Agricultural University of Norway
Department of Economics and Social Sciences
Report no. 23
ISSN 0802-9210

POLICIES FOR MULTIFUNCTIONAL AGRICULTURE

The Trade-off between Transaction Costs and Precision

By

Arild Vatn, Valborg Kvakkestad and Per Kristian Rørstad

Ås - NLH 2002

Preface

This report is part of a series of publications from the Department of Economics and Social Sciences at the Agricultural University of Norway focusing on the implications of multifunctionality for agricultural policy. The basis for this research is the fact that multifunctionality – i.e. jointness or complementarity between private and public goods – challenges the standard conclusions in economics concerning what is an optimal or reasonable policy.

This report focuses on a core issue in this respect – the trade-off between the precision of a policy and its attached transaction costs. The characteristics of this trade-off problem are clarified. Further, the level of transaction costs for different types of policy measures is estimated.

The study is financed by the Ministry of Agriculture. We would like to thank Eirik Romstad for comments on an earlier version of the manuscript.

Ås-NLH, July 2002

The authors

Table of contents

page

Summary

This report aims at clarifying what it implies that a production system is multifunctional – that it delivers a combined set of private and public outputs like food products and landscape values. On the basis of this clarification, some principles are developed concerning what should characterize an optimal policy for such a system. The main focus is on a situation where the agricultural sector of the involved country does not compete well internationally.

Given the economic perspective, optimal policies demand equality between marginal costs and gains. Concerning costs, only marginal production costs are normally considered. Taking also transaction costs into consideration, some of the standard conclusions obtained in the literature are altered. Thus, our report focuses on three interrelated issues:

- First, we have looked at the relationships between transaction costs, rights and efficiency. The conclusion is that in a world with positive transaction costs, rights define what becomes efficient. This has important implications for the formulation of trade regimes.
- Second, we have studied the optimality conditions for different policies under various assumptions about a) the relationships between private and public goods in production, and b) the implied transaction costs of various policies.
- Finally, we have focused, in quite detail, at what determines the level of transaction costs in agricultural policy.

Seen together, these evaluations are helpful in producing a more rational and consistent policy.

We have based our study on the OECD definition of multifunctionality: "Multifunctionality refers to the fact that an economic activity may have multiple outputs and, by virtue of this, may contribute to several societal objectives at once. Multifunctionality is thus an activity-oriented concept that refers to specific properties of the production process and its multiple outputs" (OECD 2001, p. 11). We will add that these multiple outputs consist of a mix of both private and public goods (bads).

What does multiple outputs mean. Actually, one may be faced with three different types or relationships. Multifunctionality may imply that private and public outputs are joint, complementary or competing. If they are *joint*, inputs cannot be specifically assigned to any of the outputs. A joint public good may be a by-product of producing a certain private good. Food security may have this characteristic. If they are *complementary*, the production of one good

contributes an element of production, which is joint with the first good and required in the making of the second good. Cultural landscape may be of this type. Finally, we may have a situation where the private and public goods *compete* over some common factor of production. Some types of biodiversity may have these characteristics, while others may be complementary to food production – at least within some ranges.

There is a relationship between the characteristics of a certain good and which type of allocation system that is the least costly to use. Public goods distinguish themselves from private ones because they are difficult to demarcate. It is thus costly to exclude anyone from consuming the good. This implies that establishing and maintaining markets for such goods becomes very costly.

While most economic analyses do not take transaction costs into consideration or assume that they are low, research show that production and transaction costs are of approximately equal size in modern economies – e.g., the United States. Thus, if cost saving is important, production and transaction costs should be considered equally important. This is of special importance when studying policies for multifunctional agriculture.

Agricultural production is directly interlinked with the eco-systems it operates within and the space it utilizes. Inputs like land, water, air, fertilizers, energy, etc., are combined in different processes. Out of this process comes tradable private goods like grain and public goods and bads like landscape values, food security, pollution etc. Any resource taken into the system has to appear in either of the above forms of outputs. Thus, while other sectors may also deliver some of the goods from agricultural production, one cannot envision an agriculture that does not have direct impact on the landscape, etc.

When a country wants to secure or increase the production also of public goods being part of this multifunctional system, it will have to look for policy instruments that can support such a development. The argument most strongly favored by economists has been to pay directly for the public goods following the rule that marginal costs of production should equal marginal gains. This is sound given zero transaction costs. We are, however, studying public goods where transacting, due to high demarcation costs, per definition is costly. The question raised is whether utilizing the *interrelations* so typical for a multifunctional system may offer less costly solutions. Paying for a public good via an associated private good would most probably be much cheaper. The question is whether we then get what we want.

The problem encountered here is thus that of balancing loss of precision against increased transaction costs. A precise solution is reached when the standard condition for optimality is met in the *production of the good* – i.e., marginal cost equals marginal gain. Transaction costs on the other hand, are the costs for acquiring information, making contracts and controlling the deal. They are the costs of 'being precise'.

To develop deeper insights concerning this trade-off, some standardized situations are studied:

- If the private and the public goods are joint in production, paying for the public good directly or via an increased price for the private good are equally precise – i.e., the resource allocation in the production of the goods will be the same. Transaction costs will, however, be much lower in the latter case since existing information from the market for the private good can be utilized. Contracting and controlling is also much easier.
- Pure jointness – as above – may not be the typical case. In practice jointness between a private and public good may be what we have termed impure. These are situations where the public good is a function both of the production of the private good and some other input. Then, paying only via the private good will incur some loss of precision. Still, it may be more efficient to pay via the private good, maybe in combination with subsidizing this other input if it is traded. The conclusion depends on the case specific trade-off between transaction costs and the loss of precision.
- If there is complementarity, the reasoning is parallel to the two prior cases. Remember that complementarity implies that *an input* used in producing the public good is joint in production with the private one. As an example, agricultural fields are joint outputs with food production and an input into the creation of a landscape. If producing the public good is based on inputs that are all joint with the private good, the policy conclusion is the same as for the situation with pure jointness. Paying via the private good is as precise as paying directly for the public good, while transaction costs are lower. If other inputs are acquired in the production of the public good, we encounter the same trade-

off problem as in the case with impure public goods. A case-by-case evaluation is necessary.

- The effect of the private good on the joint input may not be positive. It may create a public bad. Reduced water quality may be a joint output from food production. One example is nitrate pollution. Water may next be an input into the production of some landscape values, biodiversity etc. which become of lower quality. In this case corrections may be undertaken by reducing the price of the private good – e.g., the food product. The conclusion is parallel to the above reasoning. If substitutes exist for the input that causes the damage – for example mineral fertilizers can be substituted by better utilization of ammonia in manure – increasing the price of the polluting input may be preferable since it will create a more precise solution. Given that the input involved is traded, transaction costs should be low and of equal magnitude to that of the food commodity (private good) which is the alternative low cost point of instrument application.
- Finally, we have looked at the situation where the public and private good is competing over the use of the same resources. While this may not be a situation covered by the definition of multifunctionality by OECD, such situations will certainly appear. In this situation paying directly for the public good is the only relevant option.

In several of the above conclusions, the trade-off between precision and transaction costs has been very important. While precision, in principle, must be evaluated in each case, some general insights concerning the variation in transaction costs can be obtained. The report goes rather deeply into this issue. Our conclusions are based on a literature review and a study undertaken for a number of policy measures used in Norwegian agricultural policy. We build our analysis very much on the work of Oliver Williamson. It has, however been necessary to make a transformation from his arenas – i.e., transactions in markets and organizations – to adapt to the special characteristics of public/agricultural policy.

Our hypothesis has been that if a policy measure can be attached to an already traded good, i.e., a good which normally has low asset specificity and high frequency in trade, transaction costs will be very low. In contrast, if all information must be gathered specifically for the actual policy, i.e., if the good is unique (idiosyncratic in Williamson's terms) and low in frequency, transaction costs may be very high.

Measuring transaction costs is complicated enough. Comparing their levels across policy measures is very difficult, since no obvious reference point exists. We have used transaction costs as a percentage of the involved payments as our measure. This seems to be the favored solution also in the few other studies that exist.

The data generally supported our hypotheses:

- In cases where the policy measure was attached to a private good that was marketed in large quantities and easily observable – like milk and fertilizers – transaction costs only amounted to some few tenths of a percent of the involved payments (subsidies or taxes).
- If the policy measure was attached to a good that was not traded, but was easy to observe and in rather uniform and large quantities – e.g., acreage, animals etc. – transaction costs amounted to some few percent of the involved payments.
- It the policy measure was attached directly to the public good or to some 'proxy' which was more difficult to observe and/or low in quantity – e.g., special landscape ventures and organic farming – transaction costs amounted to some/several tens percent of the payments.

Certainly, the level of payments may heavily influence the measure used. Controlling for this factor rather strengthened the tendencies referred above. Thus the point of instrument application influences transaction costs substantially, and it may be efficient to accept some loss of precision to make gains in the form of reduced transaction costs.

Joint public goods may be produced for free. They are just by-products of the production of the private good. Other things equal, the higher the competitiveness of a country's agriculture is, the larger will also the supply of the joint public good be. Countries whose agriculture does not compete well may encounter substantial losses in the supply of these goods if no special policy is formulated. Certainly, on can pay for these goods directly. In some situations this is anyway the best solution. There will, however, also be situations where this is very costly compared to paying via the associated private good.

Supporting prices for agricultural commodities is attacked because it distorts trade. Certainly, trade will be influenced. However, not all such influences result in welfare losses. Remember that for free trade to always be the best solution, rights has to be defined, transaction costs has to be zero and no linkages must exist between private and public goods.

Generally, if transaction costs are positive, it matters who has the right. The rights distribution determines what becomes efficient. In our case the important issue is how the rights are formulated concerning the provisioning of public goods. If for some countries the cheapest way to produce public goods implies a system also including price subsidies, it is a loss for this country not to be allowed to do so. This type of policy measures will, however, reduce the access for other countries to some foreign markets for private goods. The basic issue raised here is whose right gets priority, the country wanting to secure its aims concerning public goods in the cheapest way possible, or the country that want free trade for the private good to utilize its competitive advantages here. One should remember: trade is just a means, not a goal in itself.

While targeting is an important claim on public policy, we observe that it has also a cost. The Tinbergen conclusion that one measure is necessary for each policy goal only holds for the optimum in a world free of transaction costs. In the real world, cost savings may be obtained by utilizing the potentials involved in joint deliveries of private and public goods. These are of two kinds: First, costs of producing the goods may be lower due to the utilization of the same inputs in more than one product. Second, transaction costs will be reduced. Certainly, not all public goods can be secured this way. Some must be paid directly for, while others can be secured the best by paying via important inputs like land and animals. Still, utilizing jointnesses and complementarities offers important and interesting possibilities for future policy-making, too. The way this is undertaken has to vary between countries/regions depending on local conditions and the relative competitiveness of the agricultural sector.

1. INTRODUCTION

The concept of multifunctional agriculture has stimulated a wide-ranging debate among researchers and policy-makers. Multifunctionality demands analyses that are far from standard. When characterizing the production of goods, we have returned to concepts like jointness - a notion that has almost vanished from the economic literature (Baumgärtner 1999). In the consumption sphere we have acknowledged that goods typically seems to be relational (Romstad et al. 2000). Both joint products and relational goods imply interrelationships that do not fit well with the type of axiomatic structure that dominates economic theory.[1]

Furthermore, it has become clear that to talk about 'optimal' policies without also taking transaction costs into account, has become rather futile. Such costs cover costs of information gathering, decision-making, contracting and controlling/policing. While transaction cost is an increasingly popular concept within economics – e.g., Williamson (1985); Eggertsson (1990); Challen (2000) – its use has also led to confusion (see Vatn and Bromley (1997) and Vatn (1998) for a discussion). The fact that transaction costs are both system specific and difficult to measure does not simplify the analysis.

Finally, if transaction costs are positive, who the rights holder is matters for what becomes an optimal resource allocation (Randall 1974). This forces us as economists to discuss issues we may find more political than economic. At least we have to be very explicit concerning the assumptions we use regarding rights when drawing our conclusions. This is important when we study issues of relevance for international trade. Basically, it is the liberalizing of food markets that have created the interest for concepts like multifunctionality and the role of transaction costs and rights for determining what is an optimal trade regime within this field.

The aims of this report are thus three fold:

- First, we want to clarify the relationships between rights and efficiency. Rights define which interests are to be protected. More specifically, in a world with positive transaction costs, rights define what becomes efficient. This observation is of special significance if private and public goods are joint in production. The implication is that the trade regime

[1] While the concept of jointness played a rather notable role in the writings of classical economists, it almost went out of use as a result of the establishment of neoclassical theory. Baumgärtner (1999) argues that an important reason for this was that it did not fit into the new theoretical structures that were established. For a definition of the concept see Chapter 2.

must be based on a specific set of rules concerning which interests – i.e., rights – different countries are allowed to defend.

- Given that rights are defined, we will then discuss which policies are optimal under different assumptions about a) jointness in production of private and public goods and b) transaction costs.
- Since transaction costs play a role, it is of interest to determine how much they do matter. The third part of the report is thus focused on measuring the level of transaction costs for different types of goods and different types of payments. The main aim is to explain the variation in transaction costs as a function of the type of regulations.

Regulation theory – e.g., environmental economics – largely assumes that transaction costs are zero. In such a situation there is no problem to formulate policies that obey the standard conditions for efficient resource allocations – i.e., allocations which in our language are precise.[2] In a world of positive transaction costs, this is not so. An important trade-off between precision and transaction costs appears. A specific aim is thus to clarify what this trade-off problem implies.

While the analyses related to the two first aims are theoretical, we have also undertaken an empirical study on transaction costs. We have put quite some effort into documenting the details of this analysis since we find this to be important when evaluating of the findings. This has therefore become a dominant part of the report.

Working in the field of joint production and positive transaction costs, it is hard to be consistent. It is too easy to resort to a standard conclusion that is well established under assumptions about zero transaction costs/easy demarcatable goods. We believe it is very important to put effort into clarifying what efficiency means in a world where transaction costs are positive and goods may be joint in production.

[2] What we mean by a precise policy, will be discussed in section 4.2

2. WHAT IS MULTIFUNCTIONALITY?

2.1 The character of the goods

While the concept of multifunctionality has gained increased attention over the last years, there is yet no unified definition established across authors. OECD makes the following clarification: "Multifunctionality refers to the fact that an economic activity may have multiple outputs and, by virtue of this, may contribute to several societal objectives at once. Multifunctionality is thus an activity-oriented concept that refers to specific properties of the production process and its multiple outputs" (OECD 2001, p. 11).

We will base our analysis on this definition, but add that the multiple outputs may consist of a mix of both private and public goods. There is an ongoing debate about the classification of these. Partly this has to do with the fact that institutional or technological changes may move a good from one category to another. The following list summarizes outputs from agriculture that in our opinion have distinct public characteristics:

- Environmental aspects
  - ° Landscape
    - - Biological diversity
    - - Recreation
    - - Aesthetics
  - ° Cultural heritage
  - ° Pollution (changes in matter cycles; genetic pollution etc.)
- Food security (availability in different situations)
- Food safety (quality/phyto-sanitary status)
- Rural concerns
  - ° Rural settlement
  - ° Local economic activity

The sub-list of environmental aspects contains both positives and negatives – like recreation opportunities and pollution. Further, the relationship between the production of some public goods and the production of private goods can be either positive or negative – like biodiversity. Baumgärtner (1999) calls this ambivalent joint goods.

It is important to acknowledge that the various goods (and bads) are components of an integrated production system. They are an interlinked set of functions. While some of the listed aspects may be produced independently of agriculture, it is difficult to imagine an agricultural system that does not affect all the elements in the above list. In this sense all the listed public goods/bads are dependent on primary production. They are characteristics of the system as a whole. In the case of the environmental aspects and also food security to a large degree, this stems from the fact that agricultural production is directly interlinked with the eco-systems it operates within and the space that it occupies.

The goods listed are complex, by which is meant that each good consists of several elements, many of which are best described as processes. Qualitative aspects are often as important as the quantitative. The fact that many of the goods are relational is of specific importance. This implies that the value of one good (or sub-element of a good) depends on the quantity and quality of others. Landscape values are typical examples. The aesthetic value may depend on the level of biodiversity. The value of a track may depend strongly on the interrelated mosaic of other landscape elements.

2.2 Private vs. public goods

The concepts of private and public goods are very important in the study of multifunctionality. Ostrom et al. (1994) offer the following structure to illustrate the distinction.

		Costs of exclusion	
		Low	High
Rivalry in use	Yes	I: Private goods	II: Common pool resources
	No	III: Club goods	IV: Public goods

Figure 2.1. Characterization of goods according to costs of exclusion and rivalry in use. Derived from Ostrom et al. (1994).

According to Figure 2.1, costs of exclusion and rivalry in use are the important dimensions when classifying the different types of goods. Private goods – category I – are easily excludable and rival in use. Everyday goods like bread and butter are typical examples. Bread comes in demarcated pieces and we can easily discriminate between uses. Furthermore, if consumed by one, another cannot consume it. Thus, it is rival in use. Public goods (IV) are at the opposite end of this characterization. Here it is too costly to exclude anyone from consuming the good. However, this consumption does not reduce the value of the good for others. Military defense is a typical example. Air was such a good when the number of humans/human settlements was low. An important sub-category of this class is many so-called positive externalities.[3]

Common pool resources (II) are also rival in use like private goods, while exclusion is not easy. It is in this category we find what is termed negative externalities like pollution in rivers.[4] This implies that excluding someone from using a resource via private property regulations is too costly, while the utilization of the resource of one agent reduces its value for the others. In the case of club goods (III), excludability is a possibility for groups, while the good is not rival in use. Tele communication is an example of this category.

The costs of exclusion or demarcation are part of what we have termed transaction costs. While they in Figure 2.1 are presented as classes (high and low), these costs will normally vary from almost zero to almost infinity. This implies that many goods may be in intermediate positions.

There are some problems with the above characterization. At least the concepts of private goods and club goods bring institutional elements – i.e., property rights considerations – implicitly into the characterization of the good or resource. This is confusing. Private goods – as defined above – may not always be governed by private property arrangements. Furthermore, it is by establishing the club that low costs of exclusion are created – i.e., it is this institutional solution that makes it possible to move the good from the category of public goods. Being a 'club good' is therefore not an inherent character of the good itself, while it is easier to form clubs for some goods than for others. Clubs may on the other hand also be formed to govern common pool resources. In fact, that is the dominant institutional solution, be it pastures, irrigation systems or many fisheries and we observe the name of this club to be 'common property'. In the case of open sea fisheries, the 'club' is often the state – i.e., state property.

In much of the literature, category II in Figure 2.1 is called 'common property resources'. In the case of Ostrom et al. (1994) they avoid the confusion of mixing resource characteristics and

---

[3] A positive externality may certainly also be characterized by some rivalry (or congestion) in the consumption.
[4] One may comment that some negative externalities only affects one or a few agents and trade may appear. In such a situation, at least no Pareto relevant externality would persist – see Chapter 3.1.

regimes by using the concept 'common pool resources'. In the case of a common pool resource, it may be governed by open access, by a common property regime or by the state.

There are actually three issues at stake here: a) what are the characteristics of the resources, b) which property regimes are used, respectively should be used to govern their utilization, and c) which system is or should be used to match supply and demand? Private goods may be produced under a private property regime, but this is not a necessity. Health care is a private good following the logic of Figure 2.1. We see, however, a great variety across countries concerning the provisioning of such goods, be they private or public. Furthermore, health care may be privately produced, but still not allocated via markets. Public systems may take care of the distribution of the good, because basic health care is considered a right to everybody. Hence, we may have private property within a non-market system of allocation.

While private goods thus may be provisioned under a variety of systems, public goods seem to demand some type of common payment structure if they are to be produced at all. This is the case unless they are free goods – provided by nature or jointly produced with private ones. Because of this, there is an important asymmetry to be observed here.

There is a tendency among us economists to favor market transactions and market allocations in general. We observe – not least in the literature about multifunctionality – a search for finding ways to privatize the provisioning of public good attributes either in the form of constructing or mimicking some market allocations or by establishing various types of 'clubs'. This has for example fostered a search for ways in which tourists may pay for landscape experiences via hotel prices or toll on roads. While this may offer possibilities in some cases where demarcation costs are rather low, there is nothing inherent in markets or clubs that should give them any *a priori* superiority.

There are actually two issues involved here. First, one must ask if markets (always) are the best way to measure values. Second, establishing markets may be a costly way to provision the good. Markets are a type of value articulating institution (Jacobs 1997) based on a specific set of assumptions. We are assumed to act as individual consumers, goods are perceived to be commodities and we articulate our preferences via prices. It is not given that this type of value articulation is considered the best for all gods. It may be that the good is regarded as a common good and that evaluation should be based on citizens' evaluation (Sagoff 1988). It may be that arguments are more relevant than price bids, etc. These issues have been especially focused in the literature on environmental evaluation (Clark et al. 2000; Foster 1997; Vatn 2000). We observe that the way people are asked to express their preferences or values influences which options that they in the end favor. Hence, there is a second order issue involved here – that of choosing which value articulating institutions should be utilized for which type of good. One cannot just take the answer on this question for given.

Moving to the second issue, we observe that transaction costs vary between types of goods and types of regimes (Bromley 1991). Markets may be the cheapest solution for allocating private goods, but not for others. The costs of demarcation etc. may be too costly. The process of demarcation – e.g. fencing an area – may furthermore influence the value of the good, bringing us back to the above issue.

The engagement put into searching for market/club solutions is not surprising given that the analysis is built on a model where goods are normally thought of as commodities and transaction costs are assumed to be low/zero. The problem is that under such an assumption any allocation system – any economic structure – is efficient. We cannot discriminate between their efficiency if transaction costs are zero since the factor that differentiates is eliminated[5]. If we accept that transaction costs are positive, their magnitude has to be explicitly evaluated. This report is basically an effort to clarify how we should do this.

2.3 Interrelations: jointness, relational and non-homogeneous goods

There is a strong tendency to think about goods as commodities – i.e., easily demarcatable objects which we as consumers can combine ourselves in whatever final product we like to make. This is rarely the case if we look at multifunctional agriculture. Goods are often joint in production; they may be relational and often non-homogeneous. Typically it is not independency, but interrelations that dominate.

Jointness implies that when an enterprise produces more than one output, inputs cannot be assigned specifically to each output. Because of this, the production function includes all

[5] This argument has been developed by Williamson (1985) and Eggertsson (1990). If transaction costs are zero it becomes impossible to differentiate between structures like free competition, oligopoly, monopoly or planned economies on efficiency grounds.

outputs as a function of the inputs (Frisch, 1971; Gravelle and Rees, 1981). Jointness can cover both goods and bads, which in principle can be both private and public.

Goods are *relational* if the state of one component of a set of goods influences the value of one or more of the others. Formulated differently, the value of a good changes more than the separate change in the value of one or more of its parts. Certainly, this is typically the situation for landscape values where it is the combination of the various elements that makes the scenery or the diversity.

There is another issue involved here. Since we in many cases – like the landscape – must consume the same good, the valuing and subsequent payment of one agent influences the possibilities for others. This is in itself a reason why public debate may be favored as an important input into the allocation of these goods (Vatn 2000).

Finally the goods involved are often *non-homogeneous*. This implies that each good – each landscape, species, etc. – has its own characteristics. It is these separate characteristics that often determines if it is valuable or not.

It is the fact that goods often are relational and non-homogeneous that makes the issue of transaction costs especially important. It is on the other hand, the potentials for joint deliveries that may offer a way out of the ‘trap’ this produces. It may make it possible to reduce the same costs substantially.

3. RIGHTS, TRANSACTION COSTS AND EFFICIENCY

3.1 Rights define what becomes efficient

Rights are also of importance when studying transaction costs and efficiency. The famous Coase theorem says that in a world with zero transaction costs, it does not matter who has the right to a good or resource. Trade will always secure optimal allocation of the resources (Coase 1960).[6] Figure 3.1 gives a simple exposition of the idea.

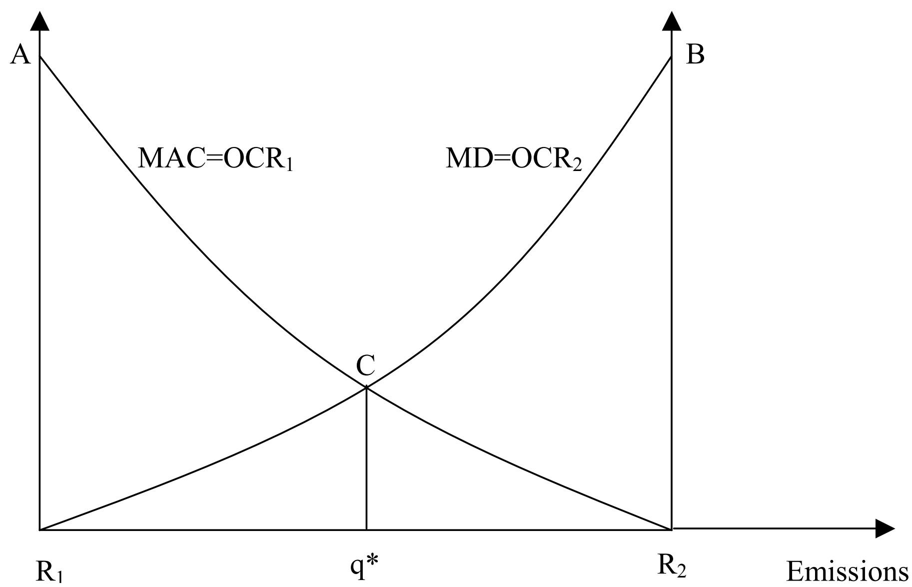

Figure 3.1. Optimal resource allocation with zero transaction costs and two different distributions of property rights

There are two agents – 1 and 2 – which are situated along a river. Agent 2 is upstream of agent 1. Agent 1 produces bread and is in need of clean water. Agent 2 produces paper and need water too. More important, the river is a low cost recipient for the emissions of polluted water that follows from the process of making paper.[7] If the baker has the right to clean water, the rights structure can be termed R_1 with an initial pollution level at R_1 in Figure 3.1. The cost for the paper mill to keep water clean – illustrated by the marginal abatement curve MAC – is very high at R_1. Accepting some emissions, the MAC will go down. It will still be above the marginal damage curve for the bakery (MD) up till C.

