ISSN 1327-8231

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 148

Complex Policy Choices about Agricultural Externalities: Efficiency, Equity and Acceptability

by

Clem Tisdell

June 2008

THE UNIVERSITY OF QUEENSLAND

ISSN 1327-8231
WORKING PAPERS ON ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 148

Complex Policy Choices about Agricultural Externalities: Efficiency, Equity and Acceptability *

by

Clem Tisdell†

June 2008

---

* A paper for a seminar to be given in The School of Economics, University of Wollongong on 19 June, 2008. This is a draft contribution for *Institutions and Sustainability: The Political Economy of Agriculture and Natural Resources*. Essays in Honor of Konrad Hagedorn. (Edited by Volker Beckmann and Martina Padmanabhan) Edward Elgar, Cheltenham, UK and Northampton, MA, USA. Forthcoming. This is a revised and extended version of working paper No. 146 in this series.

† School of Economics, The University of Queensland, Brisbane QLD 4072, Australia
Email: c.tisdell@economics.uq.edu.au

WORKING PAPERS IN THE SERIES, *Economics, Ecology and the Environment* are published by the School of Economics, University of Queensland, 4072, Australia, as follow up to the Australian Centre for International Agricultural Research Project 40 of which Professor Clem Tisdell was the Project Leader. Views expressed in these working papers are those of their authors and not necessarily of any of the organisations associated with the Project. They should not be reproduced in whole or in part without the written permission of the Project Leader. It is planned to publish contributions to this series over the next few years.

Research for ACIAR project 40, *Economic Impact and Rural Adjustments to Nature Conservation (Biodiversity) Programmes: A Case Study of Xishuangbanna Dai Autonomous Prefecture, Yunnan, China* was sponsored by the Australian Centre for International Agricultural Research (ACIAR), GPO Box 1571, Canberra, ACT, 2601, Australia.

The research for ACIAR project 40 has led in part, to the research being carried out in this current series.

<u>For more information</u> write to Emeritus Professor Clem Tisdell, School of Economics, University of Queensland, Brisbane 4072, Australia.

Complex Policy Choices about Agricultural Externalities: Efficiency, Equity and Acceptability

ABSTRACT

A feature of the research contribution of Konrad Hagedorn is his proposals for the integration of economic, social and political dimensions of agricultural policy. His wholistic approach involves, in part, an extension of new institutionalism to public policy. This article identifies a number of difficulties that arise in choosing public policies for regulating externalities generated by agricultural activity. First, it is noted that finding an economically efficient agricultural policy can be difficult because the functions involved can be irregular – they may involve features associated with the mathematics of catastrophe. This adds to the complexity of public decision-making and adds to the bounds in rational choice. Secondly, in the light of the research results of behavioural economists and other considerations, it is shown that efficient economic solutions to resource allocation are not independent of the distribution of property rights. This inevitably requires consideration of whether the distribution of these rights is equitable. Thirdly, the importance of institutional structures for the transaction costs (or more generally administrative costs) of implementing agricultural policy are stressed and this is illustrated. Fourthly, the political acceptability or practicality of implementing policies is claimed to be a relevant consideration in choosing agricultural policies. It is noted that this is influenced by existing social structures and cultural factors. Some of these issues are briefly illustrated by public policies (such as those implied by the International Convention on Biological Diversity) designed or intended to extend property rights in genetic material.

Complex Policy Choices about Agricultural Externalities: Efficiency, Equity and Acceptability

1. Introduction

As originally pointed out by Arthur Pigou (1932) and as is now well known, economic externalities (whether favourable or unfavourable) can be an important source of market failure. However, the mere presence of externalities does not mean that they are Pareto relevant. When unfavourable externalities are infra-marginal, they are often irrelevant. However, if alternative production techniques or consumption methods are available with different sets of externalities, market failure can still occur (Tisdell, 1993, Chs. 2 and 3). Even if no significant externalities are observed from an economic activity, for example when a particular type of farming is adopted, an alternative type of activity or set of farming practices may generate large positive externalities and be socially superior. In such a case, market failure also occurs even though no actual externality is observed. This implies that in order to assess whether externalities could be Pareto relevant, one has to consider not only the marginal external effects of economic activities but also their total effects (Tisdell, 2005 Ch.3). Evaluation of externalities is much more complex than has been traditionally realized and cannot be done accurately by adopting only a marginalist point of view.

Note that failure to take adequate account of externalities is not peculiar to market systems but also occurs in non-market systems, including state decision-making about resource-use. Failure to take proper account of externalities in state decision-making might also be more widespread in societies where democracy and freedom of speech and communication are limited, such as appeared to be the case in many centralized communist countries. There is considerable evidence that inadequate attention was given to the effects of adverse environmental externalities in former communist countries. One of the many examples includes the decision by the Soviet Union to extensively use waters feeding the Aral Sea for irrigating cotton with subsequent serious adverse effects on the Aral Sea itself. Not only does state decision-making often fail to take sufficient account of environmental spillovers, but also inadequate attention is sometimes given to sustainability issues. A recent example is Indonesia's transmigration programme from Java to Kalimantan. The Indonesian government has sponsored resettlement projects intended to grow rice on peat lands in Kalimantan Their soil quality is such that agricultural production is not sustainable on these lands. In addition, these land areas are often the source of fires that cause air pollution in Southeast Asia and add to greenhouse gas emissions (Singleton et al., 2004, p.70).

