural market has atomistic agents in production and consumption, each seeking to maximise their own welfare (profit). No one takes into consideration the provision of the public good when making his or her production/consumption decisions. In this situation, we have free trade for the private good, and all import and export take place at the world market price $p_w$. Hence, the output price cannot be set above $p_w$ in the domestic market. In the input market however, the processors possess oligopsony power. Assuming Cournot behaviour, we find the condition for domestic production (and processing) of the input $x_p$.

Let $\varepsilon \equiv (dx_p / dt)(t / x_p)$ denote the point elasticity of supply for the raw product. The market equilibrium conditions in the output and input markets then respectively read

$$p\left(x_c\right) = p_w \tag{4}$$

$$t\left(x_p\right)\left[1 + \frac{(1/k)}{\varepsilon}\right] = p_w \tag{5}$$

In the case of natural monopsony we have $k = 1$ whereas $k = \infty$ under perfect competition. Intermediate forms of Cournot oligopsony are represented by values of $(1/k)$

[5] Since the objective function is a mere sum of concave functions, it is concave, and the first order conditions are sufficient conditions for maximum.

between zero and one. Hence, a natural oligopsony will create a farmer-processor price spread causing a dead-weight loss to society.

**Proposition 1:** *Laissez-faire in the economy described in section 2.1 generates two inefficiencies. The first inefficiency stems from natural oligopsony in the processing sector, and the other from the missing market for the public good produced jointly with the private good.*
**Proof:** Rearranging equation (5) yields $t(x_p) - p_w = -(1/k)t'(x_p)x_p < 0$, expressing the marginal loss due to the first inefficiency. Eliminating oligopsony power yields a price-cost margin of zero. Comparison with the first best condition in equation (3), reveals an additional loss, equal to the marginal utility of the public good $v(x_p)$. ■

In this situation, the presence of oligopsony competition alone legitimates public intervention, e.g. by establishing a regulatory institution, to reduce the dead-weight loss (Sexton, 1990). Because of the scale economies in processing, increasing the number of competitors will create inefficiencies in the form of higher processing cost.

As argued in the introduction, as long as the public and private goods are produced jointly, production subsidies will generally be a low transaction cost policy instrument.[6] From equation (3) and equation (5), we find that the production subsidy necessary to replicate the first best amounts to $S = (1/k)t'(x_p^*)x_p^* + v(x_p^*)$ where $x_p^*$ is the quantity solving equation (3). The first term is the part of the subsidy that is needed to offset the distortion from the oligopsony in processing. As long as lump sum transfers are not feasible, the funding for the subsidy has to be raised through distortionary taxation, thus creating an additional inefficiency. A possible way to circumvent the oligopsony problem is to establish a *regulatory institution*. The market outcome created when a regulatory institution is introduced must be compared to the outcome with distortionary taxation, which is the realistic alternative, rather than the first best outcome.

## 2.4 Regulatory Institutions

The regulatory institutions we compare are a Regulatory Marketing Board owned by the state and a Regulatory Marketing Cooperative owned by the farmers. The two alternative market structures are illustrated in figure 1.

The Regulatory Marketing Board acts as a regulatory agent on behalf of the government. It is directly involved neither in production nor in processing, but has control of domestic marketing and international trade. For modelling purposes we let the Board be the direct purchaser of the raw product from farmers and the reseller to the processors. Hence, the processors are deprived of their market power in the input market, now facing one large supplier instead of many small ones. To further simplify the model, we assume that the Board buys the processed commodity from the processors and resells it to domestic consumers and/or abroad (export). Thus, a consumer-processor price wedge equivalent to a government levy on consumption may be induced.

[6] In fact, even if it is possible to identify and compensate the production of the public good directly, the producers will not be able to separate the production of the private and the public good, and the incentive is as if the farmers is given a regular production subsidy.