[6] Coase did not term it a theorem himself. This is done later by other economists.
[7] Coase uses a grain farmer neighboring a beef farmer as his example – i.e., showing that under the given assumptions the rights structure does not influence whether it is optimal to erect a fence or not between the land of the two.

While the MAC curve in a world of zero transaction costs is equal to the offer curve of the paper mill for emissions (=OCR_1), the MD curve constitutes the bakery's willingness to pay for clean water (OCR_2). The optimal point will be at C where the offer curves – i.e., marginal cost curves – equalizes. The optimal emission is q* with a gain that equals the area R_1AC compared to the initial situation R_1. If the right is with the paper mill, the starting point will be at R_2. The optimal point will still be the same – q* – with the gain R_2BC. The conclusion is that who has the right does not matter. Through trade the same allocation will be reached.

Even though the Coase theorem has gained much attention, it demands several important restrictions. First, the theorem demands that preferences of a population are homogeneous and homothetic.[8] If this is not the case, the income distribution inherent in the rights distribution will change the aggregate willingness to pay (offer curves) as rights are shifted. Second, the theorem demands zero transaction costs. This was strongly emphasized by Coase himself. Both assumptions are highly disputable. While it is easy to see the effect of different distributions of rights/income on the ability of various interests to defend themselves, it may be a bit more complicated to see the effect of transaction costs. Building on Randall (1974) and Bromley (1991), we may make the following illustration:

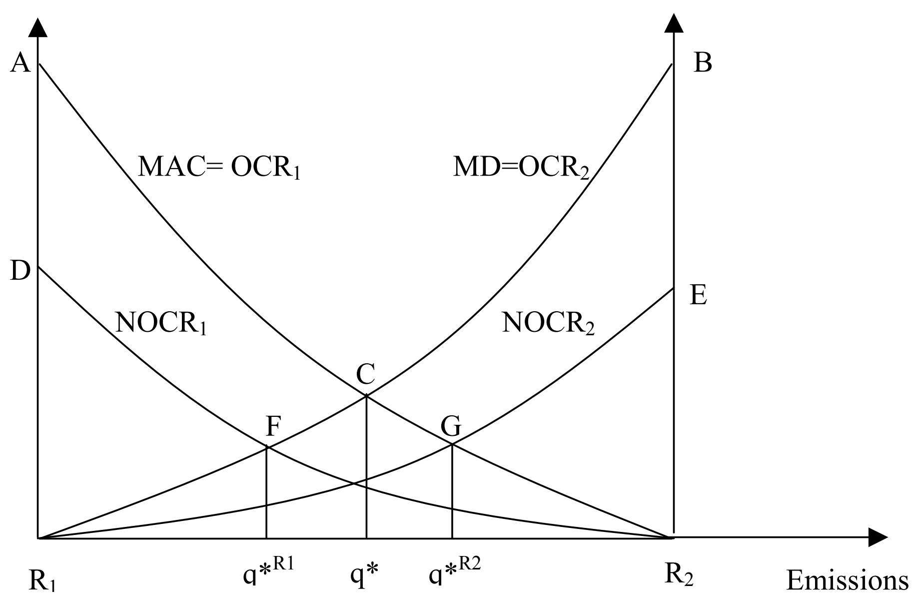

Figure 3.2. Optimal resource allocation with zero respectively non-zero transaction costs under two different distributions of property rights

[8] This secures that the demand for goods will be the same independent of the distribution of rights/income.

With positive transaction costs the gain of transacting goes down. If the rights are with the paper mill, the baker has to carry these costs. His offer curve thus shifts from MD (OCR_2) to $NOCR_2$ – the net offer curve give R_2. The difference between MD and $NOCR_2$ is then the (marginal) transaction costs. We observe that the new optimum – q^{*R2} – implies higher emissions than in the case with zero transaction costs. The gain of transacting is reduced to R_2GE.

If the rights are with the baker, it is the paper mill that has to carry the transaction costs. Its offer curve goes down similarly, and the optimum – q^{*R1} – is now below q*. Thus, with positive transaction costs, rights influence what becomes optimal to do.

The figure only considers marginal transaction costs. Furthermore, these are assumed to be increasing with increasing 'stakes'. The principal argument – that transaction costs lower the gains of trade – is not influenced by changing the assumptions about the form of the transaction costs. Still, one must be aware that transacting often involves high fixed costs. If these are greater than R_1DF or R_2GE respectively, there will be no trade and the initial rights structure determines directly the resource allocation, which will be R_1 or R_2 dependent on the given rights structure.

In the case with two agents we may assume transaction costs to be low and transactions will in most instances appear.[9] This is not so in multi person settings which is typically the case for public goods and many negative externalities. The 'ultimate' case is the climate change issue where any of the 6 billion inhabitants of the world is both an emitter and a victim. To reach a reduction in emission levels of greenhouse gases via negotiations between 6 billion people would be literally impossible. Even if the effects of climate change were proved to be disastrous, it would still be so that the 6 billion could not avoid it in a 'Coasean world' of individual negotiation. Some transaction cost reducing structures is necessary to obtain any progress. The effect of introducing such structures will be increased efficiency.

In much of the literature it is taken for given what is a gain and what is a cost, what is a positive or negative externality, etc. This is built on a belief that the demarcation can be defined on pure physical grounds. This is not possible (Coase 1960; Vatn and Bromley 1997).

[9] Still, most people may hesitate to ask the neighbor to cut trees, which are growing nearer to the boarder between the properties than allowed.

Whether the paper mill is presumed to restrict the baker's possibilities when it emits dirty water or the baker restricts the paper mill's possibilities by locating downstream and insisting that the water should be clean, is a rights issue. There is no doubt that it is the paper mill that is emitting the polluting substance. But for the harm to appear, the baker must also be there as our example is formulated. Thus, there is a distinction between what makes an emission and what makes an externality to come into being. It is only through defining rights to resources that it becomes clear what is a harm or a sacrifice.

Scheele (2001) discusses this issue explicitly for agriculture and the environment, showing the need for defining a baseline politically. It is only from the (necessarily normative) definition of that baseline, it becomes possible to evaluate whether an activity implies a positive or negative change, for example whether the *Provider Gets* or *Polluter Pays Principle* should be used.[10]

Similarly, the question of where the burden of proof lies in cases with uncertain consequences is also a fundamental rights issue. Is it the producer who must demonstrate that no negative externalities arise from production, or must the potential victim establish proof for the fact that he will be harmed? The way responsibility is defined may have immense effects on production choices and resource allocation, especially in a complex world with high transaction costs (Vatn, 2002).

3.2 Implications for joint private and public goods

Rights define which interests are to be protected, and therefore which resource allocations that in the end can be termed efficient. Furthermore, the allocation system used is characterized by a specific level of transaction costs. In welfare theory the focus is on the efficiency issue, with rights (or endowments) taken as given and transaction costs set to zero. The specific distribution of rights is a normative issue outside the scope of economics. However, in most institutional reforms such as defining environmental policies or setting rules for international trade, the foremost concern is about defining or redefining rights (Bromley, 1989). Still, the issues are very often cast in efficiency terms. This is bewildering.

---

[10] Scheele (2001) uses 'good agronomic practice' as the reference point. This concept illustrates that it may be hard to define such a point. It can still not be exempted form.

In a case with two joint goods A and B – which are both of the private kind – the problem of jointness is in itself not very challenging for policy. Transaction costs are low and both goods can easily be traded if that is a preferred way to allocate the resources. Certainly, an increased demand for A will influence the market for B, since those producing A and B jointly become more competitive in the market for the good B as a function of changed demand for A.[11]

The situation is not necessarily different if the joint product A is a private good while B is a public one. If the geographical extensions of the market for A[12] and the geographical area of the public goods regime governing B are identical, the regulation problems are fairly standard. Changes in the request for one will influence the cost of deliverance of the other. Still, the same authority governs the regimes for both goods and the desired states can in principle be obtained.

The main challenge appears when these areas of jurisdiction are not completely overlapping. In these cases external effects from one area of jurisdiction may influence what is obtainable in the other arena. More specifically, free trade for the private good may influence the possibilities for some countries to deliver joint public goods – not least those that are less competitive in the markets for private goods.

The technical arguments about this issue will be focused in Chapter 4. Concerning the rights issue, the problem is how to define rights between countries or agents in different countries. Here, there is no common authority structure like a parliament to define a common social welfare function, specifying when something is harmful to others. This issue has to be determined on the basis of *bargaining* between the states.

First, one should recognize that independent states are not equal in reality. This is important, especially concerning developing countries. More fundamentally, though, a right must be based on an authority structure that is common to all states, that is, some sort of a 'super state'. Since there is no such common norm, we observe that efficiency arguments 'intrude' the arena as a legitimate, even determining, argument concerning which rights should exist. However, this is doomed to end in circularity and confusion. We observe this in the debate about 'trade distortions'.

[11] Such shifts in the market may change which of A and B is considered bi-product.
[12] Assuming that A is traded in markets.

A trade regime giving country A the right to export its products freely to country B and vice versa may be set up based on the argument that both countries will gain from trade – i.e., comparative advantage. When, for example, country B realizes that the external effects of that trade are such that negative consequences appear, it may want to change the regime. Should that issue be determined on the basis of who gains the most from either institutional structure or should each country be given a right to define some standards to protect itself? Certainly, this is a very difficult issue when no common authority structure or social welfare function exists. It is, however, logically wrong to determine the outcome on the basis of who is willing (or able) to pay the most for a specific rights structure and then call it efficient. This reasoning is and will always be circular.

There is a tendency among us economists to define the problem in terms of separating goods. Bhagwati (2002) makes the following remark: "…there is a simple answer to reasonable concerns about multifunctionality. For we should be able to find and accept suitable policies that promote or protect the other functions of agriculture while freeing trade. Thus, greenery could be subsidized as such rather than indirectly and inefficiently through trade barriers that protect agricultural production…" (p. 81).

While there may be much to say about existing regimes, the basic message that multifunctionality and trade should be treated independently, depend on the assumptions that no jointly produced public goods exists – i.e., transaction costs are zero. These are very strong assumptions. Trade is an instrument for enhancing welfare. It is not a goal in itself. If some restrictions on free trade are necessary to obtain important goals or make it less costly to reach these, then one should use such restrictions from a welfare theoretic point of view. Again the conclusion is given by the assumptions of the model utilized.

4. OPTIMAL POLICIES UNDER DIFFERENT ASSUMPTIONS ABOUT JOINTNESS AND TRANSACTION COSTS

4.1 Agriculture – integrating human production and natural processes

While any type of production depends on natural processes one way or another, agricultural production is directly interlinked with the eco-systems it operates within and the space it uses. The links go through the combined use of inputs. This is illustrated in Figure 4.1:

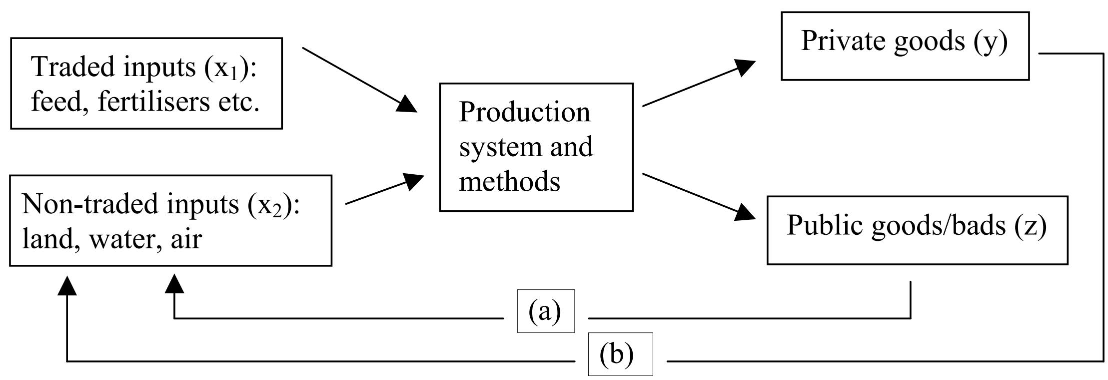

Figure 4.1. The linked set of inputs and outputs in the agricultural production system

On the input side, the figure distinguishes between inputs that are (easily) traded (x_1) and those that are not (x_2). The latter resources are typically local, and they are normally public/common pool resources (like water and air). Land is included in the category of non-traded goods in the coming analyses. This has to do with our focus. Land is often reallocated between productions without trade taking place.[13]

Inputs are combined in different production processes. Out of these come sets of outputs in the form of tradable goods (y), or public goods and bads (z). Given that matter cannot disappear, all resources that are put into the production process must in the end appear as outputs in one form or the other – i.e., either as a private good (commodity), a public good or a public bad[14] (see also Baumgärtner, 1999).

[13] While for some inputs like fertilisers, measures (e.g., taxes) can be directed at the point where the resource is traded; this possibility is restricted in the case of land. The implications of this will be discussed later.

[14] The observant reader will notice that we have here not distinguished between goods/resources that are rival and those that are non-rival in use. Since our focus from now on will only be on costs of demarcation, we have

We distinguish between private and public goods. We have also emphasized that there are at least two reasons why a good may be considered public. It may be found politically or ethically correct to provide a good to everybody free of charge. Secondly, it may be too costly to *demarcate* the good so that it is only accessible to those who pay specifically for it. The costs of transacting are simply too high. It is this latter aspect that is the focus of the rest of this report.

Outputs may be joint, complementary or competing. *Jointness* is already defined as a situation with multi outputs where inputs cannot be assigned specifically to each output. In the case of *complementarity*, the production of one good contributes to an element of production, which is joint with this first good and required in the making of a second good (Heady, 1952)[15]. This is illustrated by the arrows (a) and (b) in Figure 1 – i.e., they can be both private (tradable) and public (non-tradable). The effect on the joint production factor could, in principle, be both negative and positive. A classical example in agriculture is the production of hay, which contributes positively to soil fertility (joint product with hay), hence increasing future grain productivity (complementary product).

Complementarity occurs normally within certain ranges. Beyond these ranges the two products *compete* over the common factor of production. In the case of hay and grain competition occurs when there is an increased incentive to produce grain – i.e., the demand for grain has increased beyond a level where it starts to compete with hay concerning the use of land.

Concerning transaction costs, we observe that a substantial part of these costs are related to the costs of demarcating a good. The idea to be developed here is that it may be much easier – less costly – to apply a policy instrument to traded inputs or outputs – i.e., private goods – than to apply them to the associated public goods or bads. This has not least to do with the costs of demarcation and the associated costs of observation and control. Concerning Figure 4.1 this implies that the least costly *points of instrument application* will be the traded input x_1 or the traded output y. On the other hand, such solutions may be too imprecise compared to measures directly attached to the public good one wants to secure or promote. To develop this reasoning, a clarification of what is meant by transaction costs and precision is needed.

chosen to simplify the exposition and disregard the rivalry dimension. Thus, all goods where exclusion is (very) costly will be termed public goods.

[15] Heady (1952:222) offers two more definitions, one of which is a variant of the one used here.

4.2 Transaction costs and precision

Arrow (1969: 48) has defined transaction costs as the "costs of running the economic system".[16] This is a good definition in that it emphasizes the system dimension and implicitly makes a distinction between transaction costs and costs of production. The problem is that it is not a very practical definition. We have thus followed the operationalization made by Dahlman (1979) identifying transaction costs as costs of information gathering, contract making and control. Transaction costs are important. It is estimated that in an economy like the American, the costs of producing and the cost of transacting are each covering roughly half of the costs in the economy (Eggertsson 1990).

The distinction between production and transaction costs is of special interest when studying multifunctional agriculture. If goods can be jointly produced, there is potential for reduction in production costs. This is the effect that is normally highlighted in the literature (Hoel and Moene, 1993; Shumway et al., 1984). Second, treating goods as bundles will imply reduced transaction cost.

Tinbergen concluded – in a famous proposition – that there should be at least one policy measure for each policy objective (Tinbergen 1950). His conclusion demands zero transaction cost. If transaction costs are positive, utilizing jointness opens up possibilities for cost reductions. We may, however, experience a trade-off problem between transaction cost and the precision of the policy (Vatn, 1998).[17] In our mind this is a core technical issue in policy formulations.

What is then meant by precision? This is a concept that relates to the effect of a policy – i.e., in our case the production of a public good. A precise solution is reached when the standard condition for optimality is met in the *production of the good* – i.e., marginal cost equals marginal gain. Furthermore, loss of precision can be measured as the net gain foregone by a deviation from this standard optimality condition. In the case of pollution abatement, a solution is precise if the marginal costs of abatement are equal across all sources into a recipient.

[16] Cited in Williamson (1985).

[17] It is a bit curious that the Tinbergen proposition is so little debated. From Coase (1960) it follows that with zero transaction costs there are no reason to formulate policies at all, except those necessary to define rights. It is the fact that transaction costs are positive that defines the need for policies to be developed – i.e., forms the basis for Tinbergen. Thus it is a great failure not to take these explicitly into account when formulating rules for policy development.

Transaction costs depend on the level of precision. They are in a way the 'costs of being precise'. A distinction must be made here between transaction costs involved in the process of producing a good and the transaction costs involved in the formulation and running of a policy. The first type of transaction costs – e.g., costs related to buying inputs – are to be distinguished from the transaction costs we are interested in here – i.e., those cost that are specific to the policy. When we later talk about transaction costs, we will mean these policy-specific transaction costs.

These costs depend on the level of precision. As an example, an optimal state for a landscape will normally be defined in terms of production costs involved and utility obtained. Achieving such a state may require several policy measures directed towards changing the qualities of various elements of the landscape. The efforts involved in meeting information requirements, specifying new incentives, formulating contracts and policing them have to be weighed against the potential gains for each element involved. In doing this, one has to make a trade-off between the gain of transforming the landscape as near the precise[18] 'ideal' as possible and the transaction costs involved when doing that.

While the marginal utility of increased precision would be expected to fall as precision increases, marginal transaction costs would be expected to grow. All costs considered, it would not be reasonable to expect a precise policy to be optimal. In our example, this may imply that paying a flat subsidy per hectare to maintain an open landscape may be a better policy than to pay a specific price for each element of the landscape because the gain in reduced transaction cost is greater than the loss in precision.

4.3 Optimal policies under different conditions

To increase our insights into these issues, we will have to formulate a model, which covers the most important relationships accentuate above – i.e., goods that are joint, complementary respectively competing in production. Furthermore we will take transaction costs into account.

[18] The optimal solution in a transaction costs free world

Since, as already emphasized, the challenges are greatest in a situation with trade across the borders of units defining the public goods, we will formulate the model such that the issue of trade can be explicitly handled. We will first define the model based on the relationships highlighted in Figure 4.1. Thereafter we will go systematically through its various elements. Transaction costs are included in the model, but only verbally treated at this stage.

4.3.1 The model

Consider the following model developed on the basis of Figure 4.1:

$$\text{Max } U = U\left(y_i, y_n, z_1, z_2, z_3, TC\right) - p_y^w y_i \tag{1.a}$$

$$\text{s.t. } y_n = y_n\left(x_{11}, x_{21}\right) \tag{1.b}$$

$$z_1 = z_1\left(y_n\right),\ \ z_2 = z_2\left(x_{12}, x_{22}\left(y_n\right)\right),\ \ z_3 = z_3\left(x_{11}, x_{23}\right) \tag{1.c}$$

$$x_{jk} = r_{jk} \quad (j=1,2)\ (k=1,...,3) \tag{1.d}$$

where :

U	is social welfare
y	is a private good where the subscript i implies imports and the subscript n implies national production in country n
p_w^y	is the world market price for y
z_1	is a public good jointly produced with y_n
z_2	is a public good where one input (x_{22}) is joint to the production of y_n (complementarity). This input can affect the quality of z_2 negatively or positively
z_3	is a public good competing over the private input x_{11}
TC	transaction costs following from the type of policy used
x_{jk}	are inputs where j=1 implies tradable and j=2 implies non-tradable goods. The index k differentiates between different inputs j.
r_{jk}	are resource constraints

Equations 1.a – 1.c are assumed to be concave and twice differentiable. Observe that there is no complementary slackness/free disposal since resources either end up as the private good y (milk, meat, etc.) or the public good or bad z (food security, nitrate emissions, etc.).[19] Observe also that z_1 is a public good jointly produced with the production of the private good in country n (y_n). Furthermore, z_2 is a public good which is complementary to y_n. There is thus a joint input involved – x_{22} – which may influence the quality of z_2 either positively or negatively. z_3 is a good competing with y_n over the use of the input x_{11}. The formulation in

[19] This implies that we consider all resources to be involved in the production of the goods, even though they are not necessarily altered by this production – e.g., parts of the landscape.

1.a – 1.d should then cover the most important relationships involved when discussing multifunctional agriculture.

The interesting issue here includes the various effects on the public goods from producing y_n. Let us start by disregarding the transaction costs. On the basis of the first-order conditions, the following has to hold for an optimum[20] – i.e., a precise solution:

$$\frac{\partial U}{\partial y_n}+\frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}+\frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}=\lambda \tag{2}$$

where λ is the Lagrangian multiplier for the production constraint on the private good in country n (constraint 1.b) – i.e., marginal cost per unit of production in optimum. This expression says that the cost of producing the private good in country n should equal the sum of the marginal utilities of the private good y_n itself (=$\frac{\partial U}{\partial y_n}$), plus the marginal utility it gives through the joint good z_1 (=$\frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}$), plus the marginal utility/disutility it gives by producing x_{22} – which is an input into the production of z_2. This latter aspect is captured by the expression $\frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}$. As earlier emphasized, the expression $\frac{\partial x_{22}}{\partial y_n}$ of Equation (2) may be either positive or negative, indicating that production of y_n may reduce or enhance the utility of z_2 via its effect on x_{22}.

How can the conditions under (2) be attained? The following optimization problem can be defined for a firm producing all three types of public goods:

$$\begin{aligned}\text{Max}\,\pi = {} & p_y y_n\left(x_{11},x_{21}\right)+p_{z_1}z_1\left(y_n\left(x_{11},x_{21}\right)\right)+p_{z_2}z_2\left(x_{12},x_{22}\left(y_n\left(x_{11},x_{21}\right)\right)\right)+p_{z_3}z_3\left(x_{11},x_{23}\right)\\ & -C_n\left(\cdot\right)\end{aligned} \tag{3}$$

where p is the price of the various goods (indexed according to type of product), and $C_n(\cdot)$ is the cost function for producing y_n and z_1-z_3 with x_{11}-x_{23} as its arguments.

Assuming the private good y_n to be of equal quality to y_i and world market prices for y to be inelastic with respect to demand from country n, the price for the private good p_y should equal the given world market prices p_y^w. Furthermore, since z_1 and x_{22} are joint products of y_n, they

[20] For a complete exposition showing the derivations, see Appendix 1.

are delivered for free and may not demand any payment in optimum. Certainly, if x_{22} has a negative impact on z_2, some incentive corrections are warranted. Let us look more closely at these issues.

4.3.2 Optimal policies when the private and public goods are joint

Let us start with the simplest situation – i.e., with only a joint public good z_1 involved. The social maximization problem in (1) simplifies to:

$$\text{Max } U = U(y_i, y_n, z_1, TC) - p_y^w y_i \quad (4.a)$$

$$\text{s.t.} \quad y_n = y_n(x_{11}, x_{21}) \quad (4.b)$$

$$z_1 = z_1(y_n) \quad (4.c)$$

$$x_{j1} = r_{j1} \quad (j=1,2) \quad (4.d)$$

The firm's problem in (3) changes to:

$$\text{Max } \pi = p_y y_n(x_{11}, x_{21}) + p_{z_1} z_1(y_n(x_{11}, x_{21})) - C_n(\cdot) \quad (5)$$

To be concrete, z_1 could be food safety – i.e., the degree to which a national food production has a direct effect on keeping up the quality of a country's production system.[21] It could also be food security,[22] or it could be rural economic activity to the extent that producing food must engage rural resources. Given that y_n is considered the primary part of the two goods y and z_1, the latter can be regarded a by-product delivered for free. The amount of y_n may, however, be too low to secure optimality.