As pointed out by Galbraith (1952, 1967), the presence of democracy and freedom of speech do not ensure that governments take adequate account of externalities in their decision-making. Political lobbying and associated mechanisms can result in economic failure of a Paretian type.

In this article, the patterns and nature of agricultural externalities and their relationship to agricultural sustainability are discussed first. These can give rise to complicated mathematical relationships and add to the difficulties of rationally choosing agricultural policies. The nature of such externalities has normative implications for the choice of public policies intended to regulate agricultural spillovers and these implications are outlined. While the main emphasis in this article is on environmental externalities from and within agriculture, attention is also given to agricultural externalities arising from adverse selection. This aspect, together with the regulation of agriculture's environmental externalities, is being addressed under the EU's new Common Agricultural Policy. The implications are explored for agricultural environmental policy of features often associated with the new institutional economics, such as transaction costs and aspects of uncertainty in policy formation and implementation are considered. Subsequently, attention is given to political and social acceptability as influences on choices about agricultural policy. Then agriculture's role in biodiversity conservation is considered as a particular case. In line with the polycentric approach of Konrad Hagedorn, topics in this analysis are considered from multiple points of view and institutional structures are shown to be important in relation to economic efficiency and the political acceptability.

2. Types of Agricultural Externalities

Externalities involving agriculture can be classified in varied ways. The public's attitude about how externalities involving agriculture should be regulated are likely to be influenced by their nature. The following types of spillovers involving agriculture can be identified:

(1) **Spillovers from non-agricultural sectors of the economy affecting agriculture**. Agriculture can experience adverse environmental externalities from airborne pollution caused by emissions of particulate matter, metallic dust, acidic vapour and particles as well as water pollution from wastes from factories and mining. For instance, horse breeders from the Scone area in the Hunter Valley of New South Wales, Australia, complain that coal dust from open-cut coal mines causes their naturally alkaline soils to turn acidic. It is claimed that this has adverse consequences for the development of the bones of the thoroughbred horses and makes them less fit for racing.

(2) **Spillovers from agricultural to non-agricultural sectors of the economy**. Agriculture may, for example, create and sustain landscapes favoured by the public, such as heathlands, or in some cases, ones that are disliked by the public, such as weedy areas, for example areas of gorse in New Zealand. Similarly, while some types of agriculture conserve wild species wanted by the public, they also result in the loss of other species desired by the public. Water run-off from agricultural land containing chemicals leached from fertilizers and livestock manure as well as soil particles results in nutrient-enrichment of water bodies and this stimulates growth of aquatic algae and weeds and accelerates eutrophication of some water masses. Run-off from agricultural lands (particularly land for growing sugar cane in northern coastal Queensland) is claimed to have an adverse impact on corals in parts of the Great Barrier Reef. Corals do not survive in dirty, nutrient-rich water.

(3) **Spillovers confined to agriculture itself.** Unfavourable ones include dryland salting (if the effect extends beyond a farm where land clearing occurs), salination of watercourses as a result of land clearing, herbicide or pesticide drift, adverse externalities from water use and possible cross-fertilization of GM (genetically modified) and non-GM crops. Favourable externalities within agriculture can result from pest control by farmers having pests on their property.

Externalities may also be classified according to the mathematical nature of the spillover benefits or costs that they generate. Institutional neoclassical economic analysis usually supposes that these functions are continuous and differentiable. This, however, is a special case. In some cases, including in agriculture, marginal external economic impacts may only arise once the level of an activity exceeds some thresholds. In other cases, marginal external economic impacts of an economic activity may fall to zero once the level of the activity reaches a particular threshold or both aspects may occur. In many cases, the relationships involved are best modelled using the mathematics of catastrophe (Zeeman, 1976; Poston and Stewart, 1978; Arnold, 1992; Anon, 2008). Note that this mathematics is not only relevant to the modelling of catastrophes but can be applied to a whole host of irregular functional relationships. When such thresholds occur and different techniques of production generate varied spillover impacts, policy choices for regulating economic activities in order to attain economic efficiency can become very complicated. Often one can no longer rely on marginal effects to determine Paretian efficient policies but must estimate total effects. Furthermore, views about what is equitable can alter, that is, for example, whether or not farmers should be subsidized for creating favourable externalities that are infra-marginal. The next section demonstrates the significance of these complications.

3. Complications Arising from Thresholds in the Economic Effects of Externalities

The purpose of this section is to show how the pursuance of thresholds in the external economic effects generated by externalities can complicate policy choices for their regulation. Traditional neoclassical analysis does not take such complications into account. Several possibilities are considered. In the first case, the spillover depends on the type of technique used for production but the Paretian efficient technique is not adopted in a free market. In the illustrated case (Figure 1), all production should be obtained by using the technique with a favourable externality. In the second case (illustrated by Figure 2), economic efficiency requires a portion of supply to be provided by a technique generating a favourable externality and the remainder to be supplied by a technique involving no externalities. It is then pointed out that many externalities can be Paretian irrelevant and that thresholds can create further complications for evaluating externalities, for example, in cases where adverse externalities from the use of a method of production only emerge once the extent of its use exceeds some threshold. Often such complications imply that to achieve economic efficiency, an 'ideal' mixture of techniques should be used in production. Evaluating the economic consequences of the different available techniques in order to determine this ideal could be a Herculean task, especially if some of the available techniques have not been used or empirically tested on a large scale.

Note that in the theory outlined in this section, the assumptions of neoclassical economics are adopted. However, thresholds are allowed for in this analysis whereas in neoclassical analysis they are not.