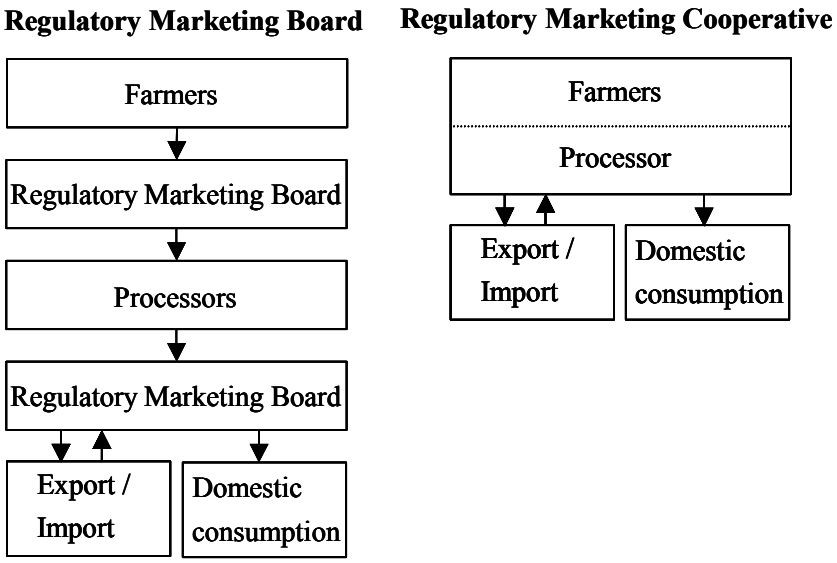


**Figure 1: Archetype Regulatory Institutions**

If a Regulatory Marketing Cooperative is chosen, the resulting market structure is quite different. Farmer owned cooperatives have played an important role in mitigating the potentially adverse performance implications of structural oligopsony. They are often exempt from antitrust regulation and allowed to integrate forward into the food-processing industry. In addition, they are often protected against competition from imports and some are given exclusive rights to purchase and process some raw products within a country or region.[7]

The member farmers are the residual claimants to the cooperative's revenues, and all profits are distributed through the price paid for the primary commodity (zero profit constraint). In his seminal work, Helmberger (1964) ascertained that the relevant objective for this kind of marketing cooperative is to maximise the 'net average revenue product (NARP), or in other words the maximum price the cooperative can return to its members given the zero profit constraint.[8]

In our model we assume that the Cooperative is the sole processor of the input (monopoly) and has the quantitative control over domestic sales, as well as imports and exports of the output. Given the assumed processing technology, one processor ($k=1$) may cover the market efficiently, having zero average processing costs.

### 2.4.1 Regulatory Marketing Board

The objective of the Regulatory Marketing Board is to obtain a market solution that secures *maximum social welfare*.

When purchasing farmers' produce, the Board may reimburse farmers by paying a linear price and/or reimbursing costs directly, i.e., a payment scheme similar to a two-part tariff. Let $\alpha \in [0,1]$ denote the share of each farmer's costs compensated by the Board

[7] Tine Norwegian Dairy was up until recently an example of a Regulatory Marketing Cooperative with an exclusive right to purchase raw milk in Norway.
[8] See Tennbakk (1996) for a discussion of the objectives of marketing cooperatives.

directly, e.g. transportation costs which vary between farms due to the spatial dispersion of farms. If $\alpha = 1$, the Board compensates each farmer for all of his individual production costs, leaving him only with his reservation utility $u^0 = 0$ (first-degree price discrimination). If $\alpha = 0$, no share of the costs is compensated directly and every farmer is paid a linear price for his output. In this situation, all except the marginal farmer obtain a positive surplus $u > u^0$. When $\alpha \in (0,1)$, we have a linear combination of the two extremes.