To illustrate this, let us look at the optimal use of x_{11}. According to the first order conditions with respect to this input, the social optimum is defined by:

$$\left(\frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}\right)\frac{\partial y_n}{\partial x_{11}} = \mu_{11} \quad (6)$$

where μ_{11} is the Lagrangian multiplier for the resource constraint on x_{11} (constraint 4.d). This implies that in optimum the cost of using the input x_{11} – let it be mineral fertilizers – must

[21] It is not necessary that the health status of a country's agriculture must be better than other countries for this to hold. It is as much a question of introducing new risks.
[22] To the degree that ongoing production produces increased security.

equal the gains it delivers. These are the marginal utilities following from the private good y_n itself ($=\frac{\partial U}{\partial y_n}$), plus the marginal utility it gives via the joint good z_1 ($=\frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}$), times the marginal effect of the input x_{11} used in producing y_n ($=\frac{\partial y_n}{\partial x_{11}}$).

The private optimum is characterized by:

$$(p_y + p_{z_1}\frac{\partial z_1}{\partial y_n})\frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n}{\partial x_{11}} \tag{7}$$

This simply says that marginal gains should equal marginal costs: in optimum the marginal income from using x_{11} in producing y and z_1 (left hand side) should equal the marginal cost of using x_{11} (right hand side).

If transaction costs are zero, it is reasonable to assume that marginal private costs equals marginal social cost – i.e., $\frac{\partial C_n}{\partial x_{11}} = \mu_{11}$. Then to reach equality between private and social optima, the prices obtained by the agent – i.e., $p_y + p_{z_1}\frac{\partial z_1}{\partial y_n}$ – must be equal the marginal utility of producing y_n with the associated joint production of the public good z_1 – i.e., $\frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}$. This follows from combining equations (6) and (7).

Let us assume the price for y in country n to be equal to the world market price:

$$p_y^n = p_y^w = \frac{\partial U}{\partial y_i} = \frac{\partial U}{\partial y_n} \tag{8}$$

This price should furthermore equal the marginal utility of consuming y. This is the standard condition for obtaining optimal supply of the private good y. The utility of consuming y is then considered to be the same independently of y being produced abroad or in country n.

Let us furthermore assume that there is no payment for the public good z_2 – i.e., $p_{z_1} = 0$. An optimal provisioning of that good may still be obtained. This is the case if $\frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n} = 0$ at the point where Equation 8 holds. This implies that the marginal utility of the public good z_1 must be zero in the point where the private good y_n is optimally provisioned. The probability of this happening decreases the less competitive country n is in producing y, since the level of the joint public product z_1 then will be low.

By paying $p_{z_1} = \frac{\partial U}{\partial z_1}$ for z_1 and assuming profit-maximizing behavior – i.e., $p_y^w + p_{z_1} \frac{\partial z_1}{\partial y_n} = \frac{\partial C_n}{\partial x_{11}} \Big/ \frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n}{\partial x_{21}} \Big/ \frac{\partial y_n}{\partial x_{21}}$ – we will restore equality between private and social optima.

However, since z_1 is a public good, it may be very costly both to observe and pay for it. Thus the above analysis assuming transaction costs to be zero is actually inconsistent. If transactions costs are zero, there is no reason to distinguish between private and public goods.[23]

Actually, in practice, the transaction cost for direct payment for public goods may in some situations be prohibitively high. While we will return to this issue more fully in Chapter 5, we will here offer some of the basic arguments concerning the problem of trade-off between precision and transaction costs.

If there are no transaction costs, distinguishing between private and public goods is, from our perspective, irrelevant. Market allocations will technically do for both. If transaction costs are positive, we have to look for the least costly option taking both production and transaction costs into consideration. If – as in our case – the private and the public goods are jointly produced, paying for the public good (z_1) directly or via the price for the private good (y_n) yields the same result concerning precision (resource allocation in the production of the good). This is so since the level of y_n determines the level of z_1 (and vice versa). Thus increasing the price for y_n from p_y^w to $p_y^w + p_{z_1} \frac{\partial z_1}{\partial y_n}$, will yield exactly the same amount of y_n and z_1 as paying separately for y_n and z_1 – i.e., direct payments for z_1. It is an *equally precise measure.*

The only issue to consider is which option involves the lowest transaction costs. Paying directly for the public good z_1 may be rather expensive since the good has to be observed, measured and paid for according to its size. Since a market for y_n already exists and necessary

[23] Remember that we are only focussing on the dimension of demarcation costs here – confer also footnote 14.

information is available, this should be a much cheaper option, and clearly preferred as long as the goods are jointly produced. There is actually no trade-off problem involved.

The above situation is a situation with what may be termed a pure joint public good. If the public good z_1 is not a strict function of the private good y_n, – i.e., it is impure – the trade-off problem between precision and transaction costs becomes a relevant and important one. As an example, it may be that securing the wanted level of, e.g., food security demands adaptations beyond protecting national production. In such a situation raising p_y^n beyond world market prices, may not be sufficient. Still, paying directly for, e.g., food security may also not be optimal. The gain in precision by moving to direct payments must be compared to the increases in transaction costs. Making the standard convexity assumptions, the optimum is reached when the marginal gain in precision equals the marginal increase in transaction costs.

Let us reformulate the model in (4):

$$\text{Max } U = U(y_i, y_n, z_1, TC) - p_y^w y_i \tag{9.a}$$

$$\text{s.t.} \quad y_n = y_n\left(x_{11}, x_{21}\right) \tag{9.b}$$

$$z_1 = z_1\left(y_n, x_{12}\right) \tag{9.c}$$

$$x_{jk} = r_{jk} \quad (j=1,2)\ (k=1,2) \qquad 9.d)$$

We observe that z_1 is a function both of y_n and the input factor x_{12}. The firm's problem changes to:

$$\text{Max } \pi = p_y y_n\left(x_{11}, x_{21}\right) + p_{z_1} z_1\left(y_n\left(x_{11}, x_{21}\right), x_{12}\right) - C_n\left(\cdot\right) \tag{10}$$

Unlike the case with a pure joint public good, there is no straightforward conclusion in this case. Paying extra for y_n as in the case of pure jointness – i.e.

$$p_y^n = p_y^w + p_{z_1}\frac{\partial z_1}{\partial y_n} = \frac{\partial C_n}{\partial x_{11}} \bigg/ \frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n}{\partial x_{21}} \bigg/ \frac{\partial y_n}{\partial x_{21}} \tag{11}$$

– will secure optimality concerning the use of the input factors x_{11} and x_{21}. There is, however, no incentive for optimal use of x_{12} in producing z_1. The firm does not meet the price for z_1 – p_{z_1}. Because of this, there is no mechanism securing that the marginal cost of using x_{12} in the production of z_1 would equal its marginal impact on the value of z_1 – i.e., most probably

$\frac{\partial U}{\partial z_1} \neq \frac{\partial C_n}{\partial x_{12}} \Big/ \frac{\partial z_1}{\partial x_{12}}$. This loss of precision must, however, be weighed against the reductions in transaction costs attained by paying only via y_n as compared with paying directly for z_1.

Another alternative in this situation could be to pay the firms for using x_{12}. This should also be a low-cost opportunity since x_{12} is a private good. There is a problem encountered here, though, if this input also is used in other productions. Then extra control mechanisms may be necessary to avoid resale of the subsidized input. The costs involved here must thus also be considered.

4.3.3 Optimal policies when the public and private goods are complementary

Introducing the complementary good z_2 adds some other important issues, both because the relationship between y_n and z works via the input factor x_{22}, and the influence on z_2 can be either positive or negative. As an example, z_2 could be surface or ground water and x_{22} nitrates originating from the production of grain, etc. Another example could be cultural landscape where x_{22} could be agricultural fields. Finally, the public good could be biodiversity, with x_{22} including species that are endangered or protected by agriculture. While agriculture in the case of surface/ground water is assumed to influence the public good negatively, the effect is positive in the case of the landscape. In the case of biodiversity, the effect may shift from positive to negative beyond a certain level of y_n (Dragun, 1998).

What will be an optimal policy in this case? Concerning the formulation of the firm's problem, equation (3) would change to:

$$\text{Max } \pi = p_y y_n\left(x_{11}, x_{21}\right) + p_{z_2} z_2\left(x_{12}, x_{22}\left(y_n\left(x_{11}, x_{21}\right)\right)\right) - C_n(\bullet) \tag{12}$$

As in the case of the impure joint public good, there is no simple conclusion to be offered. Precision will be lost if one only pays for or taxes y_n as compared with more direct measures. Let us start by assuming the effect of the input x_{22} on the production of the public good z_2 to be positive – i.e., $\frac{\partial z_2}{\partial x_{22}}>0$. Let us furthermore assume the effect of the private good y_n on the same input to also be positive – i.e., $\frac{\partial x_{22}}{\partial y_n}>0$. Paying for the public good z_2 by increasing the price for the private good y_n will secure optimality (precision) concerning the use of the production factors x_{11} and x_{21}. This will be obtained by paying a price for y_n equal to the world market price plus the marginal value of y_n in the production of the public good z_2 – i.e., $p_y^n = p_y^w + p_{z_2} \frac{\partial z_2}{\partial x_{22}} \frac{\partial x_{22}}{\partial y_n}$. This way, equality is obtained between the price paid and the social cost of using inputs x_{11} and x_{21} in producing the input x_{22}, which is jointly produced with y_n.

Parallel to the case with impure jointness, there is, however, no mechanism ensuring that the use of the private input factor x_{12} in producing the public good z_2 is optimal. Again this is so because the firm is not paid directly for producing z_2. It does not meet p_{z_2}, only p_y^n. This loss of precision must, however, be compared with the reduced transaction costs associated with paying only via y_n. Also in this case an alternative could be to pay for using via a change in the price of x_{12}. Concerning the problems involved with this solution, I refer to the discussion in 4.3.2.

What happens to the conclusion if the intermediate product – i.e., the input x_{22} – has a negative effect on the public good – i.e., if $\frac{\partial z_2}{\partial x_{22}}<0$ (and $\frac{\partial x_{22}}{\partial y_n}$ still positive)? If taxing the negative externality directly is too costly (high transaction cost), corrections may be undertaken by reducing the price of y_n. The reasoning parallels the previous case with, e.g., a positive external effect via x_{22}. Also in this case, there is the possibility of regulating via a traded input. One may restore optimality at the margin by taxing the input factors x_{11} and/or x_{21}, which in equation (9) are the sources of the problem.

Let us look at x_{11} to illustrate. In optimum we have:

$$\frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n / \partial x_{11}}{p_y^w + p_{z_2} \frac{\partial z_2}{\partial x_{22}} \frac{\partial x_{22}}{\partial y_n}} = \frac{p_{x_{11}}}{p_y^n} \tag{13}$$

where $p_{x_{11}}$ is the price for x_{11}. Since p_{z_2} in this case is negative, optimality can – as emphasized - be obtained by keeping $p_y^n \prec p_y^w$. The same resource allocation can, however be secured by increasing $p_{x_{11}}$. It is the relative prices that count.

The latter option may be interesting if there exists a substitute for x_{11} in producing y_n.[24] Compared to reducing the price of y_n, increased precision may then be obtained by taxing x_{11} instead. If x_{11} is nitrogen fertilizers, ammonia in manure could be a substitute that may be better utilized by increasing the price of fertilizer N. If x_{11} is pesticides, organic or mechanical methods would be favored. Transaction cost should be similar in the two cases, since both y_n and x_{11} are marketed goods. On this basis taxing the input should be the preferred solution. Compared to 'the ideal' – taxing the emissions – precision is certainly lost in both cases. The increased transaction cost connected to this solution may, however, make the 'ideal' inefficient.[25]

4.3.4 Optimal policies when the public and private goods are competing

Turning to z_3 – a public good that is neither joint nor complementary to y_n. Instead it is competing with y_n over the input x_{11}. In this case the only option is to pay directly for the good via public funding. The basic question to evaluate is whether the value of z_3 is high enough to pay for the combined production and transaction costs.

This is the standard conclusion that is normally defended for any public good – recall the citation from Bhagwati (2002). There is no need for further elaborations. Instead one may at this stage be motivated to look closer at the previous conclusions favoring extra pay for y_n under certain circumstances. Since y_n and z_3 are competing over x_{11}, would not this solution distort the market for x_{11} and thus for z_3? The conclusion is no. Remember the arguments for raising the prize of y_n. It was motivated by the fact that this was the least costly way to obtain desired increases in the volumes of either the joint good z_1 or the complementary good z_2. Thus, by raising the level of y_n, enhanced utility is obtained via increased volumes of z_1 or z_2. Potential increase in the prize of x_{11} is a standard reflex of this demand and incentives are consistent with the underlying preferences.

[24] Be aware that such substitution possibilities are not built into the formal model presented in the text, though.
[25] For a formalized evaluation of this issue, see Vatn (1998).

4.3.5 Concluding remarks

The above illustrations show that if jointness or complementarity is involved, it is not rational to use direct payments as a universal rule for the public good elements of a multifunctional agriculture.[26] It may be more reasonable to pay via the joint private good. The immediate implication of this is that free trade in private goods could impede the least-cost solutions. There are – as we have seen – two issues of specific interest: a) the degree to which a country's agriculture is internationally competitive, and b) the level of transaction cost associated with the various policy options. The first issue is important in the case of jointness and complementarity, since the lower a country's ability to compete in the markets for the private goods is, the lower will the 'free' delivery of joint products be. The lower this level is, the further away the country will find itself from optimal supply of these products. The second issue concerns, what is then optimal to do. Should one pay directly for the joint/complementary products or should one use the private goods as 'proxies' and thus reduce the transaction costs involved. Let us now look more thoroughly at the latter issue.

[26] Following Baumgärtner (1999) these types of interrelationships will, due to the laws of thermodynamics, always be the involved.

5. HOW IMPORTANT ARE TRANSACTION COSTS?

While high precision – i.e., targeting – for very good reasons is a strongly appreciated characteristics of any policy (WTO 1995; OECD 2001), we have recognized that it has its costs. The aim of this coming chapter is to go deeper into the issue. We will first look at why transaction costs may vary. Here we will refer some of the observations made about transaction costs in markets and organizations and transform them to our field – i.e., agricultural policy. We will conclude by producing a set of hypothesis for why transaction costs may vary. This part will be followed by a survey of existing international studies concerning the level of transaction costs for a set of policy measures in agriculture. Finally, we will present an empirical study where the hypotheses mentioned are tested on a material obtained from a study of policy measures used in Norwegian agriculture.

5.1 Why do transaction costs vary – a theoretical introduction

The literature on transaction costs has dominantly been focused on the organization of the economy: Why do firms exist – i.e., why are not all transactions made in markets? (Coase 1937[27]). Why do market organization and contract systems vary between different types of goods? (Williamson 1975, 1985, 1993; Eggertsson 1990; Furubotn and Richter 1998; North 1990). In this tradition – some term it transaction costs economics – it has been strongly emphasized that the costs of running the economic system is as important for efficiency as are the production costs. The basic idea is that the various types of market structures – i.e. the institutions of capitalism – are the result of a search for reduced transaction costs. Williamson (1985) emphasizes that 'the transaction cost approach maintains that these institutions have the main purpose and effect of economizing on transaction costs' (p. 1).

While there are opponents to such a conclusion claiming that the perspective is too narrow (e.g., Dietrich 1994; Groenewegen et al. 1995; Pitelis 1993)[28], authors like Williamson have done a very important job in defining which aspects explain why transacting is costly in some

[27] Actually Coase, in his famous paper on 'The Nature of the Firm', never used the concept of transaction costs. Still, it was these kinds of costs that in his mind made some types of coordination less costly to handle within the command system of a firm (hierarchy) as opposed to market transactions.
[28] These authors focus also on the role of interests and power relations as opposed to pure efficiency considerations. They furthermore emphasize the relationships within an economy are not only individual and contractual. They are also social and cultural. According to this position, institutions thus have a much more complex role than to foster efficiency.

cases and less so in others. While Williamson uses these factors and mechanisms to explain variations in market structures, we will utilize his work as a basis for setting up hypotheses concerning under which circumstances one should expect transaction costs to be either high or low in a public policy context.

5.1.1 Some basic propositions made in transaction cost economics

According to Williamson (1985) 'The principal dimensions with respect to which transactions differ are asset specificity, uncertainty, and frequency. The first is the most important and distinguishes transaction costs economics from other treatments of economic organization, but the other two play significant roles' (p. 52). The concept of asset specificity relates mainly to the qualitative aspects of a good. Ordinary commodities like a special brand of sugar candy are homogeneous in quality and do thus not vary between transactions. They are 'non-specific' in Williamson's terms. At the other end of the scale, we have goods that are 'idiosyncratic' – i.e., goods that are specific to the transaction like the construction of a new building, the development of a park or the undertaking of a surgery.

In the latter cases all transaction costs elements, as defined in Chapter 3, will increase in magnitude as compared to the case of homogeneous goods. Information costs are often large – not least because there is no or little prior experience concerning what is exactly to be transacted. Contracting is complicated. The qualities of the good to be transacted have to be defined specifically for the single transaction. Finally, the control of what has been delivered is also demanding. There is first off all much to be controlled, and it will normally be impossible for the parties to define all aspects of the good in the contract. The quality of the good is ex post to the transaction, making ex post contracting part of the control so to speak.

The latter aspect points towards the importance of the behavioral assumptions underlying the analysis. The problems involved in making ex ante contracting complete should not appear if actors were completely rational and had full information. While authors like Eggertsson (1990) base their analysis on complete rationality, Williamson supports the Simon (1959) position of bounded rationality. Given this perspective transaction costs become important also because humans do not have the capacity to make complete ex ante contracts. This opens up for opportunism or 'behavioral uncertainty'. Other types of uncertainties focused by

Williamson are more in line with what is normally focused in the economics literature, like stochastic variation in the market or in the production systems.

Turning to the frequency aspect, we note that this is an issue to which Williamson attaches more weight again than uncertainty – at least uncertainty of the traditional ('non-opportunism') kind. The main point is that each transaction demands set up costs. The more repetitive the transactions are, the less important do these costs become. Partly, this has to do with the fact that there are fixed transaction costs that can be spread over more transactions. It is, however, also important that learning about how different firms, agencies or individuals treat agreements will influence transaction costs related to future contracts. They will affect the form and importance of opportunism in Williamson's terms. Increased frequency implies increased trust.

5.1.2 Transforming to the agricultural policy field

Compared to the issues we are studying – agricultural policy and non-market goods – there are several issues that differ from the basic assumptions underlying Williamson's analysis:

- Firstly, we are focusing on the variation in transaction costs themselves and not their role as an intermediate factor in explaining market structures.

- Secondly, we are studying transactions that are (dominantly) related to non-market transactions. They concern relationships between public authorities and farmers. Furthermore, most of these relationships are not in the form of voluntary contracts. They rather concern publicly defined policy ramifications for performing agriculture.

- Finally, when trying to explain variation in transaction costs involved in agricultural policy, one must acknowledge that ordinary markets already exist for many of the goods produced or consumed by agriculture – the private ones. In situations where policies can be attached to existing commodity transactions, the attached information and control costs should be expected to be very low. In other situations information may have to be acquired specifically, increasing both information and control costs.

Thus, transaction costs may vary dependent on whether a policy can be attached to a good that is already marketed or not. This is an aspect of no relevance in Williamson's setting, but becomes very important in ours. On the basis of this, we will assume that transaction costs in implementing agricultural policy will vary according to the following:

1) Does important information already exist as an effect of involved market transactions, or does it not.
2) The degree of asset specificity involved
3) Frequency
   a) How often the transaction is undertaken
   b) How many transactors or agents can be treated similarly

There might be uncertainty attached to both elements 1) and 2). So instead of making uncertainty a separate point, it will be included in the discussion of each of these elements.

Market information about the transaction do already exist

Several agricultural policies use marketed goods as point of instrument application – e.g., subsidies or taxes that alter the relative price of these goods. One example is price support paid to increase prices at the farm gate. Others are taxes on, e.g., mineral fertilizers or pesticides. Information about volumes, type and quality will exist as a function of the needs involved in the market transaction itself. Thus, the only extra cost for the policy is to acquire this information and control its quality.

The latter costs may vary according to which marketing systems are involved. Let us look at the informational needs first. As an example, milk is under Norwegian conditions marketed mainly through a national cooperative. There are only two other actors involved. In the case of pesticides the number of wholesale dealers is larger. How often information must be transferred will also play a role. Finally, the direction of payment may make a difference. In the case of price subsidies, the state needs the information to designate its payments. In the case of a tax on inputs like fertilizers and pesticides, it is the marketing organization itself that collects the money, while the payments to the state may be arranged in different ways.

Concerning uncertainty and the need for control, the requirements of a certain policy may be different from the needs of the market – i.e., the marketing data do not give all information necessary, or data of little importance in the market transaction become crucial in the policy context. Certainly, the existing relationships between the different marketing organizations and the state may influence the needs for control. The greater the cost for the marketing agency of being caught in delivering wrong information, the less important the role of specific controls is.

Our hypothesis is that if information already exists in the marketing system, this has a significant impact on the level of transaction costs. This is especially the case if the policy can be constructed solely on the basis of this information. This is even more so if the necessary control is already built into the existing system. Furthermore, in the cases where the goods involved are marketed through ordinary 'mass' market channels, asset specificity is almost per definition low and frequency high. Thus, in cases of the above described kind, the mechanisms seem to be such that when the first element of transaction costs – information costs – is low, then the transaction costs attached to the two other elements – asset specificity and frequency – are also low.

Asset specificity

Asset specificity concerns variation in the quality of the good. If the public good is jointly produced with the private, asset specificity may be of importance if the value of the joint public good varies let us say between areas, types of production etc. While data is already available and the payment can be attached to a private good, transaction costs will increase somewhat if payments must vary between areas, productions etc.

Still, asset specificity becomes far more important in cases where payments are made for the public good more directly. This has to do with two factors:

- How specific or idiosyncratic is the good (or the proxy for the good)?
- How complex is it?

If the good is very specific – e.g., a local piece of landscape or a certain stone fence that one wants to maintain or develop – information gathering and contracting can be undertaken only for each concrete case. There are often few or no options for utilizing standardized routines, and the solution must be sought on the basis of an on the spot type of information.

Complexity adds to this story. If the good (proxy) consists of many elements, there is much information needed both to evaluate and to undertake control. Thus transaction costs may increase substantially. If the elements are relational, if they cross property borders, etc., transaction costs may increase even more. The specific point about complexity is that the value of easily observable proxies reduces substantially. In our language, proxies become imprecise and the policy makers may find it preferable to look for options with both higher precision and higher transaction costs.

Asset specificity often implies asymmetric information, increasing the danger of opportunistic behavior or moral hazard – to utilize the concept used in regulation theory. The transaction costs related counterpart of this is need for increased control or greater emphasis on trust building.

The hypothesis underlying this work is that asset specificity is the factor that has the greatest impact on transaction costs. Again there are implicit relations to the other factors. Asset specificity may in itself obstruct market transactions of involved goods, implying that no or little information is available in the market place. Furthermore, asset specificity implies often very low frequencies. The effect of this is that the fixed cost components can be divided on only a few other transactions.

Frequency

Frequency mainly affects transaction costs through how often the transaction is undertaken and how many operations or agents that can be treated similarly. If market information already exists – e.g., information about volumes and relevant quality aspects, etc. – transaction costs will normally be low, but still dependent on the number of agents involved and the size of each agent's operation. This is because some fixed transaction costs will always be involved. If market information does not exist or is incomplete, frequency will normally be low and transaction costs will similarly increase. Often the process of information gathering and contracting becomes specific for each single transaction.

Concerning the case with necessary information already gathered, transaction costs will not only depend on the number of agents and the volume of each agent's operation. It will also depend on how available the information is. As already mentioned, it may make a difference if the information necessary for the public authorities can be achieved from one source or must be acquired from several sources. We still believe that this is of minor importance compared to the other aspects mentioned.

5.1.3 Summary

The main points from the above discussion are summarized in Table 5.1. When constructing the table we have utilized the fact that some combinations of values concerning the three main factors – existing information, asset specificity and frequency – are found rather unlikely. We have furthermore made distinctions using a fairly coarse ordinal scale – i.e., low, medium and high. While we in our empirical study have not been able to make a strict distinction between the various transaction cost elements, they are still included in the table to specify as far as possible the relationships we believe are involved.

Table 5.1. Expected level of transaction costs given various characteristics of the transactions involved.

Transaction costs elements	**Characteristics of the transaction and the good involved**				
	A: Policy measures attached to commodities		**B: Policy measures applied to other elements than commodities**		
	Asset specificity Low		**Asset specificity** Medium		High
	Frequency High **(A1)**	Medium **(A2)**	**Frequency** Medium **(B1)**	Low **(B2)**	**Frequency** Low **(B3)**
Information	Low	Low to medium	Medium	Medium to high	High
Contract	Minimal	Minimal	Medium	Medium to high	High
Control	Minimal to low	Low to medium	Medium	Medium to high	High
Total transaction cost	Minimal to low	Low to medium	Medium	Medium to high	High

According to the table, low transaction costs are expected in a situation where the information necessary for running the policy already exists in the present commodity market organizations and frequency is high. This situation furthermore implies that asset specificity is low. In concrete terms this will be policies like product subsidies, input taxes etc.

At the other end we have the idiosyncratic goods where no prior information is readily available, asset specificity is high and frequency is low. Examples of such policies may be direct support for specific cultural heritage assets, landscape goods etc.