There are reasons to believe that thresholds could be significant in relation to externalities generated by agriculture. For example, external demand for the supply of particular agricultural landscapes may drop to zero once their supply exceeds a particular threshold. Or the external demand for particular landscapes might be zero until their transformation by agricultural production reaches a particular threshold. To give another example, the external benefits of conserving traditional breeds and crop varieties may be zero until the level of agricultural production using 'improved' breeds and crop varieties reaches a particular threshold. This type of analysis has implications for the efficiency (and equity) of subsidizing agriculture production methods in the European Union that have favourable externalities (Van Huylenbroeck and Durand, 2003; Vanslembroeck and Van Huylenbroeck, 2005). With this background in mind, let us consider some specific theoretical possibilities which allow for thresholds.

3.1 A Paretian relevant externality

For simplicity, assume that only two methods of producing an agricultural product are available. Method I has no external costs or benefits and involves the least private cost of production. Represent the market demand for this agricultural product by line DD in Figure 1 and let S_1S_1 represent its market supply curve when technique I is adopted. Using this method of production, the market would come into equilibrium at E_1. Suppose that a second method (Method II) is available but involves higher private costs of production. Consequently the supply curve S_2S_2 applies in this case. This alternative method generates a favourable externality, for instance by creating desirable landscapes, and the marginal external value obtained is assumed to be equal to the difference between curve ABCF and line DD. However, production using method II generates no marginal externality once its level exceeds X_4.

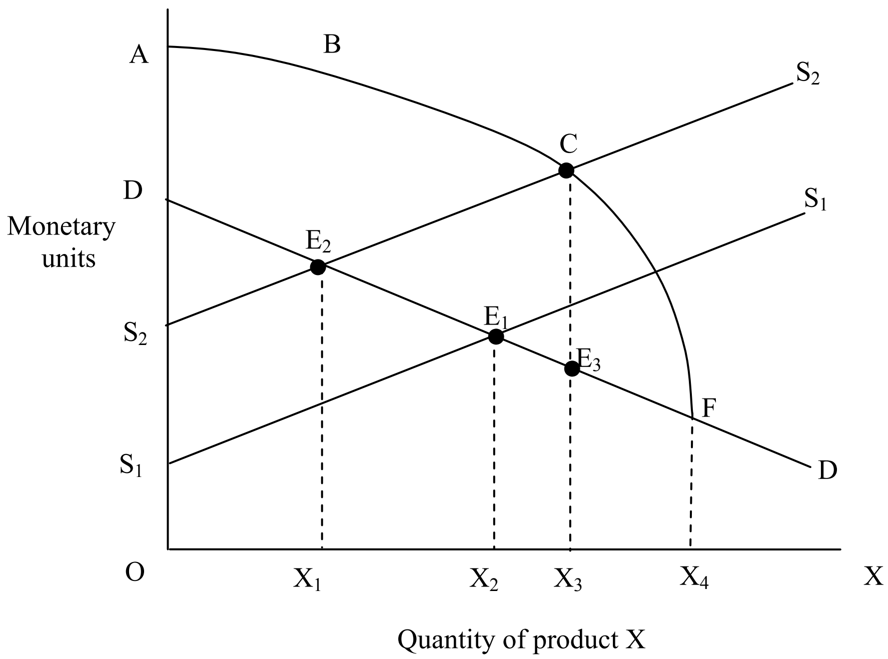

Figure 1: A case where a favourable externality can be generated by agricultural production if a technique of production is adopted by farmers that does not minimize their private costs of production. For simplicity only two alternative techniques, I and II, are assumed to be available. The use of technique I generates no externalities and results in an industry supply curve indicated by line S_1S_1. The market demand for the agricultural product X is shown by the line DD. If technique I is adopted, market equilibrium will be established at E_1 with X_2 of the product being supplied. The private marginal cost of using technique II is higher than for technique I and the industry supply curve if it is adopted is as shown by line S_2S_2. This would result in a market equilibrium corresponding to E_2. In a free market, technique I rather than II will be adopted by farmers. However, use of technique II generates a positive externality, the marginal value of which is equal to the difference between the curve marked ABCF and the line DD. If the potential Paretian improvement criterion of economic efficiency is adopted, it is desirable that technique II should be adopted rather than technique I. However, merely banning the use of technique I will not give rise to an efficient economic outcome because it will only result in production of X_1 of the agricultural product arising from technique II. The wealth-maximizing ideal level of production corresponds to point C (the point where the social marginal benefit from extra supplies of X using technique II equals the marginal private cost of its supply) and implies that agricultural production should be X_3. Economic incentives, such as a production subsidy, are needed to bring about the efficient economic result.

Taking into account the favourable externality, economic welfare benefits from agriculture production are maximized when only method II is used and X_3 of the agricultural product is supplied. This could be achieved by only allowing the use of method II and paying a subsidy of CE_3 on each unit of product X supplied. However, the externality could be infra-marginal in some cases.

3.2 An inframarginal externality which is Paretian relevant for policy and which complicates social decisions

A more complicated case is illustrated in Figure 2. As in the previous case, demand for greater quantities of the favoured landscape eventually falls to zero but in this case, satiation with the supply of the landscape occurs before market equilibrium is reached. Satiation with the landscape **incidentally** supplied as a result of agricultural activity occurs when X_1 of product X is produced using technique II. Otherwise the same assumptions as in the previous case are made. In the absence of intervention, X_3 of product X will be supplied using only technique I. However, because of landscape externalities, it is socially optimal that X_0 of the product be supplied using technique II with $X_3 - X_0$ being supplied by technique I. At X_0, the marginal value of the externality, BG, is just equal to the difference in the marginal cost of production using the alternative technique.