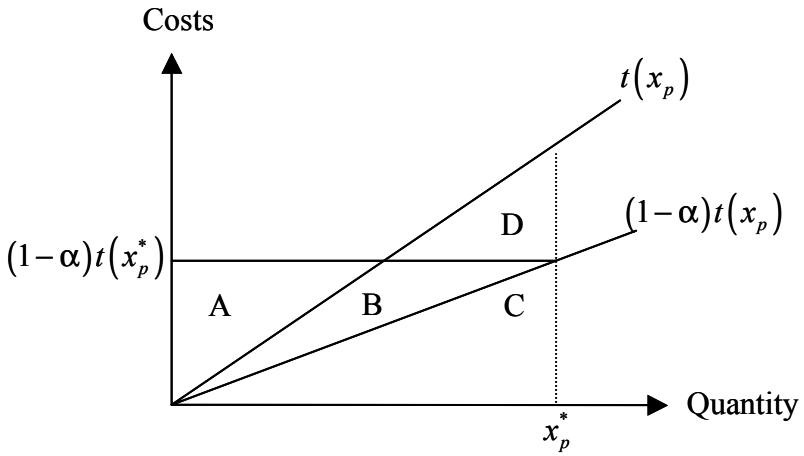


**Figure 2: Cost function of the Regulatory Marketing Board**

The Board's marginal costs, $C(x_p;\alpha) = [(1-\alpha)t(x_p) + \alpha(T(x_p)/x_p)]$, is a linear combination of marginal and average production costs, similar to a two-part tariff. The Board's total expenses is described in figure 2 where $C(x_p;\alpha)x_p = $[A+B+C]+[B+D]. The total cost of production is [B+D+C]. Further, [B+D] is the cost that is covered directly by the Board, whereas the farmers cover C individually. In order to cover the production cost of the marginal farmer, a linear price has to be paid to all farmers, equal to $(1-\alpha)t(x_p^*)$. The linear price expenses are [A+B+C], where C covers actual costs and [A+B] is the total surplus left to all but the marginal farmer. Notice that for $\alpha = 0$, the line $(1-\alpha)t(x_p)$ coincides with the marginal cost, leading to a simple linear price. For a situation with $\alpha = 1$, the line coincides with the quantity axis, and farmers are reimbursed according to their actual costs.

The Board will typically experience a net deficit, $ND$, that has to be financed by public funds. The net deficit (taxpayer's surplus) consists of total costs $C(x_p;\alpha)x_p$, less the revenues from sales of the domestically processed commodity, $p(x_c)x_c$, and revenues from net exports, $p_w(x_p - x_c)$. When lump sum taxation is not feasible, the distortionary taxation imposes an extra cost to society, $\lambda ND$, that has to be accounted for.
The Board's problem then reads

$$\max_{x_c,x_p} W^M = \overbrace{V(x_p)}^{IS} + \overbrace{\left[P(x_c) - p(x_c)x_c\right]}^{CS} + \overbrace{(1-\alpha)\left[t(x_p)x_p - T(x_p)\right]}^{FS} - (1+\lambda)\underbrace{\left[C(x_p;\alpha)x_p - p(x_c)x_c - p_w(x_p - x_c)\right]}_{ND} \tag{6}$$

Note that the processors' surplus from the 'laissez-faire' regime now is zero ($PS = 0$) because the Board compensates them only for the average processing cost, which is zero

Let $\eta \equiv -(dx_c/dp)(p/x_c)$ denote the point elasticity of demand for the processed product. The two first order conditions for welfare maximum then read

$$p(x_c)\left[1 - \left(\frac{\lambda}{1+\lambda}\right)\frac{1}{\eta}\right] = p_w \tag{7}$$

$$t(x_p)\left[1 + \left(\frac{\lambda}{1+\lambda}\right)\frac{(1-\alpha)}{\varepsilon}\right] = p_w + \left(\frac{1}{1+\lambda}\right)v(x_p) \tag{8}$$

According to equation (7), the optimal domestic price lies between the marginal cost (= $p_w$ in this model) and the monopoly price, corresponding to $\lambda = 0$ and $\lambda = \infty$ respectively. This is a general *Ramsey tax* on consumption (Ramsey, 1927).