Certainly, in comparing across the above groups it may be difficult to find a common unit of measurement. We have chosen to measure transaction costs as a percentage of the amount of money used for each policy. This is not unproblematic since increasing a per ha payment will – as an example – result in reducing the transaction costs as a percentage of program costs. Thus we will support the percentages obtained also with costs per transaction.

5.2 What do earlier studies say?

A few studies have been undertaken on transaction costs of agricultural policy programs. In the following section we will give an overview of results from the most important of these studies as background for the more detailed presentation of the Norwegian study.

5.2.1 Transaction costs of the Swedish Agri-environmental program

Eklund (1999) studied transaction costs involved in the Swedish Agri-environmental Program. The program was implemented in accordance with EU Regulation 2078/92.[29] She did a quantitative estimation of three measures in the program. Eklund also presented results from a study of two other policy measures where she built on material from the Swedish Board of Agriculture. The five measures were:

1. Preservation of bio-diversity in semi-natural grasslands and in mowed meadows
2. Preservation of cultural heritage values in the agricultural landscape
3. Preservation of an open landscape in the north of Sweden and in forest areas
4. Livestock payments (per head)
5. Arable area payments (per ha)

[29] Council Regulation (EEC) No. 2078/92 on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside.

All policy measures that Eklund discusses use other elements than commodity transactions as point of instrument application – i.e., they depend on separately collected information. The degree of asset specificity is high for both bio-diversity and cultural heritage, while the asset specificity is medium for the measure on open landscape. Eklund (1999 p. 61) writes: "…more complex and heterogeneous goods give rise to higher TC. "Open landscape" is assumed to be the easier good associated with lowest transaction costs". The degree of asset specificity should be the lowest for the support schemes for livestock and arable land.
We do not know how standardized the treatment of each agent is for the different policy measures. Again one should expect, though, that the payments per livestock and acreage are carried out both in larger volumes and in a more standardized way than concerning at least bio-diversity and cultural heritage.

The Eklund study covers only the transaction costs that the state/public agencies have and not those that the farmers have to carry. Thus, one must expect the levels to define a lower bound.

Table 5.2 gives the results. According to the table, transaction costs – measured as percentage of payments to farmers – are highest for preservation of cultural heritage followed by preservation of biodiversity and then preservation of open landscape. Transaction costs are lowest for animal grants and agri-environmental policies. Thus, the observed picture fits well with what was expected.

Table 5.2 Transaction costs for the state/public agencies for a set of Swedish agricultural policy measures, in million SEK and as percent of payments to farms

Type of measure	Payments to farms (million SEK)	Administrative TC (million SEK)	Administrative TC as percentage of farmer payments
Preservation of an open landscape[1]	593	49,3	8,3%
Preservation of bio-diversity[1]	216	29,2	13,5%
Preservation of cultural heritage[1]	245	40,5	16,5%
Arable area payments[2]	3836	103,0	2,7%
Livestock payments[2]	791	32,1	4,1%

1) For the year 1997
2) For the year 1996
Source: Eklund (1999)

5.2.2 Transaction costs for the English environmentally sensitive areas

Falconer et al. (2000) explore transaction costs for one agri-environmental policy scheme, the English environmentally sensitive area (ESA). The ESA scheme aims to maintain, improve and extend habitat or landscape features on agricultural land by voluntary management agreements. Even Falconer et al. reports only the transaction costs of the involved public agencies

As in the Swedish case, ESA applies a non-commodity point of instrument application. The degree of asset specificity is considered medium to high. Management prescriptions and payments are unique to each area: farmers choose from menus of management options with fixed compensation rates. Hence, the measure is specific for each area, while unspecific within. Habitat and landscape features are rather complex goods. This could imply that there is much information both to acquire, evaluate and to control. The study does not tell to which degree agents can be treated uniformly, the size of each agent's operation or how often the transaction is undertaken.

In 1995 the payments to the farmers through ESA were £82.6. As to transaction costs, £12.4 was used on information, contracting and policing, and £5.1 was used on environmentally monitoring costs (evaluation). This implies that the total transaction costs for the public agencies as percent of subsidy was 21.2 for ESA.

Falconer et al. (2001) estimated transaction costs functions using panel data spanning five years for the 22 environmentally sensitive areas (ESA) in England. This analysis shows that the number of scheme agreements is an important determinant of annual ESA administrative costs. There appears to be some economics of scale related to scheme participation, perhaps implying that larger, more general schemes could be cheaper to implement than a set of smaller schemes focused on particularly agri-environmental aspect of localities.

Furthermore, the costs seem to decrease over time. This suggests a potential for cost savings form fine-tuning and learning processes that occur. After a few years the balance will switch from set-up activities into contracts and more routine maintenance activities.

The number of management options is an aspect of asset specificity. It did not appear to be any significant effect linked to that number on administrative costs. This aspect of asset specificity can therefore not contribute to explain the level of the transaction costs according to the results of Falconer et al. (2001).

5.2.3 Transaction costs for agri-environmental schemes in eight EU member states

Falconer and Whitby (1999) have studied public sector transaction costs for almost forty agri-environmental policy schemes across eight EU member states. The countries are allowed great flexibility when designing schemes. The aim of the studied schemes is to reduce negative externalities of agriculture or to stimulate positive externalities through influencing land management. The schemes are based on voluntary compensated management agreements.

Falconer and Whitby (1999) also present estimations for transaction costs related to arable area payments, livestock payments, set-aside payments, beef payments and sheep payments taken from Lampe (1994), Kumm and Drake (1998) and MAFF/IBAP (1997).

Again we observe that all policy measures involved apply non-commodity points of instrument application. Still there are proxies involved, and those are generally more complex for agri-environmental schemes than arable area payments, livestock payments, etc. However, none of the policy measures are very specific. Flat-rate payments are for example used for most of the agri-environmental schemes, rather than individually negotiated payments.

The study does not give information concerning the treatment of agents – e.g., how large groups that are treated similarly, how often the transactions are undertaken, etc. We do know however, that the transactions are undertaken annually for arable area payments and livestock payments.

Agri-environmental schemes in Belgium have been implemented on a relatively small scale, compared to for example Sweden. The UK data-set included figures for some very small-scale schemes. Frequencies are therefore low when it comes to how many transactors that can be treated similarly for Belgium and some of the schemes in UK, while frequency is higher for Sweden.

Table 5.3 gives an overview of the main results:

Table 5.3 Weighted annual transaction costs (TC) for case-study agri-environmental schemes (AES) in each EU-member state in the mid 1990s and the transaction costs of agricultural commodity regimes

Country	Type of measure	Average annual TC, ECU per hectare	Average annual TC, ECU per participant	Average annual TC, ECU per 100 ECU paid as compensation	Administration as a % of total public scheme costs
Austria	AES	20,5	216,9	8,8	
Belgium	AES	58,6	388,6	63,4	
France	AES	75,6	1522,0	87,1	
Germany	AES	10,2	177,5	12,3	
Germany	Arable area payments				4
Germany	Livestock				20
Greece	AES	59,7	470,1	8,6	
Italy	AES	13,1	140,0	6,6	
Sweden	AES	9,1	190,4	11,3	
Sweden	Arable area payments				3
Sweden	Livestock payments				4
UK	AES	48,0	2445,5	47,9	
UK	Arable area payments				0,8
UK	Set-aside				3,4
UK	All crops and set-aside				1,4
UK	Beef payments				4,9
UK	Sheep				2,5

Source: Falconer and Whitby (1999), Falconer and Whitby (1999) have taken some of the numbers from Lampe (1994); Kumm and Drake (1998); MAFF/IBAP (1997)

The amount of transaction costs for agri-environmental schemes and the other schemes are not directly comparable, since the transaction costs for agri-environmental schemes are expressed as percent of compensation payments, while transaction costs for the other schemes are expressed as per cent of total costs. However, agri-environmental schemes appear generally to be more costly to administer, relative to arable area payments, livestock payments, etc. Thus the picture from the previous studies is mainly replicated. Percentages for the agri-environmental schemes vary between 7 and 87.

The results gave some support to a hypothesis that economies of scale exist in agri-environmental scheme administration. Both Belgium and UK have higher transaction costs than Sweden. Frequency may therefore explain at least some of the difference in transaction costs between the three countries.

Falconer and Whitby (1999) also analyze some examples of particular agri-environmental schemes in Germany and France. These selected from those included in the average AES figures referred in Table 5.3. Frequency and the degree of asset specificity vary between these selected agri-environmental schemes. Both the KULAP[30] agri-environmental schemes in Germany and *prime à l'herbe*[31] in France, have a strong income orientation, and are characterized by broad approaches covering the whole territory. Transaction costs are therefore expected to be low for these schemes both due to the use of unspecific proxies and high frequency of similar transactions. Another example is the MEKA[32] agri-environmental scheme in Germany that has a very high acceptance rate with a large area under the policy and a relatively simple scheme application procedure. The opposite counts for the FUL[33] scheme in Germany that has low participation and payments that are targeted on selected plots. MEKA is therefore characterized by low asset specificity and high frequency when it comes to how many transactors that can be treated similarly, while the FUL scheme is characterized by asset specificity and low frequency when it comes to how many transactors that can be treated similarly.

The empirical results show that the KULAP scheme, in Germany and the scheme, *prime à l'herbe*, in France have low administrative costs relative to total scheme spending for agri-environmental policies. The MEKA scheme in Germany had lower administrative cost than the FUL scheme. Again we find support for the hypothesis that asset specificity and frequency are important determinants of transaction costs levels.

5.3 Transaction costs for a selection of Norwegian agricultural policy measures

We will now move to our own study based on Norwegian material, where we have quantified the transaction costs of eleven different agricultural policy measures. The main difference compared to the studies documented above, is that we have looked at policy measures where instruments are applied to both *commodities and non-commodities*. We thus cover examples where the instruments are applied to traded and non-traded inputs, to production methods, and

[30] KULAP is a cultural landscape scheme (Kulturlandschaftsprogramm)
[31] *prime à l'herbe* is a support scheme for less intensive agriculture.
[32] MEKA is a market relief and cultural landscape scheme (Marktentlastungs- und Kulturlandschftsausgleich)
[33] FUL is a scheme that supports environmentally friendly agriculture (Förderprogramm Umweltschonende Landbewirtschaftung) like for example environmentally friendly methods (Agrarinfo 2002).

finally more directly to private or public goods/bads accompanied with agricultural production. It should also be mentioned that our study cover transaction costs carried both by *public authorities and farmers*.

5.3.1 Method

Transaction costs are quantified through interviews with representatives from the different public administrations, whole-sellers and farmers involved. The costs cover labor costs, general overhead as calculated per man year, computer costs, costs related to information material and postage.

We would have liked to quantify both set up and running costs. It has however been very difficult to find data on the costs of establishing the various policy instruments since this in all the chosen cases has happened some time ago. We therefore had to reduce our ambitions and focus only on running costs.

There exist no internal procedures in the involved administrations splitting transaction costs/administrative costs on the various policy measures these administrations are responsible for. Thus we had to make assessments together with the involved people about how to split these. Certainly, a lot of judgment will always have to be involved in a calculation like ours. One should be aware of the uncertainties implied.

We interviewed representatives from each of the administrative levels involved. Concerning the county and municipal levels, we selected one county and one ‘commune’ as representative for the whole group. Certainly, some replication – especially at the lowest level – would have increased the quality of the results, but could not be done due to financial constraints.

In eight out of eleven policy measures, there are some transaction costs also at the farm level. A number of farmers – from 4 up till 22 dependent on the type of instrument – were interviewed to get the necessary input about farmers’ costs. Again increasing the number of farms could have been of value in some cases.

Some transaction costs are joint for two or more policy measures. Furthermore, in cases where policy measures are applied to existing commodities, the administration of the instrument overlaps the administration of the market transaction. There are no *a priori* rules existing concerning how such joint transaction costs should be divided. We have based our choices on the thinking presented in Chapter 5.1. In cases where policy measures are applied to existing commodities, the system for operating the market must already be in place. Thus the costs for the market actors are the transaction costs following from running a system on top of the already existing marketing system.

Concerning the costs for the public administrations, the same body or office may administer several policy measures. In some cases the degree of jointness has been such that it has been impossible to split the costs on the various instruments according to specific data on time and resource use. In these cases we have split the costs evenly between policy measures on the basis of the amount of applications, etc.

The transaction costs are presented as percent of payments to farmers/taxes in 2000. This number is very sensitive to the level of the payments, and must be treated with care. The costs are therefore also presented as costs per unit of the good/'proxy' the payments/taxes are attached to – i.e., per ton of milk, per animal, per hectare, etc.

The number of years since a policy measure was established could influence the annual running transaction costs. Cost savings from fine-tuning and learning processes are likely to occur over time, confer Falconer et al. (2001). We have not considered this aspect.

When studying the eleven support schemes, we will give some background information about them, characterize the type of transaction involved and finally present the data concerning the level of transaction costs involved. Since this is not a study of the policy itself, we will not discuss the quality or relevance of each measure. We will thus just give a brief presentation of the motivation behind each of them as given in official policy documents. Our analytical focus is on the level of the transaction costs and how to explain the variations in these.

Support schemes are chosen to cover the various groups of Table 5.1. The aim was to get at least two policy measures of each category. We will start our presentation with those instruments where one should expect the lowest transaction costs (A1) and cover all groups up till the most complex situation (B3). Especially in the groups B2 and B3 we had some problems with finding good examples since there are few such schemes.

5.3.2 Price support for milk (A1)

The policy measure

Farmers who produce goat or cow milk receive price support per liter of milk they deliver. The price support is divided in a) basic support which is a per liter subsidy equal for all, and b) district support, which is distributed on the basis of regional criteria. The official purpose of the basic support is to contribute to a development in income and production at a level beyond what can be attained through the market. The measure shall also contribute to cheaper dairy products to consumers. The purpose of the district support is to contribute to a development of income and production contributing to maintenance of settlement and employment in rural areas (Ministry of Agriculture 2000a).

The Norwegian Agricultural Authority administers the price support on behalf of the Ministry of Agriculture. The Agricultural Authority transfers the payments through the dairy companies to the farmers. The dairy farmers receive the price support on milk together with the payments from the dairy company.

Characteristics of the transactions involved

This is a support scheme of category A1 – the policy measure is attached to a good that is marketed. Information about volumes and types exists independent of the policy. Milk is mainly marketed through a national cooperative. Only two other actors are involved. Hence, the cost of acquiring the needed information from the market is expected to be rather low. Concerning the basic support, the information requirements for the policy measure are equal to those needed for the marketing. The district support, however, requires specific information about where the milk is produced.

Asset specificity is low for milk.[34] The only variation in the quality that is relevant in our case is whether it is cow or goat milk. In general, information gathering and contracting should also be low cost. Asymmetric information seems not to be a big problem for price support on milk. The necessary control costs are in place as part of the ordinary marketing. The policy administration must, however, control that the dairy companies actually transfers the price support to the dairy farmers.

[34] Certainly, defining the quality of milk is not a simple task. The content of fat, protein etc. and the bacteria level have all to be measured. These procedures are necessary for the marketing purpose and do not imply any costs for the specific subsidy scheme studied here.

The price support is transacted quarterly. The total number of farmers that receive price support to milk and the size of each agents operation are furthermore large. Frequency is therefore high in this case. Farmers receive a support of 520 millions NOK (own calculations based on Budsjettnemda 2001, Arnesen pers mess., Hundnes pers mess.) for the production of 1580 millions liter milk (own calculations based on Arnesen pers mess., Hundnes pers mess.).

The expected level of transaction costs is summarized in Table 5.4.

Table 5.4 Expected level for transaction costs (TC) for price support on milk

Characteristics of transactions	Expected level of TC involved in price support on milk
Information from commodity markets exists	Yes (low costs)
The degree of asset specificity	Low
Frequency	High
Expected level of TC	Minimal to low

Empirical findings

Only one of the three national dairy companies is participating in the study. This dairy company had a market share of 99 percent in 2000 (Hundnes pers mess.). The local dairy cooperatives have no transaction costs related to transferring price support on milk (Arnesen pers mess., Lilleby pers mess.).

Price support on milk is administered together with price support on home-refined dairy products (see Chapter 5.3.4). It has been difficult for those interviewed to split the transaction costs between these two measures. The best advise from the Ministry of Agriculture and the dairy company was to divide the transaction costs on the basis of how many tons of milk that received support under each policy measure. Table 5.5 gives the results.

According to the table, total transaction costs amount to 0,24 percent of the subsidy. This is very low compared to the figures referred to in the previous chapter concerning not only agri-environmental schemes, but also per acreage and per livestock payments. As we will soon see, they are also low compared to such measures in Norway. The data thus supports our hypothesis. We also see that the transaction costs for the national dairy cooperative covers the greatest share of the total transaction costs.

Table 5.5 Transaction costs (TC) for price support on milk, as per cent of farmer payments and per ton milk

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of subsidy	TC (NOK) per ton milk
Ministry of Agriculture			0,01	0,03
Norwegian Agricultural Authority			0,04	0,13
National dairy companies			0,19	0,63
Total	520 153 321	1 253 000	0,24	0,79

5.3.3 Environmental tax on mineral fertilizers (A1)

The policy measure

From 1988 till 2000 Norway taxed mineral fertilizers. The tax was 20 % of the price of nitrogen and phosphorous. The purpose was to reduce loss of nutrients from agricultural production to the environment and collect money to finance measures like fertilizer plans.

The Agricultural Inspection Service administered the tax on behalf of the Ministry of Agriculture. It was also responsible for collecting the tax from producers and importers of mineral fertilizers.

Characteristics of the transactions involved

The fertilizer tax was attached to a marketed product with a large volume – type A1. Hence, information about volumes and types of fertilizers existed as an effect of involved market transactions. The producers and importers were also required to give information on the content of nitrogen and phosphorus in their fertilizers irrespective of the tax system (Ministry of Agriculture 1998).

The costs of acquiring the necessary information may vary according to which marketing systems were involved. There were about 20 producers and importers of mineral fertilizers (Smoland pers mess.). This number is not very large. Furthermore, one producer is dominating the market. Hence, the costs of acquiring the necessary information are not expected to be high.

There is some variation in the quality of mineral fertilizer products. Still, the complexity is low since the relevant quality elements for authorities are only volume of nitrogen and phosphorus. They have to treat each fertilizer product individually, though. The quantity of each is high and the number of transactors few. Thus frequency should be considered high. 106 017 tons of nitrogen and 13 092 tons of phosphorous were taxed at an amount of 158 millions NOK.

The level of the expected transaction costs, based on the characteristics of the transactions, is summed up in Table 5.6.

Table 5.6 Expected transaction costs (TC) of environmental tax on mineral fertilizers

Characteristics of transactions	Expected level of transactions involved in environmental tax on mineral fertilizers
Information from commodity markets exists	Yes (low costs)
The degree of asset specificity	Low
Frequency	High
Expected level of TC	Minimal to low

Empirical findings

We have interviewed two producers/importers of mineral fertilizers. One has a market share of 95 percent. The volumes of nitrogen and phosphorus are based on numbers from the season 98/99 (Agricultural Inspection Service 2002).[35]

The total amount of taxes is calculated on the basis of the tax rate per kilo nitrogen and phosphorous (Smoland pers mess.), and the volumes observed. There is no specific system for controlling the data from the producers/importers. The level of trust thus seems to be high. Table 5.7 presents the costs of the transactions involved in environmental tax on fertilizers.

[35] One of the smallest businesses had particular low volumes of nitrogen and phosphorus in 1999 due to uncertainty about removal of the environmental tax (Jevne pers mess.). We have therefore chosen to use the volumes of nitrogen and phosphorus for an average year in this case.

Table 5.7 Transaction costs (TC) for environmental tax on mineral fertilizers, as percent of tax and per ton nitrogen and phosphorus

Administration level	Tax (NOK)	TC (NOK)	TC as percent of environmental tax	TC (NOK) per ton nitrogen and phosphorus
Ministry of Agriculture			0,00	0,01
Agricultural Inspection Service			0,05	0,65
Producers and importers			0,04	0,50
Total	158 392 170	138 000	0,09	1,16

The transaction costs amount to about 0,1 percent of the tax. This is very low and in accordance with our expectations. The Agricultural Inspection Service carries the greatest share of the total costs. The transaction costs for the producers and importers are – as we observe – very low. There is probably economics of scale in administering this tax. Hence the transaction costs related to this administrative level may have increased a bit if all producers and importers had been interviewed. Still, this can in no way change the conclusion.

5.3.4 Environmental tax on pesticides (A2)

The policy measure

In Norway pesticides are taxed according to their environmental and health risks (Ministry of Agriculture 2000b). The purpose of this tax is to reduce these risks via reduced application levels etc. The level of the tax varied between 19-73 % of the price in 2000.

The Agricultural Inspection Service administers the tax on the behalf of the Ministry of Agriculture. This service also collects the tax from importers of pesticides.

Characteristics of the transactions involved

Again we are in a situation where information about the good the policy is focused at exists as an effect of involved market transactions. The costs of acquiring this information will vary according to which marketing systems are involved. There are about 25 importers of pesticides (Agricultural Inspection Service 2001a) – a fairly low number, but with volumes more evenly spread across the firms than in the case of mineral fertilizers.

The authorities have to acquire information on health[36] and environmental risks of pesticides in addition to information on imported and sold volumes (Ministry of Agriculture 2000b). The tax is differentiated according to the risks. First of all, this is a type of information that has to be acquired separately. Second, the number of products is rather high compared to fertilizers. This implies that asset specificity is higher and frequency lower. 380 ton active substance (Agricultural Inspection Service 2001b) are taxed for an amount of 52,8 millions NOK (Kraggerud pers mess.).

The importers have data on import and sale. The authorities have to rely on quarterly reports from importers and annual accountant certified reports. The needs for control are considered moderate (Kraggerud pers mess.). The level of the expected transaction costs, based on the characteristics of the transactions, is summed up in Table 5.8.

Table 5.8 Expected transaction costs (TC) of a tax on pesticides

Characteristics of transactions	Expected level of transactions involved in environmental tax on pesticides
Information from commodity markets exists	Yes (low to medium costs)
The degree of asset specificity	Low
Frequency	Medium
Expected level of TC	Low to medium

Empirical findings

Five out of about 25 importers of pesticides are interviewed. Their volume of active substance counts for 23 percent of the total volume of active substance. Data concerning the volume of active substance and the volume of the tax is calculated on the basis of data from the Agricultural Inspection Service (2001b) and Kraggerud (pers mess.). Transaction costs are computed per ton active substance.

The number of ton active substance in the year 2000, was rather small compared to the years before. It was for example half of the sales in 1999 (Agricultural Inspection Service 2001b). This was most probably due to the fact that the tax was increased in 2000 and the whole- and retail sellers seem to have made much of their purchase the year before anticipating this.

[36] Information on health risks had partly to be collected anyway due to labelling rules.

There is some control established in this case since an authorized auditor must sign reports. Table 5.9 gives the results.

Table 5.9 Transaction costs (TC) in NOK for environmental tax on pesticides, as percent of tax and per ton active substance

Administration level	Tax (NOK)	TC in NOK	TC as percent of environmental tax	TC in NOK per ton active substance
Ministry of Agriculture			0,02	26
Agricultural Inspection Service			0,13	185
Importers			0,96	1329
Total	52 800 000	585 000	1,11	1540

The total transaction costs amount to 1,1 percent of the tax. This is about ten times the level in the case of fertilizers. It should be recalled that the tax levels were approximately the same. The data thus confirms that lower frequency/higher number of products play an important role. Still, one should also remember that the volumes in 2000 were half the normal levels. The largest part of total transaction costs is with the importers.

5.3.5 Price support on home-refined dairy products (A2)

The policy measure

Price support on home-refined dairy products – mainly cheese – is a special type of price support on milk with the same purposes as ordinary price support on milk. Payments are also here given per liter of milk.

Home-refined dairy products are either sold from the farmer to the national dairy cooperative, or through other channels – mainly directly to individuals (Ministry of Agriculture 2000a). Some additional administration is thus required compared to ordinary price support on milk because of these other channels (Tørud pers mess.). One has also – in any case – to calculate how much milk that was involved when producing the product. The farmers have to make a contract either with a local dairy company or with the Norwegian Agricultural Authority to receive the subsidy[37]. The farmers are also required to deliver a sales report every month they sell dairy products to others than a dairy company (Ministry of Agriculture 2000a).

[37] No contracts have been made with the Norwegian agricultural authority until now (Herland pers med).

Characteristics of the transactions involved

Again information about volumes and types of products exists to a large extent as an effect of involved market transaction. Still, since some fraction of this product is sold outside ordinary market channels, extra costs follow. A special sales report has to be filled out and this data must be collected. Because of this, home-refined dairy products do not fit too well with the logic behind Table 5.1, which is more based on mass consumption commodities. We chose the policy instrument to illustrate this point, and to see how much this fact might influence the transaction costs involved.

If we look at asset specificity, we find that it is low for this policy measure. The only variation concerns whether it is cow or goat milk that is the basis for support. Also in the case of home-refined dairy products support is differentiated regionally. This add an extra need for information. This should not have any important impact on the costs, though.