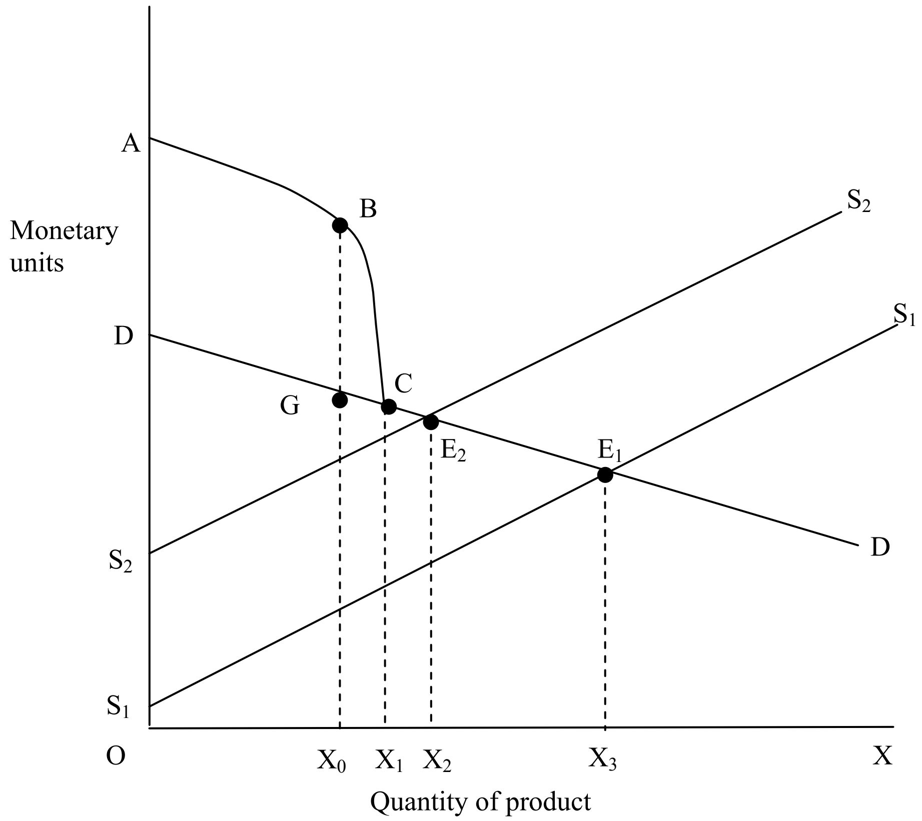

Figure 2: This figure has the same interpretation as Figure 1 and is based on the same theoretical assumptions. However, whereas the favourable externality was extra-marginal in Figure 1, here it is infra-marginal compared to the market equilibrium, E_2. Here there is no marginal external benefit from producing more than X_1 of the agricultural product using technique II but in the case illustrated in Figure 1, that does not happen until more than X_4 of X is produced using technique II. This complicates the efficient economic allocation because it requires some of the agricultural production to be supplied using technique II and some to be supplied using technique I. The combination required for economic efficiency is easily identified in Figure 3.

In this case, economic optimality can be achieved by paying a minimum subsidy on each unit of X produced equal to the excess marginal cost of its production using technique II rather than I up to an aggregate level of production of X_0. No subsidy is paid for production exceeding X_0. The per unit subsidy is lower in this case than in the previous case.

The optimality condition given the situation in Figure 2 can be clarified by reference to Figure 3. In that figure curve KLM represents the marginal value of the externality when technique II is used. This falls to zero for a level of production of X_1 or more. OH represents the marginal opportunity cost of using technique II rather than I to produce X. It is the difference between S_2S_2 and S_1S_1 in Figure 2, the difference in the per unit production cost between the techniques. The optimal outcome corresponds to point L. At this point, the marginal external value obtained by using technique II just equals the marginal opportunity cost of using it.