From the left-hand side of equation (8) we notice that as long as $\lambda > 0$, production is reduced, *ceteris paribus,* according to the 'taxation' factor on farmers' production, $[1 + (\lambda(1-\alpha)/(1+\lambda)\varepsilon)]$. The factor is increasing in $\lambda$ and decreasing in $\alpha$. The more surplus that is left to the farmers (low $\alpha$) and the higher the shadow cost of public funds (high $\lambda$), the higher is the optimal consumer-farmer price spread (tax rate on consumption). This means that the Board should compensate as high a share of the farmers' costs directly as possible. Hence, the Board's ability to improve welfare depends partly on its information of individual farmers' costs.

**Proposition 2:** *The Regulatory Marketing Board should use all information available to compensate as large a share as possible of the individual farmers production costs.*

**Proof:** We use the envelope theorem on the welfare functions in equation (6) evaluated in optimum. Differentiating the welfare function with respect to the parameter $\alpha$ yields

$$\frac{dW^M}{d\alpha} = \lambda\left[t(x_p^M)x_p^M - T(x_p^M)\right] > 0 \quad , \quad \forall x_p > 0, \lambda > 0$$

showing that welfare is increasing in $\alpha$ for positive shadow costs of public funds. ■

The right-hand side of equation (8) capture the value of increasing production through a subsidy, in order to take account of the value of the jointly produced public good. The subsidy is decreasing in the shadow cost of public funds, $\lambda$, i.e., the higher the shadow cost on public funds, the less weight is to be put on the marginal utility of the public good.

Compared to the laissez-faire solution, the introduction of the Board improves the social outcome in the market because it 'adjusts' the inefficiencies stated in Proposition 1. However, the resulting solution is not first best, since in the absence of lump-sum transfers the first best is not feasible.

The next step of the analysis is to investigate whether a marketing cooperative can improve the market outcome further.

### 2.4.2 Marketing Cooperative

In this section we analyse the Regulatory Marketing Cooperative's ability to eliminate oligopsony competition in processing and regulate the market for the private good in order to secure the provision of the jointly produced public good.

Membership in the Cooperative is *voluntary* and *open*. In our setting voluntariness means that farmers can chose whether to produce or not. Openness implies that the cooperative is obliged to market all that is delivered. Unlike an ordinary monopoly then, the cooperative can neither restrict the number of members nor the members' production.

One prominent characteristic of cooperatives is cost sharing. Let the parameter $\beta \in [0,1]$ be the share of costs covered by the Cooperative and let $(1-\beta)$ be the share of each producer's production cost covered individually. If $\beta = 1$, the Cooperative employs complete cost sharing while full individual cost coverage is represented by $\beta = 0$. This is analogous to the Boards direct subsidisation factor, $\alpha$. (See figure 2)

Being open and voluntary, the Cooperative cannot control the domestic production $x_p$, but has to adjust to the quantity produced. For a given $x_p$ it seeks to maximise the net average revenue product, denoted by $w$, with respect to domestic consumption, $x_c$. Surplus production is exported, and as above, $x_e = x_p - x_c$.

The Cooperative's maximisation problem reads

$$x_p \text{ given}; \quad \max_{x_c} w = \frac{p(x_c)x_c + p_w(x_p - x_c) - \beta T(x_p)}{x_p} \tag{9}$$

The first order condition for maximum is

$$p(x_c)\left[1 - \frac{1}{\eta}\right] = p_w \tag{10}$$

In words, it is optimal for the Cooperative to charge the monopoly price in the domestic market, discriminating between domestic and foreign consumers. Let the optimal domestic price determined by this condition be denoted $p^C$.