Concerning asymmetric information, price support on home-refined dairy products has to be evaluated similarly to ordinary milk when sold to the dairy company. In the case the receiver is someone else, the problem is small as long as a milk-quota system is in place and it is profitable for the farmers to utilize their entire quota. Farmers have low incentives of false telling of sold quantities under such institutions.

The price support is transacted quarterly. The total number of farmers that receive price support on home-refined dairy products and the size of each agents operation are rather small, though, and the number of channels used is larger than for ordinary milk. Frequency is therefore medium to low. This is again somewhat counter to what was assumed in the theoretical analysis of Chapter 5.1.

The farmers receive a support of about 1 014 779 NOK (own calculations based on numbers from Budsjettnemda 2001 and Arnesen pers mess.) for the production of 1 664 044 liter milk (Arnesen pers mess.).

The level of the expected transaction costs based on the characteristics of the transactions, is summed up in Table 5.10.

Table 5.10 Expected transaction costs (TC) of price support on home-refined dairy products

Characteristics of transactions	Expected level of transactions involved in Price support on home-refined dairy products
Information from commodity markets exists	Partly (medium costs)
The degree of asset specificity	Low
Frequency	Medium to low
Expected level of TC	Medium

Empirical findings

The National dairy cooperative is the only company, which transfer price subsidy to home-refined dairy products. As opposed to price support on milk, the local dairy cooperatives have some costs related to transacting price support in this case. These costs are mainly related to price support on home-refined dairy products that are sold to others than a dairy company (Tørud pers mess.). Three out of ten local dairy cooperatives were interviewed about their costs of transacting price support on home-refined dairy products.

Farmers that deliver home-refined dairy products to a dairy company do not have any transaction costs related to receiving the subsidy. However, farmers, which sell home-refined dairy products to others than a dairy company, have to deliver sales reports every month and some of them have to make a contract with the local dairy company. Nine of these farmers were interviewed about their costs.

The amount of milk concerned is estimated on the basis of numbers from Arnesen (pers mess.) and numbers from the interviewed farmers. The district support per liter is an estimate based on data from Budsjettnemda (2001) over total district support on milk and home-refined dairy products. The district support to the farmers is based on information from the chosen sample of these. The amount of basic support per liter milk is based on numbers form Budsjettnemda (2001) and Arnesen (pers mess.).

According to Table 5.11 the transaction costs amount to approximately 12 per cent of the subsidy. This number is substantially higher than what was observed for the ordinary milk schemes – measured per ton milk almost 80 times as high. As far as we can see, it is the low frequency, especially the low amount of products involved in each transaction that explains most of this difference. The Norwegian Agriculture Authority and the local dairy cooperative carry the main part of the transaction costs.

.

Table 5.11 Transaction costs (TC) for price support on home-refined dairy products, as per cent of farmer payments, per ton milk

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of subsidy	TC (NOK) per ton milk
Ministry of Agriculture			0,00	0,03
Norwegian Agricultural Authority			5,09	31,05
The national dairy cooperative			0,10	0,63
Local dairy cooperatives			6,13	26,80
Farmers			0,96	5,85
Total	1 014 779	125 000	12,28	64,35

5.3.6 Acreage payments (B1)

The policy measure

We shall now move from policy measures that are attached to commodities and over to systems where the point of instrument application is a non-traded item – i.e., category B in Table 5.1. We will start with goods (proxies) that are fairly easy to observe and where asset specificity is not that high – i.e. the land.

The acreage payment system is one of twelve measures under the so-called *Production support in agriculture.*[38] One main purpose of acreage payments is to strengthen and equalize income between different enterprises, farm sizes and regions in crop production. The other main aim is to maintain and develop cultural landscape through cultivation and to maintain cultivation of agricultural land (Ministry of Agriculture 2001a).

[38] We have altogether evaluated transaction costs for four of these measures – acreage payments, livestock payments, acreage and conversion support to organic farming and support for preserving cattle races – see later. One should observe the name used for this group of measures – production support in agriculture. While all measures are (partly) motivated from a public goods reasoning, the name is directed towards production – i.e., production of commodities as understood by the receivers. This is an interesting issue in itself indicating the difficulties the authorities have with introducing measures that are built on other perspectives than increasing primary production. Vatn (1984) gives several examples of similar 'double-communication' in agricultural policy.

The payments are made per decare of area planted (Ministry of Agriculture 2001a). The Ministry of Agriculture, the county and the local agricultural authorities as well as farmers are involved in the transaction of these payments.

Characteristics of the transactions involved

In this case information about quantity and quality (type of use) of the agricultural land that is entitled to support has to be collected especially. Data are collected once a year.

Asset specificity must be considered low to medium for acreage payments. The payments per decare depend on which crop that is grown, in which geographical zone the cultivation takes place and the size of the area the farmer has planted (Ministry of Agriculture 2001a). Rather standardized routines can be utilized since each of the three characteristics the payments depend on is grouped into intervals. There is some extra complexity involved since the farmer must fulfill some claims to be entitled to acreage payments. Rivers and creeks should not be closed. Stone fences should not be removed, some types of threes not cut, etc.

Already at this stage we see that assuming non-commodities to have medium to high asset specificity – as in Table 5.1 – does not necessary always hold. In this case it is the fact that information has to be gathered specifically for the policy purpose that is the main difference if we compare goods like fertilizers and pesticides. Asset specificity is not much higher.

The information about some of the characteristics of the good is asymmetric. The farmer has full information about whether the land is planted or not, about which crops that are grown and whether the claims to conserve the cultural landscape are fulfilled. The authorities must control the farm on the spot to achieve this information. The control could to some extent be demanding since the good has some complexity.

Frequency is expected to be rather high for this measure – again we observe a deviation from the assumptions behind Table 5.1. The transaction is undertaken annually. The number of agents involved and the size of each agent's operation are rather high. 63 171 farmers and 10 287 362 decares were supported in 2000 (Norwegian Agricultural Authority 2001c and Norwegian Agricultural Authority 2001d).

The level of the expected transaction costs, based on the characteristics of the transactions, is summed up in Table 5.12.

Table 5.12 Expected transaction costs (TC) of acreage payments

Characteristics of transactions	Expected level of transactions involved in Acreage payments
Information from commodity markets exists	No (medium costs)
The degree of asset specificity	Low to medium
Frequency	High
Expected level of TC	Low to medium

Empirical findings

We have interviewed representatives from the agricultural county authority in Akershus and representatives from the local agricultural authority in Eidsvoll. 22 farmers in Eidsvoll were interviewed. The data are separately documented in Lindale (2001).

The size of the area and level of payments for all administration levels are based on data from the Norwegian Agricultural Authority (2001c,d,e,f,g,h). Table 5.13 gives the results for this type of payment.

Table 5.13 Transaction costs (TC) in NOK for acreage payments, as percent of subsidy and per decare

Administration level	Subsidy (NOK)	TC in NOK	TC as percent of subsidy	TC in NOK per decare
Ministry of Agriculture			0,00	0,01
Norwegian Agricultural Authority			0,17	0,54
County authority			0,09	0,24
Local agricultural authority			0,54	1,49
Farmers			0,17	0,47
Total	3 267 347 256	31 359 000	0,96	2,74

The transaction costs amount to approximately 1 % of the subsidy. This number is about the same level as that of the pesticide tax. It seems like the high frequency and rather low asset specificity counteracts the effect of having to set up a special system for collecting data. One may ask if the control is extensive enough. At least we observe that after the system with acreage support was put into place, total acreage increased noticeably. While this must certainly have been intended, the issue is raised whether all these areas are really in use in a way fulfilling the demands of the system. The transaction costs of the local agriculture authority compose the greatest share of the total transaction costs.

5.3.7 Livestock payments (B1)

The policy measure

The purpose of livestock payments is to strengthen and equalize income between different enterprises and herd sizes in livestock production. The payment is based on the number of animals (Ministry of Agriculture 2001c). As with the acreage payments, the Ministry of Agriculture, the national, the county and the local agricultural authorities, as well as farmers are involved in the transaction of this payment.

Characteristics of the transactions involved

The situation is very much like that of the acreage payment. Data has to be specifically collected. Asset specificity is low to medium. Payments are specified per type of animal, the number of animals on each farm, and whether the livestock is located in the south or the north of Norway (Ministry of Agriculture 2001c). Standardized routines are utilized and complexity is rather low. The same issues concerning information asymmetries apply.

Frequency must be considered high. The transaction is mainly undertaken twice a year – January and August (Ministry of Agriculture 2001c). The number of agents involved and the size of each agents operation are rather high. 45 927 farmers and 57 513 977 animals were involved in the January transaction of 2000 (Norwegian Agricultural Authority 2001a,b). The number for August were 31 987 farmers and 5 198 486 animals (Norwegian Agricultural Authority 2001c,d).

The summary of expected transaction costs are thus parallel to that of acreage payments:

Table 5.14 Expected transaction costs (TC) for livestock payments

Characteristics of transactions	Expected level of transactions involved in Livestock payments
Information from commodity markets exists	No (medium costs)
The degree of asset specificity	Low to medium
Frequency	High
Expected level of TC	Low to medium

Empirical findings

Again data from the county of Akershus and the municipality of Eidsvoll makes the basis for the analysis (Lundahl 2001). 10 farmers were interviewed.

The number of animals and level of payments are based on data from the Norwegian Agricultural Authority (2001a,b,c,d,e,f,g,h,i,j,k,l). Table 5.15 gives the results.

Table 5.15 Transaction costs (TC) in NOK for livestock payments as percent of subsidy and per animal

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of subsidy	TC in NOK per animal
Ministry of Agriculture			0,00	0,00
Norwegian agricultural authority			0,26	0,09
County agricultural authority			0,22	0,03
Local agricultural authority			1,16	0,38
Farmers			0,65	1,23
Total	2 088 496 312	47 892 000	2,29	1,73

The transaction costs amount to 2,3 percent of the subsidy. The higher complexity of the good (more categories) and the fact that data are collected twice (still not twice for every farmer) may explain why the result for livestock payments seems to be somewhat higher than the acreage payments. The aggregate subsidy is, however, also significantly lower. Thus one should be careful when comparing the percentages as we observe that transaction costs per reported animal are lower than those per decare. Again we observe that it is the transaction costs of the local agriculture authority that accounts for the largest share of the costs.

5.3.8 Subsidy for reduced tillage (B1)

The policy measure

The purpose of the subsidy for reduced tillage is to reduce erosion – via reducing autumn tillage and stimulating the establishment of vegetation that reduce soil erosion from agriculture. The payment is based on decares of agricultural land with soil management that fulfils certain claims (Ministry of Agriculture 2001d).

The Ministry of Agriculture, the national, the county and the local agricultural authorities, as well as farmers are involved in the transaction of the payments.

Characteristics of the transactions involved

These payments are attached to a particular production method. No information from commodity markets exists about the good. Asset specificity must be considered medium. There are five different management practices that are supported (Ministry of Agriculture 2001d). Payments vary between these five management practices. The support is only given when certain crops, like for example grain, are grown. Payments depend on the erosion risk and to some extent in which county[39] the field is located (Norsk institutt for landbruksøkonomisk forskning 2000). However, standardized evaluations are utilized since the characteristics of importance for the payments are divided into a few intervals.

Different requirements are attached to the five soil management practices. The farmer must for example harrow straight after threshing to receive support for light autumn harrowing. Another claim is that at least 30 per cent of the surface must be covered by straw after light autumn harrowing (Ministry of Agriculture 2001d).

The authorities have information about where the farm is located. The local agricultural authority determines the erosion risk of the fields. However, the information about the other characteristics of the good is asymmetric. The farmer has full information about which crops that are grown and his own tillage practice. The authorities must make controls on the spot to achieve this information. The control may be demanding since the good has some complexity.

[39] or which municipality in the case of Oppland county

This transaction is undertaken yearly. 12 289 agents and 1 367 436 decares were involved in 2000 (Nes pers mess.). Frequency must therefore be considered medium.

The level of the expected transaction costs is summed up in table 5.16.

Table 5.16 Expected transaction costs (TC) of subsidy for reduced tillage

Characteristics of transactions	Expected level of transactions involved in Subsidy for reduced tillage
Information from commodity markets exists	No
The degree of asset specificity	Medium
Frequency	Medium
Expected level of TC	Medium

Empirical findings

We have interviewed representatives from the agricultural county authority in Østfold[40] and representatives from the local agricultural authority in Eidsberg. 10 farmers in Eidsberg were interviewed.

The number of decares and level of payments are based on information from those interviewed on each administration level. Table 5.17 presents the transaction costs for subsidy for reduced tillage.

Table 5.17 Transaction costs (TC) in NOK for subsidy for reduced tillage as percent of subsidy and per decare

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of farmer payments	TC in NOK per decare
Ministry of Agriculture			0,05	0,04
Norwegian Agricultural Authority			0,21	0,21
County agricultural authority			0,68	0,55
Local agricultural authority			2,97	2,23
Farmers			2,90	2,70
Total	132 941 146	9 053 000	6,81	5,72

[40] Østfold county was chosen instead of Akershus because the staff in Akershus had little experience with this measure.

The transaction costs amount to 6,8 percent of the subsidy – i.e., seven times that of the acreage support and almost three times that of the support per animal. Measured as cost per decare they are only the double of the acreage support, though. The latter is certainly the best comparison and is reasonable compared to the higher asset specificity, somewhat lower frequency and extra controls involved. The greatest part of the costs is with the local agriculture authority and with the farmers.

5.3.9 Acreage support to organic farming (B2)

The policy measure

The purpose of support to organic farming is to stimulate maintenance of organic farming. The support shall contribute to compensation of extra production costs and decreased yields, in addition to contribution of increased production of organic products (Ministry of Agriculture 2001b). The payments are based on decares of organic farmland.

The Ministry of Agriculture, the Agricultural Inspection Service, Debio, the national, the county and the local agricultural authority, as well as farmers are involved in the transaction of the payments.

Characteristics of the transactions involved

The authorities need information about the number of decares of land under organic cultivation, the grown species, and information about the production method to make payments to farmers (Ministry of Agriculture 2001b). The two first types of information are not part of any existing files. However, information about the production method may exist already for some organic farms. Reliable labeling systems can be seen as a condition for sale of organic products. Hence, when organic farmers produces for the Debio label, information about the production method already exists.

Asset specificity is medium for acreage support to organic farming. The type of species grown varies between farmers, and there are some complexity involved concerning the production method. Hence, there are some variations in the quality aspects of interest to the authorities.

The information about how many decares that are cultivated organically, what kind of species that are grown or the production method is asymmetric. The authorities must control the data on the spot to achieve the necessary control. The control is rather simple in the case of which species are grown and the number of decares, since complexity is low for these characteristics. However, control of the production method is rather demanding since it consists of many elements.

The transaction is undertaken once a year (Ministry of Agriculture 2001b). 1929 farmers received 19 millions NOK in acreage support for 170 925 decares of organic land in 2000 (Norwegian Agricultural Authority 2001a and Norwegian Agricultural Authority 2001b). Frequency is therefore low for this policy measure.

The level of the expected TC, based on the characteristics of the transactions, is summed up in table 5.18.

Table 5.18 Expected transaction costs (TC) for acreage support to organic farming

Characteristics of transactions	Expected level of transactions involved in Acreage support to organic farming
Information from commodity markets exists	No
The degree of asset specificity	Medium
Frequency	Low
Expected level of TC	Medium to high

Empirical findings

Representatives from the agricultural county authority in Akershus and representatives from the local agricultural authority in Aurskog-Høland were interviewed. 17 farmers from Aurskog-Høland were interviewed.

Transaction costs related to controlling the production method is not relevant for farmers that participate in the labeling system. It has however not been possible to divide between farmers that participate in the labeling system and farmers that do not, but still farm organically. These data are in separate files, which we could not combine. The costs of the Agricultural Inspection Service, Debio and farmers' transaction with Debio are costs of controlling the production method. We have chosen to present total transaction costs with and without the costs associated with the control of production method.

Acreage support to organic farming is administered together with conversion support to organic farming. It has been difficult for the Ministry, the Agricultural Inspection Service, Debio and the local agricultural authorities to split their costs between the two measures. The best advises from them were to divide costs on the basis of how many decares that received support under each policy measure.

Some of the organic farmers receive both acreage and conversion support. So even in this case a split on the basis of the number of decares that received support under each policy instrument was necessary.

The number of decares and level of payments for all the administration levels are based on statistics from Norwegian Agricultural Authority (2001a,b,k,l,m,n). Table 5.19 gives the figures.

Table 5.19 Transaction costs (TC) in NOK for acreage support to organic farming, as per cent of farmer payments and per decare

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of subsidy	TC in NOK per decare
Ministry of Agricultural			0,09	0,10
Norwegian Agricultural Authority			4,80	5,38
Agricultural Inspection Service			0,12	0,13
Debio			36,53	40,96
County agricultural authority			0,67	0,84
Local agricultural authority			10,57	14,52
Farmers, transactions with the state			2,20	3,38
Farmers, transactions with Debio			8,29	12,75
Total, included control of production method	19 169 023	12 128 000	63,27	78,07
Total, excluded control of production method	19 169 023	3 515 000	18,34	24,23

The costs amount to 18 per cent of the subsidy when the costs concerning control of production method are excluded. The total transaction costs amount to 63 per cent of the subsidy when these costs are included. The ‘right’ percentage lies somewhere in between. The quite substantial difference indicates the importance of asset specificity when complexity is involved.

5.3.10 Conversion support to organic farming

The policy measure

Farmers who want to convert from conventional to organic agriculture have to follow certain procedures for a period before they can be confirmed as organic farmers. These farmers receive a once-and-for-all payment per decare. The purpose of the policy measure is to stimulate conversion to organic farming. The support shall contribute to compensation of extra production costs and decreased yields (Ministry of Agriculture 2001b).

Also in this case the Ministry of Agriculture, the Agricultural Inspection Service, Debio[41], the national, the county and the local agricultural authority, as well as farmers are involved in the transaction.

Characteristics of the transactions involved

The authorities have defined that they need information about the quantity of conversed land, the grown species, and the production method to give conversion support (Ministry of Agriculture 2001b). These are informations that have to be collected separately. Asset specificity is equal to that of acreage support for organic farming. The same concerns potential problems created by asymmetric information.

The transaction is undertaken annually (Ministry of Agriculture 2001b). 418 farmers received 6,9 millions NOK in conversion support for 16 180 decares of land under conversion in 2000 (Norwegian Agricultural Authority 2001a and Norwegian Agricultural Authority 2001b). Most farmers do only convert parts of their fields each year. Frequency is thus low. Table 5.20 shows the expectations concerning the transaction costs.

Table 5.20 Expected transaction costs (TC) for conversion support to organic farming

Characteristics of transactions	Expected level of transactions involved in Conversion support to organic farming
Information from commodity markets exists	No
The degree of asset specificity	Medium
Frequency	Low
Expected level of TC	Medium to high

[41] Debio is an organisation that approves that the agricultural production method is organic, through annually inspections of the production method on each farm.

Empirical findings

Also in this case we interviewed representatives from the agricultural county authority in Akershus and representatives from the local agricultural authority in Aurskog-Høland. Four farmers from Aurskog-Høland were interviewed. We have used the same method for splitting costs as for acreage support to organic farming and the same basis for data concerning the number of decares and level of payments.

Table 5.21 gives the results.

Table 5.21 Transaction costs (TC) in NOK for conversion support to organic farming, as per cent of farmer payments and per decare

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of subsidy	TC per decare in NOK
Ministry of Agriculture			0,02	0,10
Norwegian Agricultural Authority			13,35	56,86
Agricultural Inspection Service			0,03	0,13
Debio			9,62	40,96
County agricultural authority			0,61	2,79
Local agricultural authority			3,71	20,79
Farmers, transactions with the state			0,43	2,50
Farmers, transactions with Debio			1,28	7,35
Total	6 893 400	2 002 000	29,04	131,50

Transaction costs are about 30 per cent of the subsidy. Again the level is within the expected range. In this case the main costs fall on the Norwegian Agricultural Authority and Debio.

5.3.11 Support for preserving cattle races (B2)

The policy measure

The purpose of this measure is to contribute to preservation of old – i.e., local – cattle-races (Ministry of Agriculture 2001e). The payments are made per animal. The Ministry of Agriculture, the Norwegian Museum of Agriculture, the national, the county and the local agricultural authorities, as well as farmers are involved in this transaction.

Characteristics of the transactions involved

Information must be specifically acquired. Asset specificity must be considered medium for this measure. Payments are per animal and are equal for all old cattle-races. Standardized routines are therefore utilized. However, old cattle races have a quality aspect that is rather complex. The cattle must be 7/8 thoroughbred.

Again there is asymmetric information. The transaction is undertaken annually. The number of old cattle-races is very limited. About 437 farmers received 965 064 NOK in support for preserving cattle races for 1 597 old cattle in 2000 (Norwegian Agricultural Authority 2001a, b). Frequency is therefore low when it comes to the number of agents involved and the number of cattle.

Table 5.22 Expected transaction costs (TC) for support for preserving cattle races

Characteristics of transactions	Expected level of transactions involved in Support for preserving cattle races
Information from commodity markets exists	No
The degree of asset specificity	Medium
Frequency	Low
Expected level of TC	Medium to high

Empirical findings

Data in this case are based on interviews with representatives from the agricultural county authority in Akershus and representatives from some local agricultural authorities in the same county. However, due to the limited extent of this measure, the representatives from these two administration levels were not able to separate the costs involved in managing the preservation of cattle races from those concerning ordinary production support. These costs are thus not covered. They should, however, be very low. Four out of eleven farmers that received this support in Akershus were interviewed.

A register over the ancestors of the actual cattle is needed. Cattle farmers can be members of an organization called '*Husdyrkontrollen*' (the animal control), which administers a register over the ancestors of each animal. The costs of running this register are excluded since it would have been in place irrespective of support for preserving cattle races. However, farmers that do not take part in this organization are obliged to register their cattle in a register administrated by the Norwegian Museum of Agriculture. The costs of running this register are included in our estimates. The number of animals and data on subsidy levels are based on statistics from the Norwegian Agricultural Authority (2001a,b).

According to Table 5.23 the transaction costs amount to 2/3 of the subsidy if costs related to the register of the Norwegian Museum of Agriculture are excluded. The percent rises to approximate 140 if these costs are included. Since even the first measure is high, the low frequency combined with a low volume of support seems to be important when explaining the difference to the other measures classified as B2. The Norwegian Agriculture Authority carries by far the greatest share of the total transaction costs if we exclude the register costs. These are carried by the museum.

Table 5.23 Transaction costs (TC) in NOK for support for preserving cattle races, as per cent of subsidy and per animal

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of subsidy	TC in NOK per animal
Ministry of Agricultural			0,49	2,94
Norwegian Agricultural Authority			57,20	345,65
The Norwegian museum of agriculture, control costs			0,83	5,01
The Norwegian museum of agriculture, costs related to register			72,15	435,97
County agricultural authority			Unknown	Unknown
Local agricultural authority			Unknown	Unknown
Farmers			7,77	38,20
Total, register excluded	965 064	640 000	66,28	391,79
Total, register included	965 064	1 336 000	138,43	827,77

5.3.12 Support for special landscape ventures (B3)

The policy measure

The aim with the support for special landscape ventures (SLV) is to contribute to maintaining environmental values in the agriculture and to encourage ventures on buildings that are worthy of preservation (Ministry of Agriculture 1999). Payments are given to five different ventures types: 1. preservation and promotion of biodiversity, 2. preservation of old cultivated land, 3. promotion of availability and experience of qualities in or in connection with agricultural land, 4. preservation of cultural cites and 5. restoration of protected buildings or buildings that are worthy of preservation. The payments are given per venture.

The Ministry of Agriculture, the national, the county and the local agricultural authorities, as well as farmers are involved in the transaction of the payments.

Characteristics of the transactions involved

We are now looking at a policy measure where similar treatment is almost impossible across both receivers and administrative levels. The payments are directed towards a public good. No previous information exists and the good is specific for each case. Firstly, the quality of the venture varies according to which of the 5 categories the venture belongs to. Secondly, the variation between ventures within each category is huge. Each venture has a unique quality, and must therefore be treated individually. Payments are thus also calculated specifically for each venture. There are no options for utilizing standardized routines when treating the applications.

Complexity is high for SLV. The relevant quality elements for the authorities to consider are numerous. There is much information both to evaluate and to control. The application shall contain a wide range of information like information about the purpose of the venture, its extent, enterprise plans, drawings, budgets, funding plan, maps, photos and the status of the area in the municipality (Ministry of Agriculture 1999). The authorities have to rely on on-the-spot observations before and after the investment is done. Control is rather demanding.

Frequency is low both concerning how often the transaction is undertaken and how many agents that can be treated similarly. Payments to farmers for a venture is transacted once when the payment is 10 000 NOK or less. Part payment can be undertaken when the payment is more than 10 000 NOK (Ministry of Agriculture 1999). 3 106 applications of SLV-payments were treated in 2000 and total payments were 113 millions NOK (Lundahl 2001).

Table 5.24 Expected transaction costs (TC) for special landscape ventures (SLV)

Characteristics of transactions	Expected level of transactions involved in SLV
Information from commodity markets exists	No
The degree of asset specificity	High
Frequency	Low
Expected level of TC	High

Empirical findings

We interviewed representatives from the agricultural county authority in Akershus and representatives from the local agricultural authority in Eidsvoll. 6 farmers in Akershus were interviewed.[42]

The number of ventures and level of payments for all levels are based on answers from the interviewed persons. Table 5.25 gives the results.