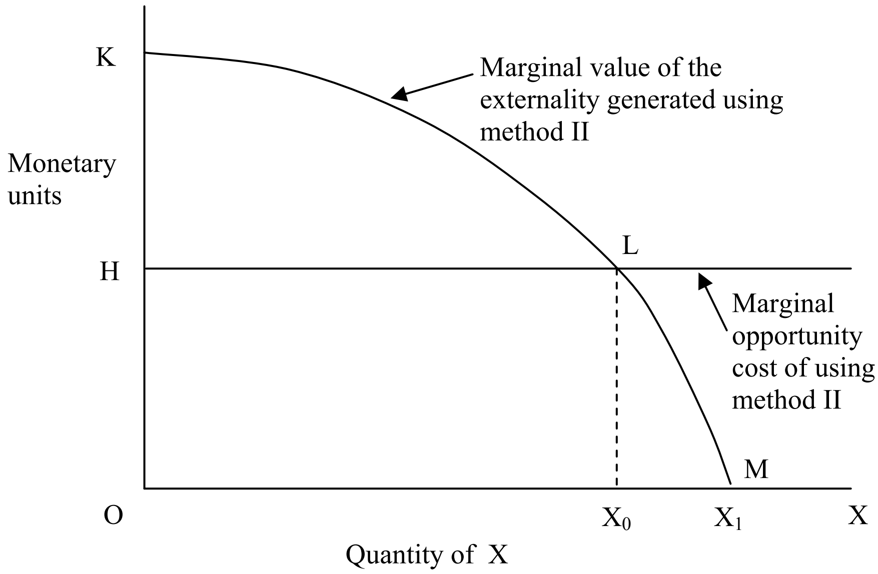

Figure 3: An illustration of the 'efficient' solution to the situation depicted in Figure 2. The difference between the social marginal value of using technique II rather than technique I to produce X is shown by curve KLM. This falls to zero when X_1 or some of X is produced using technique II. The line HL indicates the difference between the private marginal cost of using technique II rather than I to produce X. It is equivalent to the distance between lines S_2S_2 and S_1S_1 in Figure 2. The efficient economic solution is for only X_0 of X to be produced using technique II and for the remainder of demand ($X_2 - X_0$), as shown in Figure 2 to be met using technique I. This complicates agricultural policy-making. Note that use of technique II is still generating positive marginal externalities where it is efficient to switch to technique I to provide the extra supplies of the agricultural product.

In the situation illustrated in Figure 2, a regulating authority requires more information than in the case shown in Figure 1 to regulate externalities so as to achieve a Paretian optimum. In most cases of this type, a regulatory authority is unlikely to have sufficient information to regulate economic activity optimally. However, it may be able to obtain an idea of when beneficiaries are likely to be satiated by a particular favourable environmental feature. It will never be optimal to proceed beyond the satiation point and if opportunity costs are involved, it will usually be socially optimal to supply less of the environmental amenity than results in satiation with it.

3.3 Some externalities are Paretian irrelevant

The economic evaluation of externalities is complicated further by the fact that some externalities are Paretian irrelevant (Tisdell, 1970, 1993 Chs. 3-4; Walsh and Tisdell, 1973). For example, an infra-marginal externality can be Paretian irrelevant in relation to the equilibrium of a market. This is because it does not affect the market equilibrium. If the externality is favourable, there is no economic efficiency argument for providing a subsidy to suppliers of the externality. This is assuming that the socially optimal technique has already been adopted by suppliers. If on the other hand, the infra-marginal externality is an unfavourable one, its total effect needs to be assessed. This is because the total social cost of supplying the commodity may exceed its economic value. In that case, it is economically efficient to ban production of the commodity (Tisdell, 2005).

3.4 Further complications

Some externalities do not occur until the level of production or economic activity exceeds a threshold. The presence of such externalities further complicates the choice of policies to maximize economic efficiency. For example, the loss of traditional breeds of livestock or plant varieties may not involve external costs until production using 'improved' breeds or modern crop varieties exceeds some threshold level. Significant social economic costs from the displacement of traditional breeds and crop varieties only emerges after this threshold is reached. Only after this point is it likely to become efficient to subsidize the conservation of traditional breeds and plant varieties. Social decisions will need to be made about how much traditional agricultural genetic material should be conserved taking into account its potential (or actual) externality and public good attributes of this material.

The above discussion indicates that when agricultural externalities occur, a mixture of techniques or methods to produce the aggregate level of supply of a commodity is often efficient from an economics point of view. Neoclassical economics has not given enough attention to factors influencing the optimal **mixture** of methods or techniques for production taking into account externalities

4. Adverse Selection as an Unfavourable Externality and Possible Threshold Effects

The phenomenon of adverse selection of products involves unfavourable externalities. Adverse selection involves asymmetric information about a product and occurs when buyers are unable to easily ascertain the quality of a product by inspection, even though it is known to suppliers. The problem then arises when products of inferior quality cost less to produce than those of superior quality, that the inferior ones my be traded as being of top or acceptable quality. This can cause the whole market for the products to collapse or result in only the inferior products being traded (Akerloff, 1970; Varian, 1987, pp. 630-635). This happens even though buyers have an effective demand for the superior products.

The conditions under which agricultural products are produced are often difficult to determine by inspecting the final product. Therefore, there is a high risk of adverse selection occurring for agricultural products. It is often not clear, for instance, from inspection whether food products are produced under hygienic conditions, are organic produce or not, or are derived from free-range animals or not. Furthermore, it is usually not clear from inspection whether agriculturally based products are derived from GMOs or not, whether their production involved a lack of consideration of animal welfare, whether production techniques were used that pose a potential health risk to humans, (for example, mad cow disease), or whether they actually originate from regions or areas from where they are claimed to come from.

Processes of adverse selection can also be subject to thresholds and sharp variations (spikes). For example, when the proportion of defective or inferior products traded in a market (or sub-market) reaches a particular proportion the market may collapse altogether or the rate of decline in the demand for the product may suddenly alter from falling at a declining rate to falling at an increasing rate. The latter involves a cusp (a spike) in the relationship. Furthermore, once a market collapses, it may be very difficult to re-establish trust in the products involved and re-create the market. This means that hysteresis is present. It is a type of path-dependence. This phenomenon is not taken into account in neoclassical economic theory but is one of the focal interests of the mathematics of catastrophe.

Governments can help to overcome some of these problems by requiring the correct labelling of products and by imposing penalties for non-compliance. Also laws may be passed specifying that minimum hygiene conditions are to be complied with in producing and trading in commodities that could pose a health risk. Governments may be active in enforcing these laws and non-compliance with them is likely to make sellers subject to claims for damages from injured buyers. Standards may also be attested to by trusted non-government organizations and other bodies.