The farmers' individual share of the marginal production costs defines the supply curve as $(1-\beta)t(x_p)$. A farmer will produce one unit only if the NARP price, $w$, exceeds his individually covered costs. Market equilibrium is defined by

$$(1-\beta)t(x_p) = \frac{p^C x_c^C + p_w(x_p - x_c^C) - \beta T(x_p)}{x_p} \tag{11}$$

We notice that the equilibrium quantity, $x_p^C$, is found where the marginal farmer's individually covered cost of production equals the average net revenue from both the domestic and the international market, net the shared costs.

Let the superscript $C$ refer to the optimal quantities for the Cooperative. By rearranging equation (11) and defining $C(x_p;\beta) \equiv [(1-\beta)t(x_p^C) + \beta T(x_p^C)/x_p^C]$ (analogous to the Board's marginal cost), we see how the zero-profit constraint is met

$$\left[p^C - p_w\right]x_c^C = \left[C\left(x_p^C;\beta\right) - p_w\right]x_p^C \qquad (11)'$$

The Cooperative utilises all the profits extracted from the domestic market to subsidise domestic production.[9] If $C(x_p^C;\beta) < p^C$, then $x_p^C > x_c^C$ and the Cooperative is a net exporter.[10] It commits itself to price discrimination between the domestic market and the world market for the processed commodity. Implicitly, the domestic market is "taxed" in order to subsidise increased production. The magnitude of domestic production and hence the provision of the public good depends on the amount of surplus that can be extracted from the domestic market (the difference between the world market price and the domestic monopoly price).

Similarly to the situation with a Regulatory Marketing Board, the outcome is affected by the degree of cost sharing within the Cooperative.

**Proposition 3:** *The input quantity produced, $x_p^C$, is increasing in $\beta$. This implies that input production will always be highest when all production costs are shared equally among the farmers, $\beta = 1$, and lowest when costs are covered individually, i.e., when $\beta = 0$.*

**Proof:** Implicit derivation of $x_p^C$ with respect to $\beta$ in the market equilibrium equation (11) yields

$$\frac{\partial x_p^C}{\partial \beta} = \frac{t\left(x_p^C\right)x_p^C - T\left(x_p^C\right)}{(1-\beta)t'\left(x_p^C\right)x_p^C + t\left(x_p^C\right) - p_w} > 0 \quad , \quad \forall\, x_p, x_c > 0$$

showing that the input quantity is increasing in $\beta$. ■

Unlike the Board whose objective is to maximise social welfare, the Cooperative has the welfare of its owners (the farmers) at heart. Hence, the Cooperative does not take the welfare of consumers into consideration when the price is set, and extracts more revenue from the processed commodity market. This helps support a higher production of the raw product and a higher provision of the jointly produced public good. Moreover, the Cooperative is restricted by the zero-profit constraint, whereas the Regulatory Marketing

[9] This corresponds to the result obtained in Ippolito and Masson (1978).

[10] From equation (11)' we see that if $C(x_p^C;\beta) > p^C$ then $x_p^C < x_c^C$. In this situation the Cooperative is a net importer and will use the revenue raised from import, caused by the price differential $(p^C - p_w)$, to subsidise domestic production.

Board may have its deficit covered by public funds. Hence, domestic consumption will be too low under the Cooperative regime, and for the same degree of cost sharing, total social welfare will be strictly lower than in the market with a Regulatory Marketing Board.

Whereas in the Board case it is socially optimal and in accordance with the Board's objective to compensate as high a share of production costs as possible, it is not clear whether the Cooperative will prefer the high compensation or low compensation solution. Both extremes may cause tensions in the organisation (Tennbakk, 1996). The Cooperative may therefore prefer an intermediate solution, $\beta \in (0,1)$.

We could stop the analysis here, having established that the Board performs socially better than the unrestricted Cooperative. The basis for continuing though, is the possibility that the Cooperative has superior information of the farmers' costs and that some of the inefficiencies inherent to the Cooperative solution can be adjusted through other regulations.