Table 5.25 Transaction cost (TC) in NOK for special landscape ventures (SLV-payments), as per cent of farmer payments and per venture

Administration level	Subsidy (NOK)	TC (NOK)	TC as percent of subsidy	TC in NOK per venture
Ministry of Agriculture			0,02	6,72
Norwegian Agricultural Authority			3,31	1 341,44
County agricultural authority			3,06	1 731,06
Local agricultural authority			45,90	16 432,35
Farmers			1,63	1108,25
Total	113 249 017	61 059 000	53,92	20 619,82

Transaction costs are at a level of about half the level of the subsidy. The percentage may be extra problematic to use in this case. The transaction costs are about 20.000 NOK per venture. The local agricultural authorities are carrying most of the costs.

5.3.13 Comparing the different policy measures

One should remember the reservations taken concerning the problems with comparing across policy measures. Transaction costs measured as percentage of payments is maybe the only applicable when comparing across such a variety of policy instruments. Still, one should be aware that this percentage is strongly influenced by the level of payments. Thus measured on a percent basis the subsidy for reduced tillage comes out with approximately 7 times as high costs as the acreage payment. Measured on a per unit of land basis, the factor is only 2:1. The percentage for the tax on pesticides is high due to low volumes traded in 2000.

[42] Lundahl has interviewed persons from, the Norwegian, the county and the local agricultural authority.

Table 5.26 summarizes the main results from the study:

Table 5.26 Transaction costs (TC) for different types of policy measures – measured as percent of payments

A: Policy measures applied to existing commodities		**B: policy measures applied to other elements than existing commodities**	
A1: Price support on milk	0,24	B1: Acreage payments	1,0
A1: Environmental tax on fertilizers	0,09	B1: Livestock payments	2,3
		B1: Subsidy for reduced tillage	6,8
A2: Environmental tax on pesticides	1,1	B2: Acreage support to org. farming:	
A2: Price support on home refined dairy Products	12,3	-control of production method excluded	18,3
		-control of production method included	63,3
		B2: Conversion support to org. farming	29,0
		B2: Support for preserving cattle races	
		-register excluded	66,3
		-register included	138,4
		B3: Support for special landscape ventures	53,9

Given this, there are three deviations from the expected pattern:

- Price support to home-refined dairy products has transaction costs clearly above the expected level. This is mainly explained by low frequency – a characteristic not assumed for measures of type A. There are also some needs for acquiring information, which is not part of existing data from the marketing bodies.

- Acreage and livestock payments have low transaction costs. This is mainly explained by frequencies beyond what was expected for any of the B categories.

- The cost for the preservation program for cattle races is high due partly to the low frequency and partly to the way the costs are measured – i.e., as percentage of the subsidy. Subsidies are relative low in this case.

To illustrate further the sensitivity of the percentage measure to the size of the payment (subsidy/tax), we have reorganized data. Table 5.27 shows the results both according to the type of policy measure and the level of payments.

Table 5.27 Subsidy/tax payments and TC measured as percent of subsidy/tax payments

Policy instrument	**Subsidy/tax in NOK**	**TC as percent of subsidy/tax**	
		Measures A	**Measures B**
B1: Acreage payments	3 267 347 256		0,96
B1: Livestock payments	2 088 496 312		2,29
A1: Price support on milk	520 153 321	0,24	
A1: Environmental tax on fertilizers	158 392 170	0,09	
B1: Subsidy for reduced tillage	132 941 146		6,81
B3: Support for special landscape ventures	113 249 017		53,92
A2: Environmental tax on pesticides	52 800 000	1,11	
B2: Acreage support to organic farming	19 169 023		18,34
B2: Conversion support to organic farming	6 893 400		29,04
A2: Price support on home-refined dairy products	1 014 779	12,28	
B2: Support for preserving cattle races	965 064		66,28

The table confirms that the level of total payments – which also captures important aspects of frequency – is of importance. The general picture is clear. Policy measures of type A have transaction costs far below those of measures B with similar aggregate payments. One measure stands out especially. The measure with the highest asset specificity – i.e., the support for special landscape ventures – has much higher transaction costs than other policy measures of equal size. This confirms the point made by Williamson that asset specificity is a very important factor when explaining variation in transaction costs.

5.4 Back to the trade-off problem

The above analyses only give point estimates for the transaction costs. While we cannot say anything empirically about how far the existing adaptation is from an optimum concerning the level of transaction costs, we can develop the reasoning about the trade-off problem raised in Chapter 4 a bit further. The problem, which we have to look more carefully at, is the problem of defining the optimal level of control costs and the associated optimal level of information gathering. We will close Chapter 5 by discussing this.

5.4.1 Precision and the role of information and control

Figure 5.1 illustrates the problem of optimal transaction costs with focus on control costs. We have used cultural landscape as a basis for the analysis.

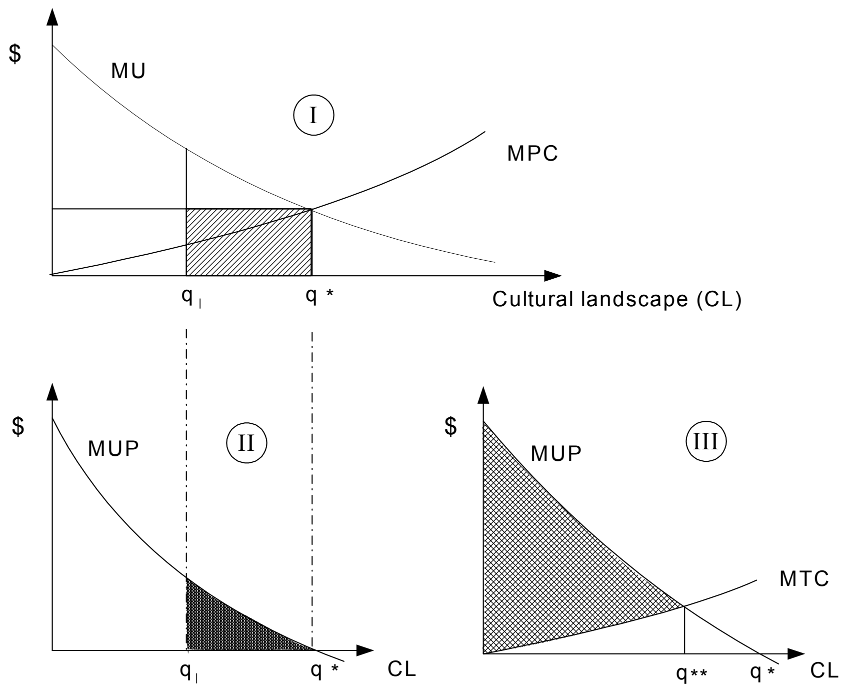

Figure 5.1 Optimal transaction costs concerning supply of cultural landscape.

Part I of the figure shows the optimum if we only consider the utility of landscape values and the costs of producing these landscape values. This optimum will be found in q^* – i.e., where the marginal utility (MU) equals the marginal production costs (MPC). Since the landscape is a good with many qualities that are costly to measure, it may be that without specific controls of what is actually delivered, the real delivery may be just q_1. The information is asymmetric and the firms (farmers) may utilize this. In this situation the firms supposed to deliver the good will earn the hatched area without delivering anything.

The area between the MU and MPC curve is a measure of net utility of increased precision. Part II thus shows the marginal utility of precision, MUP(=MU-MPC). The shaded area represents the loss of precision when farmers freely comply only up to q_1 as measured against the 'ideal' situation in part I.[43] To increase precision some information and control measures need to be in place. Transaction costs will appear. Their marginal value (MTC) is depicted in part III of the figure. Given that the double hatched area is greater than the fixed transaction costs involved, a

[43] The observant reader will see that given no TC as in part I, controls etc. are free. Thus a deviance between q^* and q_1 does not appear in such an 'ideal' situation. This is an example of the type of inconsistencies that is so hard to avoid in analyses of these issues. Being aware of it, we have still chosen to build Figure 5.1 in the defined steps to make the argument more transparent.

new optimum is found in q^{**}. It is assumed that the regulatory scheme results in exactly this amount being produced. In most situations it will be very difficult to find this optimum precisely, because one will not be able to determine at which level of transaction costs there is equality between what is the (assumed) optimum and the actual delivery.

From this reasoning we see that in this case payments will be made for some landscape values that are not delivered (q^{*} - q^{**}). The higher the transaction costs are, the lower the difference between what is required and what is actually delivered will tend to be. Precision increases. Still, it will be too costly to secure that all goods up till q* are delivered.

The size of the transaction costs, and hence the difference between q^{*} and q^{**}, is also dependent on the degree to which agents want to conform to the established policy. Further, Figure 5.1 is not explicit on the qualitative aspects of the landscape. It mirrors landscape as a one-dimensional good. A great part of the transaction costs will deal with securing the qualities required. In situations dominated by complex/relational goods, transaction costs may, as already indicated, be substantial. A way to reduce these costs may then be to utilize the agent's own insights and establish more participatory processes. Such participation may be important in itself and not just as way of reducing transaction costs.

5.4.2 Transaction costs, participation and behavior

The above reasoning leads us to another important problem. The *type of policy measure used* – not only the size of payments – may influence agents' behavior, specifically the need for control. The existence of so-called intrinsic motivation may create situations where the conclusions following from the standard utility maximization hypothesis may lead to bad predictions and drive policy into unnecessarily costly paths.

The literature on intrinsic motivation or crowding out effects is increasing (see Sunstein 1993; van Vugt et al. 1996; Frey 1997a; Frey 1997b; Frey and Oberholzer Gee 1997; Tenbrunsel and Messick 1999; Frey and Jegen 2001). Its development was triggered by observations that increased price actually resulted in reduced supplies or that increased control resulted in lower compliance. This kind of 'perverse' action may follow from the fact that the incentive used does not follow the logic of the situation as conveyed by the agents. The payment may not be adequate or the producer may look upon the good as something it is his duty to provide in any event. Examples are found in such widely different areas as the giving of blood, choice of transportation type, and environmental issues.

Concerning control, Tenbrunsel and Messick (op.cit.) suggest that reduced compliance may result from a reduction in the agents' autonomy and self-respect. Beyond a certain level of control, the effects of not complying are, however, so big, that the degree of compliance increases again. They thus find that compliance as a function of control is U-formed.

In our situation these observations may be very important. First, the agents will usually be farmers, who have generally a strong perception of being individual decision-makers. Second, the goods involved may appeal to different forms of intrinsic motivation and self-respect. Many identity-shaping elements seem to be attached especially to landscape values (Krogh 1995). This may also be the case, to some extent, for food safety. Finally, the goods are complex and often relational. This makes it very important to create a climate where cooperation and not control is predominant. Creating a common culture is not only shaping identity. It is also a way of simplifying communication. It reduces the level of transaction costs through a reduced need for control and makes it possible to utilize the creativity of the individual farmer and his/her community to produce high quality goods.

Studies by Ward and Lowe (1994) and Lowe et al. (1997) show how focusing on information and participation increased 'precision' considerably through establishing a better common understanding. Their studies focused on environmental issues, and they illustrated the effects of a change in the relationship between authorities and farmers concerning the delivery of these kinds of goods. Participation changed the 'game' from one of conflict and control to one of cooperation. These studies also show that what is considered legitimate behavior – i.e., what in economic terms is conceived as a cost by the actors – is influenced by the relationships between them.

These observations also tell us that it may be difficult to evaluate the level of TC ex ante, since it is only ex post one knows whether the policy engaged people in a positive way or not.

6. Conclusions

In this report the focus has been on multifunctional agriculture. This is a situation where many goods are

a) joint – here in the meaning that goods have both private and public attributes, or
b) complementary – here implying that a (private) good produces a joint output that is input into the production of another (public) good or bad.

Our ana,yses show that if jointness or complementarity is involved and transaction costs are positive, direct payments for the public goods will not in general be an optimal solution. It may be more reasonable to pay via the joint private good. There are – as we have seen – two issues of specific interest: a) the degree to which a country's agriculture is internationally competitive, and b) the level of transaction cost associated with the various policy options.

Concerning the first issue, we have concluded that the less competitive a country's agriculture is in markets for the private goods, the lower will the 'free' delivery of joint products be. The rationale for a country to use policies that operate via the private goods thus increases the higher the degree of jointness/complementarity is, and the lower the international competitiveness of the sector is concerning the private goods. Certainly, given that total costs do not exceed total gains.

The conclusion depends, however, also on the level of transaction costs associated with the various options. Our analyses show that these costs may vary substantially between various options due to variations in information costs, asset specificity and frequency. Lowest transaction costs are found in cases where policy measures can be attached to existing commodities like milk and fertilizers. Highest costs are found in situations where payments are directed towards goods that are site specific and frequencies are low. The variation across measures is substantial.

This implies that if goods are joint, one obtains the same level of delivery of private and public goods – the same level of precision – by paying for the private as by paying for the public good. The reduction in transaction associated with the first option may, however, be substantial. In cases where jointness is impure or the private and public goods are complementary, the conclusion is not so straightforward. In this case the conclusion depends on an evaluation of the trade-off between precision and transaction costs. Paying for the private good reduces both transaction costs and precision.

Support directed at input factors like land and animals do also show rather low transaction costs. These may offer good 'compromises' between competing aims in many situations. One should, however, observe that there is a great danger when using *only* this type of measures since adverse adaptations may appear. This is the case if prices for private goods fall below variable costs.[44]

In the case of multifunctional agriculture, a reasonable trade-off between transaction costs and precision is strongly linked to the relationships that exist between the goods involved. To the degree that the goods are jointly produced, high precision can be obtained by a few, simple policy measures. If there is a private good among the joint products, a simple incentive mechanism is likely to be found. To the degree that one has to pay separately for each good – and certainly there are many situations where this will apply due to the specificity of some goods – it is a challenge to develop simple criteria without loosing important information. In analyzing these issues, one must not confuse what is least costly – i.e., to pay via a joint private product – and jointness as a potential quality of the public good. Principally the first has to do with transaction costs and the cost of production while the latter has to do with the quality of the good.

While the prime *technical issue* focused here, the trade-off between precision and transaction costs, an important *value question* has also been discussed. It concerns whose rights should be defended if countries have conflicting interests: the one protecting its public goods or the one that faces reduced export possibilities as a function of this protection. This is an issue about what is considered a fair treatment of conflicting interests. It cannot be solved on the basis of efficiency arguments.

The insights from this report have two consequences. Properly conducted, economic analysis may give less support to the creation of a single market for food commodities than is often believed. However, the paper also presents a more stringent way to evaluate the legitimacy of existing national policies. Certainly, it offers a basis for critical analysis also in that respect. Further work is, however, needed to make the ideas more operational in that respect.

[44] More precisely variable costs plus other fixed costs than land and animals.

7. References

7.1 Written sources

Agrarinfo, 2002. *Förderprogramm Umweltschonende Landbewirtschaftung – FUL.* http://www.agrarinfo.rpl.de/lpp_mainz/ful/index.html, 25.06.02.

Agricultural Inspection Service, 2001a. *Godkjente importører og norske tilvirkere av plantevernmidler.* http://www.landbrukstilsynet.no/plantevernmidler/plvmimportorer.cfm, 13.12.01

Agricultural Inspection Service, 2001b. *Omsetningsstatistikk for plantevernmidler 1996-2000.* Landbrukstilsynet.

Agricultural Inspection Service, 2002. *Omsetningsstatistikk mineralgjødsel.* http://www.landbrukstilsynet.no/dokument.cfm?m_id=68&d_id=891. 14.01.02.

Arrow, K., 1969. The organization of economic activity. Issues pertinent to the choice of market versus nonmarket allocation. In *The Analysis and Evaluation of Public Expenditure: The PPB System*. Vol. 1. U.S. Joint Economic Committee, 91st Congress, 1st Session. Washington D.C.: U.S. Government Printing Office, pp.59-73.

Baumgärtner, S., 1999. *Ambivalent Joint Production and the Natural Environment. An Economic and Thermodynamic Analysis.* Heidelberg: Physica Verlag.

Bhagwati, J., 2002. *Free Trade Today*. Princeton and Oxford, Princeton University Press.

Bromley, D. W., 1989. *Economic Interests and Institutions. The Conceptual Foundations of Public Policy*. Oxford: Basil Blackwell.

Bromley, D.W., 1991. *Environment and Economy: Property Rights and Public Policy*. Oxford, Blackwell.

Budsjettnemda 2001. *Totalkalkylen for jordbruket. Jordbrukets totalregnskap 1999 og 2000 og budsjett 2001. Totale inntekter, kostnader og vederlag til arbeid og egenkapital i jordbruket.* NILF, Oslo.

Challen, R., 2000. *Institutions, Transaction Costs and Environmental Policy*. Cheltenham, Edward Elgar.

Clark, J., J. Burgess, and C.M. Harrisson, 2000. "I struggled with this money business": respondents' perspectives on contingent valuation. *Ecological Economics*, 33:45-62.

Coase, R.H., 1937. The Nature of the Firm. *Economica*, 4:386-405.

Coase, R.H,. 1960. The Problem of Social Cost. *The Journal of Law and Economics*, **3**:1-44.

Dahlman, C.J., 1979. The Problem of Externality. *The Journal of Law and Economics*, **22**:141-162.

Dietrich, M., 1994. *Transaction Cost Economics and Beyond. Towards a new economics of the firm*. London, Routledge.

Dragun, A.K., 1998. The Agricultural Production of the Environment. Some Nordic Issues. *Swedish Journal of Agricultural Research,* **28**:49-55.

Eggertsson, T., 1990. *Economic behavior and institutions*. Cambridge, Cambridge University Press.

Eklund, A., 1999. *Transaction Costs of the Swedish Agri-environmental Program.* Sweden, Uppsala, Report 128, Swedish University of Agricultural Sciences.

Falconer, K. and M. Whitby, 1999. The invisible cost of scheme implementation and administration. In Huylenbroeck, G. Van and M. Whitby (eds.). *Countryside Stewardship: Farmers, policies and markets*. Elsevier Science, Oxford UK.

Falconer, K., P. Dupraz and M. Whitby, 2001. An investigation of policy administrative costs using panel data for the English environmental sensitive areas. *Journal of agricultural economics,* 1:83-103.

Foster, J. (ed). *Valuing Nature? Economics, Ethics and Environment*. London, Routledge.

Frey, B.S., 1997a. *Not Just For the Money. An Economic Theory of Personal Motivation*. Cheltenham: Edward Elgar Publishing Limited.

Frey, B.S., 1997b. A Constitution for Knaves Crowds Out Civic Virtue. *Economic Journal*, **107**(443):1043-53.

Frey, B.S. and F. Oberholzer-Gee, 1997. The Cost of Price Incentives: An Empirical Analysis of Motivation Crowding-Out. *American Economic Review,* **87**(4):746-755.

Frey and R., Jegen, 2001. Motivation Crowding Theory. Journal of Economic Surveys, **15**(5):589-611.

Frisch, R. (1971). *Innledning til produksjonsteorien.* 9th edition, 2. printing. Oslo: Universitetsforlaget.

Furubotn, E.G. and R. Richter, 1998.*Institutions and Economic Theory. The Contribution of the New Institutional Economics*. AnnArbor, the University of Michigan Press.

Gravelle, H. and R. Rees, 1981. *Microeconomics.* London, Longman.

Groenewegen, J., C. Pitelis and S.E. Sjöstrand, 1995**.** *On Economic Institutions. Theory and Application.* Aldershot, Edward Elgar.

Heady, E.O., 1952. *Economics of Agricultural Production and Resource Use*. New York: Prentice Hall Inc.

Hoel, M. and K. Moene, 1993. *Produksjonsteori.* Oslo, Universitetsforlaget.

Jacobs, M., 1997. Environmental Valuation, Deliberative Democracy and Public Decision-Making Institutions. In Foster, J. (ed). *Valuing Nature? Economics, Ethics and Environment*. London, Routledge, pp. 211-231.

Krogh, E., 1995. *Landskapets fenomenologi*. Doctor Scientarium Theses 1995:15. Department of Economics and Social Sciences, Agricultural University of Norway.

Kumm, K.I. and Drake, L., 1998. *Transaction costs to farmers of environmental compensation.* Department of economics, SLU, Uppsala, Sweden (unpublished paper)

Lampe, K., 1994. *Mögliche Auswirkungen der EU-Agrarreform auf die Agrastuktur und die Entwiklung des Ländlichen Raumnes in Niedersächsischen Teil der Eurigio.* Eurigio-Sumposium, Bad Bentheim.

Lowe, P., J. Clark, S. Seymour and N. Ward, 1997. *Moralising the Environment: The Politics and Regulation of Farm Pollution.* London, UCL Press.

Lundahl, T., 2001. *Kulturlandskap og transaksjonskostnader i Norsk landbruk. En analyse av to kulturlandskapsrettede miljøvirkemidler innen Norsk landbruk.* Hovedfagsoppgave ved Institutt for økonomi og samfunnsfag, Norges landbrukshøgskole, Ås.

MAFF/IBAP, 1997. The Government's Expenditure Plans, 1996/7-1998/9. CM 1903 HMSO, London.

Ministry of Agriculture 1998. *Forskrift om handel med gjødsel og jordforbedringsmidler m.v.* http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Ministry of Agriculture 1999. *Forskrift for tilskudd til spesielle tiltak i landbrukets kulturlandskap med freda og verneverdige bygninger*. http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Ministry of Agriculture 2000a. *Forskrift om tilskott til mjølkeproduksjon.* http://www.lovdata.no/for/sf/ld/index.html, 13.12.01

Ministry of Agriculture 2000b. *Forskrift om plantevernmidler*. http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Ministry of Agriculture 2001a. *Forskrift om areal- og kulturlandskapstilskudd*. http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Ministry of Agriculture 2001b. *Forskrift om tilskudd til økologisk landbruk*. http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Ministry of Agriculture 2001c. *Forskrift om tilskudd til husdyr*. http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Ministry of Agriculture 2001d. *Forskrift om tilskudd til endra jordarbeiding. Fastsatt av Landbruksdepartementet 2. juli 1999 etter samråd med Norges Bondelag og Norske Bonde- og Småbrukarlag og med hjemmel i lov av 12. mai 1995 nr 23 om jord (jordlova) §3 og §18. Endret 5 juli 2000 nr. 761, 2 juli 2001 nr. 984.* http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Ministry of Agriculture 2001e. *Forskrift om tilskudd til bevaringsverdige storferaser.* http://www.lovdata.no/for/sf/ld/index.html, 13.12.01.

Norsk institutt for landbruksøkonomisk forskning, 2000. *Håndbok for driftsplanlegging 2000/2001*. NILF, Oslo.

North, D.C., 1990. I*nstitutions, Institutional Change and Economic Performance.* Cambridge, Cambridge University Press.

Norwegian Agricultural Authority, 2001a. *Landsoversikt 31.12.00.* http://www.statenskorn-forretning.no/skf/pt5040/0020/ 0020199.HTM, 17.10.01.

Norwegian Agricultural Authority, 2001b. *Totalt 31.12.00.* http://www.statenskorn-forretning.no/skf/pt900/0020/0020199. htm, 17.10.01.

Norwegian Agricultural Authority, 2001c. *Landsoversikt 31.07.00.* http://www.statenskorn-forretning.no/skf/pt5040/0010/ 0010L99.htm, 17.10.01.

Norwegian Agricultural Authority, 2001d. *Totalt 31.07.00.* http://www.statenskorn-forretning.no/skf/pt900/0010/ 0010L99.htm, 17.10.01.

Norwegian Agricultural Authority, 2001e. *Akershus 31.07.00. Produksjonstilskudd i jordbruket, ordinær utbetaling.* http://www.statenskornforretning.no/skf/pt5040/0010/0010f02.HTM, 17.10.01.

Norwegian Agricultural Authority, 2001f. *Akershus 31.07.00. Produksjonstilskudd i jordbruket, liste over produksjoner pr. 31.07.00.* http://www.statenskornforretning.no/skf/pt900/0010/0010f02.HTM, 17.10.01.

Norwegian Agricultural Authority, 2001g. *Eidsvold 31.07.00. Produksjonstilskudd i jordbruket, ordinær utbetaling.* http://www.statenskornforretning.no/skf/pt5040/0010/00100237.HTM, 17.10.01.

Norwegian Agricultural Authority, 2001h. *Eidsvold 31.07.00. Produksjonstilskudd i jordbruket, liste over produksjoner pr. 31.07.00.* http://www.statenskornforretning.no/skf/pt900/0010/00100237.HTM, 17.10.01.

Norwegian Agricultural Authority, 2001i. *Eidsvold 31.12.00. Produksjonstilskudd i jordbruket, liste over produksjoner pr. 31.12.00.* http://www.statenskornforretning.no/skf/pt900/0020/00200237.HTM, 16.10.01.

Norwegian Agricultural Authority, 2001j. *Eidsvold 31.12.00. Produksjonstilskudd i jordbruket, ordinær utbetaling.* http://www.statenskornforretning.no/skf/pt5040/0020/00200237.HTM, 12.11.01.

Norwegian Agricultural Authority, 2001k. *Akershus 31.12.00. Produksjonstilskudd i jordbruket, ordinær utbetaling.* http://www.statenskornforretning.no/skf/pt5040/0020/ 0020f02.HTM, 17.10.01.