Other institutional arrangements can also evolve to address the phenomenon of adverse selection. For example, some large **retailers,** such as supermarkets, attest to the quality of the products that they sell and offer money-back guarantees. They check the products supplied to them and are able to enforce quality and other conditions on their suppliers. Similarly, the sellers of some branded products are able to establish trust in their brands. These institutional arrangements can, however, create significant barriers to entry of new suppliers of quality products.

Adverse selection can result in lack of sustainability of agricultural production of superior products, can reduce regional production of specialities and in some cases, could lead to the complete collapse of individual agricultural markets. Elimination of adverse selection benefits both buyers as well as sellers of superior or sought after products. Some institutional arrangements are more prone to the occurrence of adverse selection than others. For example, depending on the type of products being traded, free market institutional arrangements often need to be supplemented by additional institutional structures to prevent major losses in economic efficiency and in order to sustain the operation of socially desirable markets. In many cases, hybrid governance or institutional structures evolve (or may only evolve) to address such problems and they support the sustainability of markets (Van Huylenbroeck and Verbecke, 2008). These institutional structures may evolve on their own accord and in other cases, they may be able to evolve with government assistance. The social and economic attributes of the hybrid systems that evolve need to be examined carefully to decide on how beneficial they are and whether superior systems are possible.

5. Environmental Externalities and Sustainability

Lack of sustainability of agricultural production and of incomes often, but not always, arises from adverse environmental externalities affecting agriculture (Tisdell, 1999, Ch. 4). Examples include depletion of shared water bodies such as aquifers, as a result of open-access or poorly regulated access to the water, spillovers from salting such as reduced water quality, or environmental pollution caused by other industries that adversely impact on agricultural production. It is also possible that loss of genetic diversity could eventually have adverse consequences for the sustainability of agricultural production.

However, lack of sustainability of the productivity of agriculture cannot always be attributed to environmental externalities. Taking into account the discount rates which landholders apply, it may pay them to mine their land. The higher their discount rate, the more likely landholders are to do this. A higher discount rate results in stronger preferences for farm income now rather than in the future. Rising relative returns from investing off-farm rather than on-farm and easier access to off-farm investment opportunities can also have a similar effect. In both cases, lack of agricultural sustainability is a consequence of private decisions by farmers rather than a consequence of externalities.

Sometimes, particular institutional arrangements for the use of shared resources (subject to adverse externalities) can increase the economic efficiency of their use and promote the sustainability of agricultural production. For example, co-operative arrangements between persons for the management of a shared natural resource may benefit all (Swallow et al., 2008). Nevertheless, co-operative agreements, may only evolve if the number of effective parties is relatively small or if legal obligations provide a stimulus for their formation, as in the case of the New York water supply. In that case the water authority was legally required to supply water which met a minimum standard of quality. The water authority decided that rather than incur extra costs to treat this water, the most economical solution would be for farmers in its water catchment to plant trees to improve water quality. It was able to reach a co-operative agreement with these farmers to achieve this, as reported in Swallow et al. (2008).

In other cases, for example, institutional reform which results in the introduction of tradable permit systems may result in the more efficient use of shared resources. However, such systems will only result in sustainability if production of the aggregate allowable use of the shared natural resource does not lead to its over exploitation. Furthermore, systems of tradable resource rights are more complex than is commonly realized and can involve a high level of transaction costs, as pointed out by Tisdell (2009, Ch.6). These systems involve hybrid economic governance structures (Van Huylenbroeck and Verbeke, 2008) in the sense that they combine government regulation with the use of market forces to manage the shared use of natural resources.

6. Equity, Efficiency and Agricultural Externalities

The presence of externalities is often believed to provide a case for public intervention in an economy in order to bring about a Paretian improvement, particularly if the transaction costs involved in intervention are low or zero. Nevertheless, externalities can be Paretian irrelevant (see Section 3) in which case there are no economic efficiency grounds for intervention.

Whether there are equity grounds for public intervention when externalities are Paretian irrelevant is less clear. If an externality is favourable and Paretian irrelevant, should those who benefit from it have to pay those who generate it? The case for this seems to be weak because those who engage in the activity already gain from it in any case and it is coincidental that the external beneficiaries also gain. Compared to its absence, there is a Paretian improvement as a result of the activity occurring. But what if an adverse externality is involved? Those creating the adverse externality gain from it but those who suffer from it lose compared to the original situation. Even if the adverse externality is Paretian irrelevant, there could be a case in such circumstances to compensate the victims on distributional grounds.

The above indicates that the case for transferring income to agriculturalists on the basis that they create favourable externalities is sometimes weak on economic grounds. The externalities may be infra-marginal and Paretian irrelevant. However, compensation to farmers seems justifiable when it is intended that they should alter their activities at a cost to them in order to change the nature or extent of the favourable externalities they create. The minimum necessary compensation in such cases would be the extra cost the agriculturalists incur to comply with the policy. To the extent that farm income supports under the Common Agricultural Policy (CAP) focus on this aspect, they could be regarded as being equitable and as promoting economic efficiency. In practice, however, it is debatable whether environmental policies can be so finely tuned. It may be that some agricultural subsidies are being paid for the generation of Paretian irrelevant externalities or that a greater amount is being paid than the costs to farmers of generating additions to favourable externalities. The presence of infra-marginal and extra-marginal externalities complicates the formulation of environmental policies.