### 2.4.3 Cooperative with Price Cap and Production Subsidy

While the Board must cover the budgetary deficit through distortionary taxation, the Cooperative is using the revenue from the domestic market to subsidise the production of the input directly (internal transfer within the organisation). If not regulated, it is optimal for the Cooperative to charge the monopoly price in the domestic market. To mitigate such exploitation of domestic consumers, the government can impose a price cap, $\overline{p}$, set between the monopoly price and the world market price.

The Cooperative's implicit zero profit restriction (budgetary balance) hinder the achievement of optimal social welfare under this regime. This can be overcome by introducing a 'subsidy wedge', which decouples the production decision and the consumption decision. Hence, let the farmers receive a production subsidy $S$ covered by public funds. Assume further that a public Agency determines the price cap $\overline{p}$ and the production subsidy $S$ in order to maximise social welfare, and that the Cooperative is free to maximise $w$, given $\overline{p}$ and $S$.

This can be viewed as a game where the Agency moves at the first stage and the Cooperative at the second. We solve the game (find the subgame perfect Nash equilibrium) by backward induction.

**Stage 2**

As long as the price cap $\overline{p}$ is set below the monopoly price, it will be binding for the Cooperative. Hence, the quantity, $\overline{x}_c$, supplied to the domestic market is determined by the equation

$$p(x_c) = \overline{p} \tag{12}$$

It is obvious that the consumers' surplus will be higher and the Cooperative's profit lower under a binding price cap than under an unrestricted Cooperative.

Farmers, now getting a production subsidy $S$, will produce until the cost of the marginal farmer equals $w + S$:[11]

[11] Recall that the farmers produce one unit each.

$$(1-\beta)t(x_p) = \frac{\overline{p}\,\overline{x}_c + p_w(x_p - \overline{x}_c) - \beta T(x_p)}{x_p} + S \tag{13}$$

Rearranging equation (13) we get the total subsidy that has to be financed by taxpayers

$$Sx_p = \left[ C(x_p;\beta)x_p - p_w(x_p - \overline{x}_c) - \overline{p}\,\overline{x}_c \right] \tag{13'}$$

**Stage 1**

The Agency has full knowledge of the Cooperative's optimal response, i.e., conditions (12) and (13), and will set the price cap $\overline{p}$ and the subsidy $S$ correspondingly in order to maximise social welfare. Maximising with respect to the price cap is identical to maximising with respect to $x_c$. By inserting the expression for the subsidy from equation (13)' into the maximisation problem, maximising with respect to the subsidy will be equivalent to maximising with respect to $x_p$. Hence, the Agency's problem is

$$\begin{aligned} \max_{x_c, x_p} W^A = {} & \overbrace{V(x_p)}^{IS} + \overbrace{\left[ P(x_c) - p(x_c)x_c \right]}^{CS} + \overbrace{(1-\beta)\left[ t(x_p)x_p - T(x_p) \right]}^{FS} \\ & - (1+\lambda)\underbrace{\left[ C(x_p;\beta)x_p - p_w(x_p - x_c) - px_c \right]}_{ND} \end{aligned} \tag{14}$$

and the first order conditions for maximum are

$$p(x_c)\left[ 1 - \left( \frac{\lambda}{1+\lambda} \right)\frac{1}{\eta} \right] = p_w \tag{15}$$

$$t(x_p)\left[ 1 + \left( \frac{\lambda}{1+\lambda} \right)\frac{(1-\beta)}{\varepsilon} \right] = p_w + \left( \frac{1}{1+\lambda} \right) v(x_p) \tag{16}$$

This solution provides the Agency with the optimal price cap $\overline{p}^A$ and the optimal production subsidy $S^A$ such that

$$\overline{p}^A = p\left(x_c^A\right) \text{ where } x_c^A \text{ is determined by equation (15)} \tag{17}$$

$$S^A = S\left(x_p^A\right) \text{ where } x_p^A \text{ is determined by equation (16)} \tag{18}$$

The first-order condition stated in equation (15) is identical to the first-order condition for the Board stated in equation (7). Consequently, consumption will be identical under the two regimes.