Norwegian Agricultural Authority, 2001l. *Akershus 31.12.00. Produksjonstilskudd i jordbruket, liste over produksjoner pr. 31.12.00.* http://www.statenskornforretning.no/skf/pt900/0020/0020f02.HTM, 17.10.01.

Norwegian Agricultural Authority, 2001m. *Aurskog-Høland 31.12.00. Produksjonstilskudd i jordbruket, liste over produksjoner pr. 31.12.00.* http://www.statenskornforretning.no/skf/pt900/0020/ 00200221.htm, 30.10.01.

Norwegian Agricultural Authority, 2001n. *Aurskog-Høland 31.12.00. Produksjonstilskudd i jordbruket, ordinær utbetaling.* http://www.statenskornforretning.no/skf/pt5040/0020/00200221.HTM, 12.11.01.

OECD, 2001. *Multifunctionality. Towards an analytical framework*. Paris, OECD.

Ostrom, E., E. Gardner and J. Walker, 1994. *Governing the Commons: The Evolution of Institutions for Collective Action.* An Arbor, The University of Michigan Press.
Pitelis, C., (ed.) 1993. *Transaction Costs, Markets and Hierarchies.* Oxford, Blackwell.
Randall, A., 1974. Coasian Externality Theory in a Policy Context. *Natural Resources Journal*, **14**:35-54.
Romstad, E., A. Vatn, P.K. Rørstad and V. Søyland, 2000. *Mulitifunctional Agriculture. Implications for policy design*. Rapport 21, Inst. for økonomi og samfunnsfag, Norges landbrukshøgskole, Ås.
Sagoff, M., 1988. *The Economy of the Earth*. Cambridge, Cambridge University Press.
Scheele, M., 1999. *Environmental Services Provided by Agriculture. The Setting of Environmental Targets and Reference Levels*. Published in the report from the workshop 'Non-Trade Concerns in a Multifunctional Agriculture', 9-11 March, Sanner, Gran, Norway. The Norwegian Ministry of Agriculture.
Shumway, R.C., R.D. Pope and E. Nash, 1984. Allocatable Fixed Inputs and Jointness in Agricultural Production: Implications for Economic Modeling. *American Journal of Agricultural Economics,* **66**(1):72-78.
Simon, H., 1959. Theories of decision making in economics and behavioural science. *American Economic Review.* 49:253-58
Sunstein, C.R., 1993. Endogenous Preferences, Environmental Law. *Journal of Legal Studies*, **22**(2): 217-254.
Tenbrunsel, A.E. and D.M. Messick, 1999. Sanctioning Systems, Decision Frames and Cooperation. *Administrative Science Quarterly*, **44**:684-707.
Tinbergen, J. (1950): *On the Theory of Economic Policy.* Amsterdam, North-Holland.
van Vugt, M., P.A.M. van Lange and R.M. Meertens, 1996. Commuting by car or public transportation? A social dilemma analysis of travel mode judgments. *European Journal of Social Psychology*, **26**:373-395.
Vatn, 1984. *Teknologi og politikk. Om framveksten av viktige styringstiltak i norsk jordbruk 1920-1980.* Oslo, Landbruksforlaget
Vatn, A., 1998. Input vs. Emission Taxes. Environmental Taxes in a Mass Balance and Transactions Cost Perspective. *Land Economics*, **74**(4):514-525.
Vatn, A., 2000. The Environment as a Commodity. *Environmental Values*, 9:493-509.
Vatn, A., 2002. Efficient or Fair: Ethical Paradoxes in environmental policy. In Bromley, D. and J. Paavola (eds.). *Economics, Ethics and Environmental Policy: Contested Choices*. Blackwell, pp 148-163.
Vatn A. and D.W. Bromley, 1997. Externalities - A Market Model Failure. *Environmental and Resource Economics*, **9**:135-151.
Ward, N. and P. Lowe, 1994. Shifting Values in Agriculture – the Farm Family and Pollution Regulation. *Journal of Rural Studies,* **10**(2):173-184.
Williamson, O.E., 1975. *Markets and Hierarchies. Analysis and Antitrust Implications.* London: The Free Press
Williamson, O.E., 1985. *The Economic Institutions of Capitalism. Firms., Markets, Relational Contracting.* New York: The Free Press.
Williamson, O.E., 1993. The Evolving Science of Organization. *Journal of Institutional and Theoretical Economics,* 149:99-118.
WTO, 1995. *The Results of the Uruguay Round of multilateral trade negotiations. The legal texts*. Genevé, WTO.

7.2 Personal messages

Arnesen, H. Head of Finance (Økonomisjef), The national dairy cooperative.
Frank, S.K. Adviser (Rådgiver), The Norwegian agricultural authority.
Haugen, R. Vice President and Principal Officer (Nestleder og kontorleder), Debio
Herland H.F. Higher Executive officer (Førstekonsulent), The Norwegian agricultural authority.
Hundnes, B. Higher Executive officer, The Norwegian agricultural authority.
Jevne, P.G. Director (Direktør), Hydro Agri Norway.
Kraggerud, A. Higher Executive officer, The agricultural inspection service.
Lilleby, O. Head of Organisation (Orgainisasjonssjef), The national dairy cooperative
Nes. Å. Senior Executive Officer (Seniorkonsulent), The Norwegian agricultural authority.
Smoland, G. Head of Section (Seksjonssjef), The agricultural inspection service.
Tørud, B. Head of Organisation, The local dairy cooperative in the Eastern part of Norway, (Tine Østlandsmeieriet).

Appendix 1

Optimal policies when goods are joint or complementary – a technical appendix

In this Appendix, we will present the derivations behind the results presented in Chapter 4.3 of the main text.

A1.1 The complete model

$$\text{Max } U = U\left(y_i, y_n, z_1, z_2, z_3, TC\right) - p_y^w y_i \tag{A1.a}$$

$$\text{s.t. } \; y_n = y_n\left(x_{11}, x_{21}\right) \tag{A1.b}$$

$$z_1 = z_1\left(y_n\right), \;\; z_2 = z_2[x_{12}, x_{22}(y_n)], \;\; z_3 = z_3\left(x_{11}, x_{23}\right) \tag{A1.c}$$

$$x_{jk} = r_{jk} \quad \text{(j=1,2) (k=1,...,3)} \tag{A1.d}$$

where:

U	is social welfare
y	is a private good where the subscript i implies imports and the subscript n implies national production in country n
p_w^y	is the world market price for y
z_1	is a public good jointly produced with y_n
z_2	is a public good where one input (x_{22}) is joint to the production of y_n (complementarity). This input can affect the quality of z_2 negatively or positively
z_3	is a public good competing over the private input x_{11}
TC	transaction costs following from the type of policy used
x_{jk}	are inputs where j=1 implies tradable and j=2 implies non-tradable goods. The index k differentiates between different inputs j.
r_{jk}	are resource constraints

Equations (A1.a) – (A1.c) are assumed to be concave and twice differentiable. There is no complementary slackness/free disposal. z_1 is a public good jointly produced with the production of the private good in country n (y_n). z_2 is a public good which is complementary to y_n.

Substituting (A1.c) into (A1.a) we get the following Lagrangian for the problem in (A1.a) – (A1.d):

$$\begin{aligned} & y_i, y_n, z_1(y_n), z_2[x_{12}, x_{22}(y_n)], z_3(x_{11}, x_{23}), TC\} - p_y^w y_i \\ & + \lambda[-y_n + y_n(x_{11}, x_{21})] + \sum_{j=1}^{2} \sum_{k=1}^{3} \mu_{jk}(-x_{jk} + r_{jk}) \end{aligned} \tag{A2}$$

We get the following first order conditions:

$$\frac{\partial L}{\partial y_i} = \frac{\partial U}{\partial y_i} - p_y^w = 0 \tag{A3.1}$$

$$\frac{\partial L}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n} - \lambda = 0 \tag{A3.2}$$

$$\frac{\partial L}{\partial x_{11}} = \lambda\frac{\partial y_n}{\partial x_{11}} + \frac{\partial U}{\partial z_3}\frac{\partial z_3}{\partial x_{11}} - \mu_{11} = 0 \tag{A3.3}$$

$$\frac{\partial L}{\partial x_{21}} = \lambda\frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \tag{A3.4}$$

$$\frac{\partial L}{\partial x_{12}} = \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{12}} - \mu_{12} = 0 \tag{A3.5}$$

$$\frac{\partial L}{\partial x_{22}} = \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}} - \mu_{22} = 0 \tag{A3.6}$$

$$\frac{\partial L}{\partial x_{23}} = \frac{\partial U}{\partial z_3}\frac{\partial z_3}{\partial x_{23}} - \mu_{23} = 0 \tag{A3.7}$$

Combining (A3.2) with (A3.3) and (A3.4) respectively, we get:

$$\frac{\partial L}{\partial x_{11}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} + \frac{\partial U}{\partial z_3}\frac{\partial z_3}{\partial x_{11}} - \mu_{11} = 0 \tag{A3.8}$$

$$\frac{\partial L}{\partial x_{21}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \tag{A3.9}$$

A1.2 Pure jointness between a private and public good

We will now focus on a situation where there are only two goods involved – y and z_1. The goods are jointly produced. We get the following reformulation of the model in (A1):

$$\text{Max } U = U(y_i, y_n, z_1, TC) - p_y^w y_i \tag{A3.a}$$

$$\text{s.t. } y_n = y_n(x_{11}, x_{21}) \tag{A3.b}$$

$$z_1 = z_1(y_n) \tag{A3.c}$$

$$x_{j1} = r_{j1} \quad (j=1,2) \tag{A3.d}$$

All the variables are defined as in A1.

Substituting (A3.c) into (A3.a) we get the following Lagrangian for the above problem:

$$y_i, y_n, z_1(y_n), TC] - p_y^w y_i + \lambda[-y_n + y_n(x_{11}, x_{21})] + \sum_{j=1}^{2} \mu_{j1}(-x_{j1} + r_{j1}) \qquad \text{(A4)}$$

We get the following first order conditions:

$$\frac{\partial L}{\partial y_i} = \frac{\partial U}{\partial y_i} - p_y^w = 0 \qquad \text{(A5.1)}$$

$$\frac{\partial L}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n} - \lambda = 0 \qquad \text{(A5.2)}$$

$$\frac{\partial L}{\partial x_{11}} = \lambda \frac{\partial y_n}{\partial x_{11}} - \mu_{11} = 0 \qquad \text{(A5.3)}$$

$$\frac{\partial L}{\partial x_{21}} = \lambda \frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \qquad \text{(A5.4)}$$

Combining (A5.2) with (A5.3) and (A5.4) respectively, we get

$$\frac{\partial L}{\partial x_{11}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} - \mu_{11} = 0 \qquad \text{(A5.5)}$$

$$\frac{\partial L}{\partial x_{21}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \qquad \text{(A5.6)}$$

For a firm producing y_n and z_1 we get the following maximization problem:

$$\text{Max}\, \pi = p_y y_n(x_{11}, x_{21}) + p_{z_1} z_1[y_n(x_{11}, x_{21})] - C_n(\cdot) \qquad \text{(A6)}$$

The first order conditions are:

$$\frac{\partial \pi}{\partial x_{11}} = p_y \frac{\partial y_n}{\partial x_{11}} + p_{z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} - \frac{\partial C_n(\cdot)}{\partial x_{11}} = 0 \qquad \text{(A7.1)}$$

$$\frac{\partial \pi}{\partial x_{21}} = p_y \frac{\partial y_n}{\partial x_{21}} + p_{z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} - \frac{\partial C_n(\cdot)}{\partial x_{21}} = 0 \qquad \text{(A7.2)}$$

Rearranging (A7.1) and (A7.2) we get:

$$p_y + p_{z_1}\frac{\partial z_1}{\partial y_n} = \frac{\partial C_n}{\partial x_{11}} \Big/ \frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n}{\partial x_{21}} \Big/ \frac{\partial y_n}{\partial x_{21}} \qquad \text{(A8)}$$

Combining (A5.5) with (A7.1) we get

$$\frac{\partial y_n}{\partial x_{11}} = \frac{\mu_{11}}{\frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}} = \frac{\partial C_n / \partial x_{11}}{p_y + p_{z_1}\frac{\partial z_1}{\partial y_n}} \tag{A9.1}$$

With TC=0 we can assume $\frac{\partial C_n}{\partial x_{11}} = \mu_{11}$. This implies that in optimum:

$$p_y + p_{z_1}\frac{\partial z_1}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n} \tag{A9.2}$$

Similar expressions are obtained by combining equations (A5.6) and (A7.2)

A1.3 Impure jointness between a private and public good

The next step is to switch to a situation where y and $z_1$are impure joint goods – i.e., z_1 is a function of y and some other input factor (here x_{12}). We get the following formulation of the model:

$$\text{Max } U = U\left(y_i, y_n, z_1, TC\right) - p_y^w y_i \tag{A10.a}$$

$$\text{s.t.} \quad y_n = y_n\left(x_{11}, x_{21}\right) \tag{A10.b}$$

$$z_1 = z_1\left(y_n, x_{12}\right) \tag{A10.c}$$

$$x_{jk} = r_{jk} \quad (j=1,2) \;\; (k=1,2) \tag{A10.d}$$

All the variables are defined as in (A1).

Substituting (A10.c) into (A10.a) we get the following Lagrangian for the above problem:

$$y_i, y_n, z_1(y_n, x_{12}), TC] - p_y^w y_i + \lambda[-y_n + y_n(x_{11}, x_{21})] + \sum_j \sum_k \mu_{jk}(-x_{jk} + r_{jk}) \tag{A11}$$

We get the following first order conditions:

$$\frac{\partial L}{\partial y_i} = \frac{\partial U}{\partial y_i} - p_y^w = 0 \tag{A12.1}$$

$$\frac{\partial L}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n} - \lambda = 0 \tag{A12.2}$$

$$\frac{\partial L}{\partial x_{11}} = \lambda\frac{\partial y_n}{\partial x_{11}} - \mu_{11} = 0 \tag{A12.3}$$

$$\frac{\partial L}{\partial x_{12}} = \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial x_{12}} - \mu_{12} = 0 \tag{A12.4}$$

$$\frac{\partial L}{\partial x_{21}} = \lambda\frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \tag{A12.5}$$

Combining (A12.2) with (A12.3) and (A12.5) respectively, we get

$$\frac{\partial L}{\partial x_{11}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} - \mu_{11} = 0 \tag{A12.6}$$

$$\frac{\partial L}{\partial x_{21}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \tag{A12.7}$$

For a firm producing y_n and z_1 we get the following maximization problem:

$$\text{Max}\,\pi = p_y y_n\left(x_{11}, x_{21}\right) + p_{z_1} z_1[y_n(x_{11}, x_{21}), x_{12}] - C_n\left(\cdot\right) \tag{A13}$$

The first order conditions are:

$$\frac{\partial \pi}{\partial x_{11}} = p_y\frac{\partial y_n}{\partial x_{11}} + p_{z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} - \frac{\partial C_n(\cdot)}{\partial x_{11}} = 0 \tag{A14.1}$$

$$\frac{\partial \pi}{\partial x_{12}} = p_{z_1}\frac{\partial z_1}{\partial x_{12}} - \frac{\partial C_n(\cdot)}{\partial x_{12}} = 0 \tag{A14.2}$$

$$\frac{\partial \pi}{\partial x_{21}} = p_y\frac{\partial y_n}{\partial x_{21}} + p_{z_1}\frac{\partial z_1}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} - \frac{\partial C_n(\cdot)}{\partial x_{21}} = 0 \tag{A14.3}$$

Rearranging A14.1 and A14.3 we get:

$$p_y + p_{z_1}\frac{\partial z_1}{\partial y_n} = \frac{\partial C_n}{\partial x_{11}}\bigg/\frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n}{\partial x_{21}}\bigg/\frac{\partial y_n}{\partial x_{21}} \tag{A.15}$$

Combining (A12.6) with (A14.1) we get

$$\frac{\partial y_n}{\partial x_{11}} = \frac{\mu_{11}}{\frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n}} = \frac{\partial C_n / \partial x_{11}}{p_y + p_{z_1}\frac{\partial z_1}{\partial y_n}} \tag{A16.1}$$

With TC=0 we can assume $\frac{\partial C_n}{\partial x_{11}} = \mu_{11}$. This implies that in optimum:

$$p_y + p_{z_1}\frac{\partial z_1}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial y_n} \tag{A16.2}$$

Similar expressions are obtained by combining equations (A12.7) and (A14.2)

Furthermore, combining (A12.4) with (A14.2) and assuming $\frac{\partial C_n}{\partial x_{12}} = \mu_{12}$ an optimum must also be characterized by:

$$p_{z_1}\frac{\partial z_1}{\partial x_{12}} = \frac{\partial U}{\partial z_1}\frac{\partial z_1}{\partial x_{12}} \quad \text{or} \quad \frac{\partial U}{\partial z_1} = \frac{\partial C_n}{\partial x_{12}} \Big/ \frac{\partial z_1}{\partial x_{12}} \tag{A.17}$$

A1.4 Private and public goods are complementary

$$\text{Max } U = U(y_i, y_n, z_2, TC) - p_y^w y_i \tag{A18.a}$$

$$\text{s.t. } y_n = y_n(x_{11}, x_{21}) \tag{A18.b}$$

$$z_2 = z_2[x_{12}, x_{22}(y_n)] \tag{A18.c}$$

$$x_{jk} = r_{jk} \quad (j=1,2)\ (k=1,2) \tag{A18.d}$$

All variables are defined as in (A1)

Substituting (A18.c) into (A18.a) we get the following Lagrangian for the above problem:

$$\begin{aligned} &y_i, y_n, z_2[x_{12}, x_{22}(y_n)], TC\} - p_y^w y_i + \lambda[-y_n + y_n(x_{11}, x_{21})] \\ &+\sum_{j=1}^{2}\sum_{k=1}^{2}\mu_{jk}(-x_{jk} + r_{jk}) \end{aligned} \tag{A19}$$

We get the following first order conditions:

$$\frac{\partial L}{\partial y_i} = \frac{\partial U}{\partial y_i} - p_y^w = 0 \tag{A20.1}$$

$$\frac{\partial L}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n} - \lambda = 0 \tag{A20.2}$$

$$\frac{\partial L}{\partial x_{11}} = \lambda \frac{\partial y_n}{\partial x_{11}} - \mu_{11} = 0 \tag{A20.3}$$

$$\frac{\partial L}{\partial x_{21}} = \lambda \frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \tag{A20.4}$$

$$\frac{\partial L}{\partial x_{12}} = \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{12}} - \mu_{12} = 0 \tag{A20.5}$$

$$\frac{\partial L}{\partial x_{22}} = \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}} - \mu_{22} = 0 \tag{A20.6}$$

Combining (A20.2) with (A20.3) and (A20.4) respectively, we get:

$$\frac{\partial L}{\partial x_{11}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} - \mu_{11} = 0 \tag{A20.7}$$

$$\frac{\partial L}{\partial x_{21}} = \frac{\partial U}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} - \mu_{21} = 0 \tag{A20.8}$$

For a firm producing y_n and z_2 we get the following maximization problem:

$$\text{Max}\, \pi = p_y y_n\left(x_{11}, x_{21}\right) + p_{z_2} z_2[x_{12}, x_{22}(y_n)] - C_n\left(\cdot\right) \tag{A21}$$

The first order conditions are:

$$\frac{\partial \pi}{\partial x_{11}} = p_y \frac{\partial y_n}{\partial x_{11}} + p_{z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}\frac{\partial y_n}{\partial x_{11}} - \frac{\partial C_n(\cdot)}{\partial x_{11}} = 0 \tag{A22.1}$$

$$\frac{\partial \pi}{\partial x_{12}} = p_{z_2}\frac{\partial z_2}{\partial x_{12}} - \frac{\partial C_n(\cdot)}{\partial x_{12}} = 0 \tag{A22.2}$$

$$\frac{\partial \pi}{\partial x_{21}} = p_y \frac{\partial y_n}{\partial x_{21}} + p_{z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}\frac{\partial y_n}{\partial x_{21}} - \frac{\partial C_n(\cdot)}{\partial x_{21}} = 0 \tag{A22.3}$$

$$\frac{\partial \pi}{\partial x_{22}} = p_{z_2}\frac{\partial z_2}{\partial x_{22}} - \frac{\partial C_n(\cdot)}{\partial x_{22}} = 0 \tag{A22.4}$$

Rearranging A22.1 and A22.3 we get:

$$p_y + p_{z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n} = \frac{\partial C_n}{\partial x_{11}}\Bigg/\frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n}{\partial x_{21}}\Bigg/\frac{\partial y_n}{\partial x_{21}} \tag{A23}$$

Rearranging A22.2 and A22.4 we get:

$$p_{z_2} = \frac{\partial C_n}{\partial x_{12}}\Bigg/\frac{\partial z_2}{\partial x_{12}} = \frac{\partial C_n}{\partial x_{22}}\Bigg/\frac{\partial z_2}{\partial x_{22}} \tag{A24}$$

Given TC = 0, it is reasonable to assume equality between social and private costs. We get:

$$\frac{\partial C_n}{\partial x_{11}} = \mu_{11} \quad \Rightarrow \quad p_y + p_{z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n} \tag{A25.1}$$

$$\frac{\partial C_n}{\partial x_{21}} = \mu_{21} \quad \Rightarrow \quad p_y + p_{z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n} \tag{A25.2}$$

$$\frac{\partial C_n}{\partial x_{12}} = \mu_{12} \quad \Rightarrow \quad p_{z_2}\frac{\partial z_2}{\partial x_{12}} = \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{12}} \quad \text{or} \quad \frac{\partial U}{\partial z_2} = \frac{\partial C_n}{\partial x_{12}}\Bigg/\frac{\partial z_2}{\partial x_{12}} = p_{z_2} \tag{A25.3}$$

$$\frac{\partial C_n}{\partial x_{22}} = \mu_{22} \quad \Rightarrow \quad p_{z_2}\frac{\partial z_2}{\partial x_{22}} = \frac{\partial U}{\partial z_2}\frac{\partial z_2}{\partial x_{22}} \quad \text{or} \quad \frac{\partial U}{\partial z_2} = \frac{\partial C_n}{\partial x_{22}}\Bigg/\frac{\partial z_2}{\partial x_{22}} = p_{z_2} \tag{A25.4}$$

In complete and well functioning markets (including TC=0), $p_{x_{11}} = \mu_{11} = \frac{\partial C_n}{\partial x_{11}}$ in optimum.

From (A22.1) it further follows that $\frac{\partial y_n}{\partial x_{11}} = \frac{\partial C_n / \partial x_{11}}{p_y + p_{z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}}$. Combining these we get

$$\frac{\partial y_n}{\partial x_{11}} = \frac{p_{x_{11}}}{p_y + p_{z_2}\frac{\partial z_2}{\partial x_{22}}\frac{\partial x_{22}}{\partial y_n}} \tag{A.26}$$

Appendix 2

The policy instruments studied – Norwegian names and translations to English

Policy instrument – in English	Policy instrument – in Norwegian
Price support for milk	Pristilskudd på melk (grunn og distriktstilskudd)
Environmental tax on mineral fertilizers	Miljøavgift på mineralgjødsel
Environmental tax on pesticides	Miljøavgift på plantevernmidler
Price support on home-refined dairy products	Pristilskudd på hjemmeforedla melkeprodukter
Acreage payments	Areal- og kulturlandskspastilskudd
Livestock payments	Produksjonstilskudd til husdyr
Support for reduced tillage	Tilskudd til endret jordarbeiding
Acreage support to organic farming	Arealtilskudd til økologisk landbruk
Conversion support to organic farming	Omleggingstilskudd til økologisk landbruk
Support for preserving cattle-races	Tilskudd til bevaringsverdige storferaser
Support for special landscape ventures	Tilskudd til spesielle tiltak i landbrukets kulturlandskap

Appendix 3

Data from the transaction cost analysis

Appendix 3 gives an overview over the data of the empirical analysis of transaction costs. The appendix shows the various components of the estimated costs. In some cases we have split the cost components of a single administration level, for example between different sections in the Norwegian Agricultural Authority. This is illustrated by giving this information in *italics.* Total transaction costs in NOK for each policy instrument is estimated by multiplying transaction costs as per cent of subsidy with total subsidy/tax of the policy instrument.