A further set of economic efficiency versus equity issues are raised by the Coase theorem (Coase, 1960) which he illustrated by an agricultural example. This theorem was welcomed by strong advocates of private property rights and seemed to provide solid support for those, such as Posner (1981), favouring aggregate wealth maximization as the desirable goal for the organization of society. Nevertheless, a serious shortcoming of Coase's theorem is that it ignores equity issues and only concentrates on economic efficiency. The theorem asserts that in the absence of transaction costs, a Paretian optimum can be achieved if either polluters have the right to pollute or if others have the right to a pollution-free environment. However, the distribution of income is entirely different depending on whether those generating the adverse externality are given the right or those affected by it. A choice between the alternatives must be made on the grounds of justice. It is less well known that Coase's **efficient solution** to the externality problem is sensitive to the distribution of property rights.

This second limitation of Coase's theorem means that **the Paretian efficient use of shared natural resources varies with the distribution of property rights** in these; that is with the distribution of resource entitlements, Consequently, the efficient economic solution to Coase's resource-use problem cannot be divorced from the distribution of those rights. There are at least two reasons why this is so. As is well known in neoclassical welfare economics, changes in resource allocation which are able to bring about a Paretian improvement depend upon the initial endowments of those involved in economic activity: they restrict for example, points on the contract curve which can result in a Paretian improvement compared to the original position (Tisdell and Hartley, 2008). However, a very important effect can also be the status quo or endowment effect.

Research by behavioural economists finds that the willingness of individuals to pay (WTP) for an environmental good is generally less than their willingness to accept compensation (WAC) for its loss. This has been described as the endowment or status quo effect (Kahneman et al., 1991, Knetsch, 1987, 1990). This effect results in a different bargained outcome given Coase's approach depending upon whether those creating an adverse externality have the right to create it or whether those adversely affected by it have the right to disallow it. Hence, the efficient economic solution is sensitive to the distribution of rights. This can be illustrated by a simple example.

Suppose an area of land is in a relatively natural state that is privately owned and suitable for agriculture. The owners are basically agriculturalists and would like to transform the land so its agricultural productivity can be raised. They need to clear the land of trees (of forest) but this creates an adverse externality for others whom we shall call conservationists.

If agriculturalists do not have the right to clear the land of trees, their marginal willingness to pay conservationists to allow this might be as indicated by line ABC in Figure 4. On the other hand, if agriculturalists have the right to land clearing, their marginal willingness to accept compensation to forgo land clearing might be as indicated by line DEF. Similarly, the marginal willingness to pay curve (to avoid deforestation) for conservationists might be as indicated by line GEH and their marginal willingness to accept payment for deforestation might be as shown by line JBK. It follows if landowners (agriculturalists) have the right to clear their land, that E is the Coasian bargained solution. If on the other hand, conservationists have the right to tree-cover of the land, B is the Coasian bargained solution. In the former case, a larger percentage of the land is cleared, x_2, than in the latter case which involves x_1 of the land being cleared. The efficient economic result is therefore varies with the distribution of property rights.

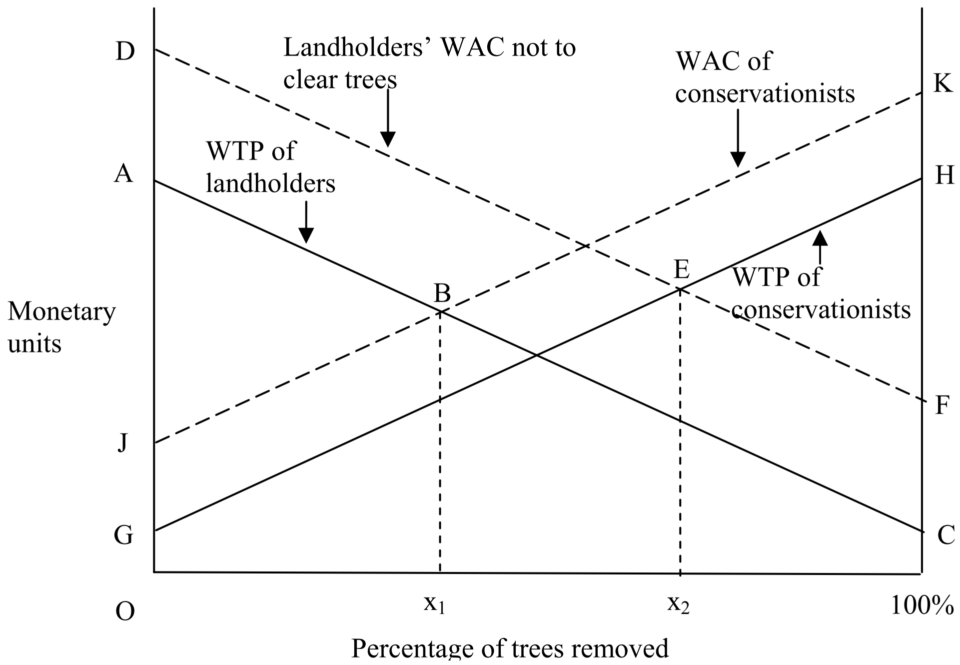

Figure 4: Coase (1960) argued that in many cases the clear specification of property rights in environments would facilitate an efficient economic response to the occurrence of externalities. However, because willingness to accept compensation for loss of these rights usually exceeds willingness to pay for such rights, the efficient economic outcome is sensitive to the legal distribution of property rights in the environment. This means that economic efficiency and equity are not independent. In the case illustrated, it is assumed that landholders obtain an economic benefit from clearing trees on their land but conservationists suffer an economic loss. If landholders have the legal right to all trees on their land, they will find it economic to remove them all in the absence of compensation to refrain from this. In the case shown, the marginal willingness of conservationists to pay landholders to refrain from removal of trees is indicated by line GEH and the willingness of landholders to accept compensation is indicated by the broken line DEF. In the absence of transaction costs, a bargained solution (an efficient solution) corresponding to point E should emerge. This will result in x_2% of trees being removed. On the other hand, if the property rights in the trees are reversed, the bargained outcome would correspond to point B. This efficient economic solution would result in only x_1% of trees being removed. Thus, even in the absence of transaction costs, the Paretian efficient solution depends on the distribution of property rights.