The condition in equation (16) is identical to the solution for the Board in equation (8) except for the cost sharing parameter, $\beta$. Hence, while the Board solution depends on the part of the individual farmers costs being directly compensated by the Board, the

regulated Cooperative solution depends on the degree of cost sharing between the farmers within the Cooperative.

**Proposition 4:** *In a situation where lump sum transfers are not feasible ($\lambda > 0$) the socially optimal choice of regulatory institution depends on the cost sharing abilities of the alternative institutions. Hence, a Regulatory Marketing Board should be chosen if $\alpha > \beta$, and a Regulatory Marketing Cooperative regulated by a price cap and a production subsidy if $\beta > \alpha$. If $\alpha = \beta$ and/or $\lambda = 0$, the choice of institution will not affect welfare.*

**Proof:** We use the envelope theorem on the welfare functions in equation (6) and in equation (14), both evaluated in optimum. The differentiation is done with respect to the parameters $\alpha$ and $\beta$ respectively

$$\frac{dW^M}{d\alpha} = \lambda\left[t\left(x_p^M\right)x_p^M - T\left(x_p^M\right)\right] > 0 \quad , \quad \forall x_p > 0, \lambda > 0$$

$$\frac{dW^A}{d\beta} = \lambda\left[t\left(x_p^A\right)x_p^A - T\left(x_p^A\right)\right] > 0 \quad , \quad \forall x_p > 0\ \lambda > 0$$

■

In words; as long as lump sum transfers are not feasible ($\lambda > 0$), social welfare will be highest under the regime that perform the highest reduction of the individual farmer's share of his production costs.

# 3 Concluding remarks

The analysis shows that the Regulatory Marketing Board, through its general objective of maximising social welfare, is generally a more powerful agent in achieving the second best solution in the market studied. If the Marketing Cooperative is not regulated it can not be expected to perform better as a government agent than the Board. The relevant argument, which may tilt the solution in favour of choosing the Cooperative as the government agent after all, is its ability to share costs internally.

Hence, the policy implication of these findings is to choose an (unrestricted) Regulatory Marketing Board if available information makes it possible for the Board to perform as high a degree of direct cost compensation to the farmers as can be employed by the Cooperative. However, if an appropriately regulated Cooperative can achieve a higher degree of cost sharing than the Board, the Cooperative should be chosen as regulatory institution.

This means that the Cooperative's best strategy in order to maintain its position as market regulator is associated with having superior information about the cost structure in the production of the raw product, as well as processing, and its ability to cross-subsidise internally. However, the question of cost sharing causes tension between high and low cost members and is increasingly contested within the Cooperative. If the controversy results in a lower degree of cost sharing, the Cooperative will be less attractive as regulatory institution

The above analysis is based on a model with full information at zero costs. If collecting information has a price, the Cooperative has another advantage, not modelled. By letting the farmers forming a Cooperative, the number of processors is reduced to one, securing efficient scale in processing and no use of oligopsony power. This reduces the information required relative to the situation with a Board, which has to collect information to regulate the processing sector. However, this reduction in required information has to be balanced against the increased information needed to set the price cap and the production subsidy at the appropriate levels.

Our analysis argues that multifunctionality (joint production) along with natural oligopsony are legitimate arguments for intervention in agricultural markets. As mentioned in the introduction, such market interventions must affect trade. From the first order conditions under all regimes, we see that they all entail lower consumption and higher production levels domestically, relative to the laissez-faire solution. Consequently, they all will lead to increased net exports. This is recognised as trade distortion according to international agreements (e.g. WTO). In the case of joint production, we have shown that it is desirable to subsidise production and consequently distort trade. Moving from a situation with 'laissez-faire' to a properly regulated market improves social welfare. The problem though is that some groups (other countries) may be worse off, and, as usual, it is not obvious that the 'winners' compensate the 'losers'.

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