1. PRICE SUPPORT ON MILK

Administration level	Cost/hour	Work. hours	TC in NOK	Numb. of litres	TC/ton	Subsidy	TC (% of sub)
The Ministry of Agriculture	500	82,4	41200	1580261992	0,03	520153321	0,01
The Norwegian agricultural authority							
Section for price support			*197591*				
Section for production regulation			*11626*				
Section for external control			*29*				
Total, national agricultural authority			209246	1580261992	0,13	520153321	0,04
The national dairy cooperative	213	4664,4	992705	1564195093	0,63	514864799	0,19
Total for all adm. lev.			**1253348**		**0,79**		**0,24**

2. ENVIRONMENTAL TAX ON MINERAL FERTILIZERS

Administration level	Cost/hour	Work. hours	TC in NOK	Ton N	TC/ton N	Ton P	TC/ton P	TC/ton N and P	Tax	TC (% of tax)
The Ministry of Agriculture	500	1,9	938	106 017	0,01	13 092	0,07	0,01	158392170	0,00
The agricultural inspection service										
Labour costs	*333*	*225,0*	*75000*							
Computer costs			*2500*							
Total, agricultural inspection service		225,0	77500	106 017	0,73	13 092	5,92	0,65	158392170	0,05
Producers and importers										
Hydro										
Reporting to the stat	*666*	*16,0*	*10656*							
Control			*5000*							
Other tasks			*3344*							
Accountant			*1000*							
Total, Hydro			*20000*	*80000*	*0,25*	*9600*	*2,08*	*0,22*	*118880000*	*0,02*
Chemco			*25000*	*184*	*135,87*	*15*	*1666,67*	*125,63*	*257*	*9722,33*
Total, producers and importers			45000	80184	0,56	9615	4,68	0,50	118880257	0,04
Total for all adm. lev.			**138394**		**1,30**		**10,67**	**1,16**		**0,09**

3. ENVIRONMENTAL TAX ON PESTICIDES

Administration level	Cost/hour	Work. Hours	TC in NOK	Ton act. sub.	TC/ton ac. s.	Tax	TC (% of tax)
The Ministry of Agriculture	500	19,5	9750	380	25,64	52800000	0,02
The agri. inspection service	333	211,5	70430	380	185,24	52800000	0,13
Importers of pesticides							
BASF	*240*	*58,5*	*14040*	*3,9*	*3572,52*		
ABC Agropartner	*240*	*7,5*	*1800*	*7,8*	*231,96*		
Novartis Agro			*40000*	*18,0*	*2218,52*		
Agrovekst produkter			*5000*	*20,0*	*250,00*		
FKØV		*16,0*	*54000*	*36,7*	*1471,39*		
Average of importers			114840	86,4	1328,86	12001793	0,96
Total for all administration levels			**585400**		**1539,75**		**1,11**

4. PRICE SUPPORT ON HOME REFINED DAIRY PRODUCTS

Administration level	**Cost/hour**	**Work. hours**	**TC in NOK**	**Number of litres**	**TC/ton**	**Subsidy**	**TC (% of sub)**
The Ministry of Agriculture	500	0,1	44	1664044	0,03	1014779	0,00
The Norwegian agricultural authority							
Section for price support			*21955*				
Section for production regulation			*17439*				
Section for external control			*29*				
Section sale and market arrangements for milk			*12246*				
Total, national agricultural authority			51668	1664044	31,05	1014779	5,09
The national dairy cooperative	213	4,9	1045	1664044	0,63	1014779	0,10
Local dairy cooperatives							
Nr. 1			*7500*	*544330*	*13,78*	*193349*	*3,88*
Nr. 2	*213*	*37,5*	*7981*	*139701*	*57,13*	*96408*	*8,28*
Nr. 3	*213*	*22,5*	*4789*	*72291*	*66,25*	*41106*	*11,65*
Total, local dairy cooperatives			20270	756322	26,80	330863	6,13
Farmers that sell dairy products from the farm							
Nr. 1	*143*	*6,0*	*860*	*3993*	*215,38*	*8785*	*9,79*
Nr. 2	*143*		*450*	*14600*	*30,82*	*30660*	*1,47*
Nr. 3	*143*	*6,0*	*860*	*15000*	*57,33*	*30150*	*2,85*
Nr. 4	*143*	*2,4*	*344*	*28000*	*12,29*	*61600*	*0,56*
Nr. 5	*143*	*2,0*	*287*	*15000*	*19,13*	*13948*	*2,06*
Nr. 6	*143*	*0,2*	*24*	*2000*	*12,00*	*721*	*3,33*
Nr. 7	*143*	*2,2*	*310*	*40000*	*7,75*	*4640*	*6,68*
Nr. 8	*143*	*0,7*	*93*	*5000*	*18,60*	*10050*	*0,93*
Nr. 9	*143*	*2,8*	*406*	*20000*	*20,30*	*9120*	*4,45*
Total, farmers that sell dairy products from the farm.			3633	143593	25,30	169665	2,14
Farmers that sell dairy products to a dairy			0	1279436	0,00	780235	0,00
Farmers			9730	1664044	5,85	1014779	0,96
Total, all administration levels			**124656**		**64,35**		**12,28**

5. ACREAGE PAYMENTS

Administration level	Cost/hour	Work. hours	TC in NOK*	Decares	TC/decare	Subsidy	TC (% of sub)	Applic.	TC/applic.
The Ministry of Agriculture									
Precept work	*500*	*37,5*	*18750*						
Occasional telephones	*500*	*75,0*	*37500*						
Total, agricultural ministry		112,5	56250	10287362	0,01	3267347256	0,00	63171	0,89
The Norwegian agricultural authority			5520000	10287362	0,54	3267347256	0,17	63171	87,38
County agricultural authority									
Registering	*260*	*12,0*	*3120*						
Other administration	*281*	*616,7*	*173293*						
Control	*281*	*35,2*	*9902*						
Total, county agricultural authority		663,9	186315	790572	0,24	216159959	0,09	3018	61,73
Local agricultural authority	253	299,5	75784	50789	1,49	14141479	0,54	241	314,45
Farmers	143	1,2	172	369	0,47	102743	0,17	1	171,60
Total for all administration levels			**31359153**		**2,73**		**0,96**		**636,06**

6. LIVESTOCK PAYMENTS

Administration level	Cost/hour	Work. hours	TC in NOK	Animals	TC/animal	Subsidy	TC (% of sub.)	Applic.	TC/applic.
The Ministry of Agriculture									
Precept work	*500*	*56,3*	*28125*						
Occasional telephones	*500*	*75,0*	*37500*						
Total, agricultural ministry		131,3	65625	62712463	0,00	2088496312	0,00	77914	0,84
The Norwegian agricultural authority			5520000	62712463	0,09	2088496312	0,26	77914	70,85
County agricultural authority									
Registering	*260*	*22,0*	*5725*						
Other administration	*281*	*264,3*	*74314*						
Control	*281*	*52,9*	*14863*						
Total, county agricultural authority		339,2	94902	3213080	0,03	42676087	0,22	1804	52,61
Local agricultural authority									
Treatment of applications	*253*	*187,5*	*47436*						
Control	*253*	*15,0*	*3795*						
Manuel payments	*253*	*60,0*	*15179*						
Other administration	*253*	*7,5*	*1897*						
Total, local agricultural authority		262,5	68307	179618	0,38	5908232	1,16	232	294,43
Farmers									
Nr. 1	*143*	*5,1*	*728*	*55*	*13,24*	*46200*	*1,58*	*2*	*364,10*
Nr. 2	*143*	*4,7*	*678*	*1120*	*0,61*	*120000*	*0,57*	*2*	*339,03*
Nr. 3	*143*	*0,8*	*119*	*70*	*1,71*	*61320*	*0,19*	*2*	*59,69*
Nr. 4	*143*	*12,3*	*1767*	*150*	*11,78*	*120000*	*1,47*	*2*	*883,39*
Nr. 5	*143*	*3,9*	*561*	*368*	*1,52*	*120000*	*0,47*	*2*	*280,54*
Nr. 6	*143*	*2,8*	*394*	*102*	*3,86*	*68141*	*0,58*	*2*	*196,97*
Nr. 7	*143*	*3,4*	*489*	*55*	*8,98*	*56000*	*0,87*	*2*	*244,72*
Nr. 8	*143*	*2,0*	*287*	*240*	*1,19*	*120000*	*0,24*	*2*	*143,25*
Nr. 9	*143*	*2,0*	*287*	*1020*	*0,28*	*40800*	*0,70*	*2*	*143,25*
Nr. 10	*143*	*2,3*	*322*	*1400*	*0,23*	*120000*	*0,27*	*2*	*161,16*
Control			*14*						
Total, farmers			5646	4580	1,23	872461	0,65	20	282,31
Total for all administration levels			**47891519**		**1,73**		**2,29**		**701,03**

7. SUBSIDY FOR REDUCED TILLAGE

Administration level	Cost/hour	Work. hours	TC in NOK	Decares	TC/decare	Subsidy	TC (% of sub.)	Applic.	TC/applic.
The Ministry of Agriculture									
Precept work	*500*	*22,5*	*11250*						
Other administration	*500*	*52,5*	*26250*						
Instructions to the Norw. Agric. Auth.	*500*	*22,5*	*11250*						
Information	*500*	*22,5*	*11250*						
Total, agricultural ministry		120,0	60000	1397436	0,04	132941146	0,05	12289	4,88
The Norwegian agricultural authority									
Working costs	*312*	*678,4*	*211661*						
Information materials			*22000*						
Computer costs			*50000*						
Total, Norwegian agricultural authority			283312	1397436	0,21	132941146	0,21	12289	23,05
County agricultural authority									
Guidance	*291*	*105,0*	*30555*						
Computer costs	*291*	*15,0*	*4365*						
Contact with the N. Agr. Auth.	*291*	*7,5*	*2183*						
Control	*291*	*7,5*	*2183*						
Writing letters to farmers	*291*	*45,0*	*13095*						
Complains	*291*	*7,5*	*2183*						
Information materials			*15000*						
Registration of applications	*249*	*105,0*	*26145*						
Reports to the loc. Agri. Auth.	*249*	*7,5*	*1868*						
Payments	*249*	*7,5*	*1868*						
Other administration	*249*	*45,0*	*11205*						
Telephones	*249*	*7,5*	*1868*						
Requests	*301*	*30,0*	*9030*						
Material info costs			*17000*						
Total, county agricultural authority		390,0	138545	252874	0,55	20281942	0,68	1893	73,19
Local agricultural authority									
Material info costs			*4500*						
Labour costs	*260*	*324,8*	*84448*						
Total, local agric. aut.		324,8	88948	40000	2,23	3000000	2,97	220	404,31

7. SUBSIDY FOR REDUCED TILLAGE

Administration level	Cost/hour	Work. hours	TC in NOK	Decares	TC/decare	Subsidy	TC (% of sub.)	Applic.	TC/applic.
Farmers									
Nr. 1									
Labour costs	*143*	*1,0*	*143*						
Driving costs			*19*						
Telephones			*10*						
Total, nr. 1			*172*	*178*	*0,97*	*11000*	*1,56*	*1*	*172,00*
Nr. 2	*143*	*3,0*	*429*	*370*	*1,16*	*32000*	*1,34*	*1*	*429,00*
Nr.3	*143*	*1,8*	*263*	*150*	*1,75*	*12000*	*2,19*	*1*	*263,00*
Nr. 4	*143*	*17,3*	*2474*	*300*	*8,25*	*30300*	*8,16*	*1*	*2473,90*
Nr. 5	*143*	*2,0*	*286*	*80*	*3,58*	*7400*	*3,86*	*1*	*286,00*
Nr. 6	*143*	*0,3*	*36*	*86*	*0,42*	*7500*	*0,48*	*1*	*36,00*
Nr, 7	*143*	*2,5*	*358*	*220*	*1,63*	*20900*	*1,71*	*1*	*357,50*
Nr. 8									
Labour costs	*143*	*1,8*	*263*						
Driving costs			*58*						
Total, nr. 8			*321*	*150*	*2,14*	*14250*	*2,25*	*1*	*321,00*
Nr. 9	*143*	*3,0*	*429*	*100*	*4,29*	*8000*	*5,36*	*1*	*429,00*
Nr. 10									
Labour costs	*143*	*3,0*	*429*						
Driving costs			*16*						
Total, nr. 10			*445*	*270*	*1,65*	*33750*	*1,32*	*1*	*445,00*
Total Farmers			5212	1904	2,70	177100	2,90	10	521,24
Total for all administration levels			**9053292,043**		**5,72**		**6,81**		**1019,56**

8. ACREAGE SUPPORT TO ORGANIC FARMING

Administration level	Cost/hour	Work. hours	TC in NOK	Decares	TC/decare	Subsidy	TC (% of sub.)	Applic.	TC/applic.
The Ministry of Agriculture	500	34,3	17129	170952	0,10	19169023	0,09	1929	8,88
The Norwegian agricultural authority			920000	170952	5,38	19169023	4,80	1929	476,93
The agricultural inspection service	333	68,5	22838	170952	0,13	19169023	0,12	1929	11,84
Debio			7002946	170952	40,96	19169023	36,53	1929	4500,00
County agricultural authority									
Registering	*260*	*0,7*	*182*						
Other administration	*281*	*43,2*	*12147*						
Total, county agricultural authority		43,9	12329	14708	0,84	1830643	0,67	139	88,70
Local agricultural authority	277	90,1	24923	1716	14,52	235686	10,57	28	890,10
Farmers transactions with the state									
Nr. 1									
Labour costs	*143*	*2,5*	*358*						
Stamp			*3*						
Total nr. 1			*361*	*20*	*18,06*	*4400*	*8,21*	*1*	*361,13*
Nr. 2									
Labour costs	*143*	*2,5*	*358*						
Driving costs			*64*						
Total nr. 2		*2,5*	*422*	*35*	*12,06*	*6820*	*6,19*	*1*	*422,13*
Nr. 3									
Labour costs	*143*	*0,1*	*12*						
Total nr 3		*0,1*	*12*	*323*	*0,04*	*48290*	*0,02*	*1*	*11,94*
Nr 4									
Labour costs	*143*	*2,0*	*287*						
Stamp			*7*						
Total nr. 4		*2,0*	*294*	*60*	*4,89*	*13200*	*2,22*	*1*	*293,51*
Nr. 5	*143*	*6,0*	*860*	*24*	*35,81*	*5280*	*16,28*	*1*	*859,52*
Nr. 6									
Labour costs	*143*	*2,0*	*287*						
Stamp			*7*						
Total nr. 6		*2,0*	*294*	*10*	*29,35*	*2200*	*13,34*	*1*	*293,51*

8. ACREAGE SUPPORT TO ORGANIC FARMING

Administration level	Costs/hour	Work. hours	TC in NOK	Decares	TC/decare	Subsidy	TC (% of sub.)	Applic.	TC/applic.
Nr. 7									
Labour costs	*143*	*1,0*	*143*						
Stamp			*7*						
Total nr. 7		*1,0*	*150*	*13*	*11,56*	*1430*	*10,51*	*1*	*150,25*
Nr. 8									
Labour costs	*143*	*1,0*	*143*						
Stamp			*7*						
Total nr. 8		*1,0*	*150*	*242*	*0,62*	*26620*	*0,56*	*1*	*150,25*
Nr. 9									
Labour costs	*143*	*0,8*	*107*						
Stamp			*4*						
Total nr. 9		*0,8*	*111*	*15*	*7,40*	*1650*	*6,72*	*1*	*110,94*
Nr. 10									
Labour costs	*143*	*1,2*	*173*						
Driving costs			*15*						
Total nr. 10		*1,2*	*188*	*17*	*11,04*	*3740*	*5,02*	*1*	*187,68*
Nr. 11	*143*	*1,8*	*251*	*10*	*25,07*	*1100*	*22,79*	*1*	*250,69*
Nr. 12	*143*	*1,3*	*179*	*51*	*3,51*	*8572*	*2,09*	*1*	*179,07*
Nr. 13	*143*	*1,0*	*143*	*55*	*2,60*	*12100*	*1,18*	*1*	*143,25*
Nr. 14	*143*	*0,5*	*72*	*20*	*3,58*	*4400*	*1,63*	*1*	*71,63*
Nr. 15									
Labour costs	*143*	*3,8*	*550*						
Driving costs			*12*						
Total costs nr. 15		*3,8*	*562*	*240*	*2,34*	*37400*	*1,50*	*1*	*562,38*
Nr. 16	*143*	*0,0*	*0*	*91*	*0,00*	*11961,95*	*0,00*	*1*	*0,00*
Nr. 17									
Labour costs	*143*	*1,0*	*143*						
Driving costs		*19,2*							
Total costs nr. 17		*20,2*	*143*	*13*	*11,02*	*1430*	*10,02*	*1*	*143,25*
Total, farmers transactions with the state			4191	1239	3,38	190594	2,20	17	246,54

8. ACREAGE SUPPORT TO ORGANIC FARMING

Administration level	Costs/hour	Work. hours	TC in NOK	Decares	TC/decare	Subsidy	TC (% of sub.)	Applic.	TC/applic.
Farmers transactions with Debio									
Nr. 1	*143*	*3,5*	*501*	*20*	*25,07*	*4400*	*11,40*	*1*	*501,39*
Nr. 2	*143*	*2,0*	*287*	*35*	*8,19*	*6820*	*4,20*	*1*	*286,51*
Nr. 3									
Inspection	*143*	*5,5*	*788*						
Preparation	*143*	*8,0*	*1146*						
Total nr. 3		*13,5*	*1934*	*323*	*5,99*	*48290*	*4,00*	*1*	*1933,91*
Nr. 4	*143*	*4,0*	*573*	*60*	*9,55*	*13200*	*4,34*	*1*	*573,01*
Nr. 5									
Inspection	*143*	*6,0*	*860*						
Preparation	*143*	*8,0*	*1146*						
Total, nr. 5		*14,0*	*2006*	*24*	*83,56*	*5280*	*37,98*	*1*	*2005,54*
Nr. 6									
Inspection	*143*	*2,0*	*287*						
Preparation	*143*	*0,1*	*12*						
Total nr. 6		*2,1*	*298*	*10*	*29,84*	*2200*	*13,57*	*1*	*298,44*
Nr. 7									
Inspection	*143*	*1,5*	*215*						
Preparation	*143*	*1,0*	*143*						
Total nr. 7		*2,5*	*358*	*13*	*27,55*	*1430*	*25,04*	*1*	*358,13*
Nr. 8	*143*	*11,0*	*1576*	*242*	*6,51*	*26620*	*5,92*	*1*	*1575,78*
Nr. 9									
Inspection	*143*	*1,3*	*179*						
Preparation	*143*	*0,3*	*36*						
Total nr. 9		*1,5*	*215*	*15*	*14,33*	*1650*	*13,02*	*1*	*214,88*
Nr. 10									
Inspection	*143*	*1,1*	*162*						
Preparation	*143*	*0,6*	*81*						
Total nr 10		*1,7*	*244*	*17*	*14,33*	*3740*	*6,51*	*1*	*243,53*
Nr. 11	*143*	*6,0*	*860*	*10*	*85,95*	*1100*	*78,14*	*1*	*859,52*

8. ACREAGE SUPPORT TO ORGANIC FARMING

Administration level	Costs/hour	Work. hours	TC in NOK	Decares	TC/decare	Subsidy	TC (% of sub.)	Applic.	TC/applic.
Nr. 12									
Inspection	*143*	*1,5*	*215*						
Preparation	*143*	*0,5*	*72*						
Total nr. 12		*2,0*	*287*	*51*	*5,62*	*8572*	*3,34*	*1*	*286,51*
Nr. 13									
Inspection	*143*	*3,0*	*430*						
Preparation	*143*	*1,0*	*143*						
Total nr 13		*4,0*	*573*	*55*	*10,42*	*12100*	*4,74*	*1*	*573,01*
Nr. 14									
Inspection	*143*	*2,0*	*287*						
Preparation	*143*	*2,0*	*287*						
Total nr. 14		*4,0*	*573*	*20*	*28,65*	*4400*	*13,02*	*1*	*573,01*
Nr. 15									
Inspection	*143*	*5,3*	*756*						
Preparation	*143*	*19,2*	*2750*						
Total nr. 15		*24,5*	*3507*	*240*	*14,61*	*37400*	*9,38*	*1*	*3506,83*
Nr. 16									
Inspection	*143*	*4,0*	*573*						
Preparation	*143*	*7,0*	*1003*						
Total nr. 16		*11,0*	*1576*	*91*	*17,32*	*11961,95*	*13,17*	*1*	*1575,78*
Nr. 17									
Inspection	*143*	*2,0*	*287*						
Preparation	*143*	*1,0*	*143*						
Total nr. 17		*3,0*	*430*	*13*	*33,06*	*1430*	*30,05*	*1*	*429,76*
Total, farmers transactions with Debio			15796	1239	12,75	190594	8,29	17	929,15
Total for all adm. levels			**12128241**		**78,07**		**63,27**		**7152,14**
Total, control of prod. met. exc.			**3514801**		**24,23**		**18,34**		**1711,15**

9. CONVERSION SUPPORT TO ORGANIC FARMING

Administration level	Costs/hour	Work. hours	TC in NOK	Decares	TC/decare	Subsidy	TC (% of sub.)	Applic.	TC/applic.
The Ministry of Agriculture	500	3,2	1621	16180	0,10	6893400	0,02	418	3,88
The Norwegian agricultural authority			920000	16180	56,86	6893400	13,35	418	2200,96
The agricultural inspection service	333	6,5	2162	16180	0,13	6893400	0,03	418	5,17
Debio			662804	16180	40,96	6893400	9,62	418	4500,00
County agricultural authority									
Registering	*260*	*0,3*	*78*						
Other administration	*281*	*18,5*	*5202*						
Total, county agricultural authority		18,8	5280	1890	2,79	867300	0,61	32	164,99
Local agricultural authority	277	28,6	7922	381	20,79	213600	3,71	9	880,21
Farmers trans. with the state									
Nr. 1			*39*	*90*	*0,44*	*54000*	*0,07*	*1*	*39,31*
Nr. 2			*111*	*15*	*7,40*	*9000*	*1,23*	*1*	*110,94*
Nr. 3			*144*	*13*	*11,04*	*7800*	*1,84*	*1*	*143,52*
Nr. 4			*23*	*10*	*2,34*	*3000*	*0,78*	*1*	*23,43*
Control			*3*						
Total, farmers trans. w. the state			320	128	2,50	73800	0,43	4	80,07
Farmers transactions with Debio									
Nr. 1	*143*	*2,8*	*394*	*90*	*4,38*	*54000*	*0,73*	*1*	*393,95*
Nr. 2	*143*	*1,5*	*215*	*15*	*14,33*	*9000*	*2,39*	*1*	*214,88*
Nr. 3	*143*	*1,3*	*186*	*13*	*14,33*	*7800*	*2,39*	*1*	*186,23*
Nr. 4	*143*	*1,0*	*146*	*10*	*14,61*	*3000*	*4,87*	*1*	*146,12*
Total, farmers trans. w. Debio			941	128	7,35	73800	1,28	4	235,29
Total for all adm. levels			**2002038**		**131,50**		**29,04**		**8070,57**

10. SUPPORT FOR PRESERVING CATTLE RACES

Administration level	Costs/hour	Work. hours	TC in NOK	Animals	TC/animal	Subsidy	TC (% of sub.)	Applic.	TC/applic.
The Ministry of Agriculture	500	9,4	4688	1597	2,94	965064	0,49	437	10,73
The Norwegian agricultural authority			552000	1597	345,65	965064	57,20	437	1263,16
The Norwegian museum of agriculture									
Control			*8000*	*1597*	*5,01*	*965064*	*0,83*	*437*	*18,31*
Register			*696250*	*1597*	*435,97*	*965064*	*72,15*	*437*	*1593,25*
Total, museum of agriculture			704250	1597	440,98	965064	72,97	437	1611,56
County agricultural authority									
Local agricultural authority									
Farmers									
Nr. 1	*143*	*1,0*	*148*	*3*	*49,34*	*1896*	*7,81*	*1*	*148,03*
Nr. 2	*143*	*1,0*	*143*	*1*	*143,25*	*632*	*22,67*	*1*	*143,25*
Nr. 3	*143*	*0,2*	*29*	*4*	*7,16*	*1264*	*2,27*	*1*	*28,65*
Nr. 4	*143*	*0,2*	*24*	*1*	*23,88*	*632*	*3,78*	*1*	*23,88*
Total, farmers			344	9	38,20	4424	7,77	4	85,95
Total for all adm. levels			**1335937**		**827,77**		**138,43**		**2971,39**
Total for all adm. levels, register exc.			**639687**		**391,79**		**66,28**		**1378,14**

11. SUPPORT FOR SPECIAL LANDSCAPE VENTURES

Administration level	Costs/hour	Work. hours	TC in NOK	Subsidy	TC (% of sub.)	Numb. of vent.	TC/venture
The Ministry of Agriculture	500	37,5	18750	113249017	0,02	2791	6,72
Norwegian agricultural authority							
Labour costs	*311*	*5286,0*	*1643946*				
Computer costs			*1500000*				
Information material			*600000*				
Total, Norwegian agricultural authority			3743946	113249017	3,31	2791	1341,44
County agricultural authority	286	792,9	226 769	7406682	3,06	131	1731,06
Local agricultural authority	253	649,5	164 324	358000	45,90	10	16 432,35
Farmers							
Nr. 1	*143*	*15,0*	*2145*	*160000*	*1,34*	*1*	*2145,00*
Nr. 2	*143*	*2,5*	*358*	*11000*	*3,25*	*1*	*357,50*
Nr. 3	*143*	*5,0*	*715*	*25000*	*2,86*	*1*	*715,00*
Nr. 4	*143*	*17,5*	*2503*	*160000*	*1,56*	*1*	*2502,50*
Nr. 5	*143*	*4,0*	*572*	*44100*	*1,30*	*1*	*572,00*
Nr. 6	*143*	*2,5*	*358*	*7500*	*4,77*	*1*	*357,50*
Total, farmers			6650	407600	1,63	6	1108,25
Total for all administration levels			**61059320**		**53,92**		**20619,82**