The reasons why the endowment or status quo effect exists and can be quite large has not yet been fully explained in the available economic literature. It may, however, be reinforced by the income effect.

In reality, the presence of transaction costs can be expected to hinder or block the realization of an efficient Coasian bargained outcome to the control of environmental externalities. In some cases, transaction costs will be least if the government intervenes to address the externality problem directly. Direct government intervention to regulate environmental externalities is sometimes (but not always) the most economical policy option. Determining the most efficient institutional structures for regulating externalities is a challenging task because it requires account to be taken of transaction costs and the possible presence of asymmetric information. These aspects are ignored in neoclassical economic analysis and therefore, some new institutional economists have branded it Nirvana economics. Let us consider transactions costs and asymmetric information in relation to the regulation of externalities.

7. Transaction Costs Involved in Public Regulation of Externalities

While public regulation of externalities can bring Paretian gains, this is by no means assured. Agency costs (transaction costs) are involved in the public regulation of externalities. This can be so high as to prevent a Paretian gain which would otherwise occur. Information deficiencies on the part of regulators are also a problem and improved knowledge can only be obtained at a cost which in some cases, can prove to be excessive.

Furthermore, principal-agent problems (which partly occur because of asymmetry of information) can arise if public servants look mainly towards their own self interest. They may try to maximize their income and that of their agency from their regulatory activities. They may fail to regulate environmental spillovers in a least cost manner and could absorb all the revenue obtained from environmental charges (or more if funded from general public revenue) in their administrative expenditure.

The problem can be illustrated by the Figure 5. For simplicity, suppose the point emission of a water pollutant that adversely affects agriculturalists and other water users. Suppose that the marginal externality costs imposed by the emission of the pollutant are as indicated by line OBD in Figure 5 and that line ABC represents the marginal benefit to polluters of being able to pollute. In the absence of regulation, polluters will emit x_2 of the water-borne pollutant per cent of time. This results in a social economic deadweight loss equivalent to the area of triangle BCD. A potential Paretian improvement is possible by reducing the level of these emissions from x_2 to x_1.

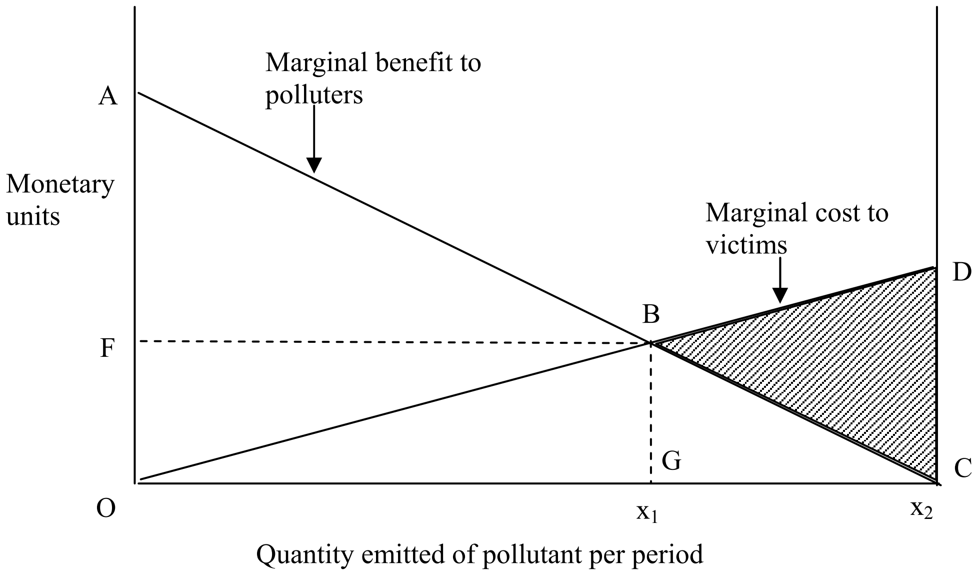

Figure 5: When transaction and related costs are taken into account, the cost of public regulation of externalities can exceed the social economic benefits otherwise obtained. In the case illustrated in the absence of regulation polluters will emit x_2 units of the pollutant per period of time. A potential Paretian gain can be achieved by reducing the level of emissions to x_1. This results in a potential net economic benefit equal to the area of triangle BCD. However, if the government's administrative expenditure to bring this about exceeds the area of the triangle, this regulation results in a net Kaldor-Hicks economic loss.

This could be achieved by the government imposing a charge of OF on each unit of the pollutant emitted. This would yield the equivalent of the area OFBG in public revenue. However, a Kaldor-Hicks loss will occur if the cost of administering the scheme exceeds the area of triangle BCD. This means that the economic gainers from the intervention (victims of pollution and the government) would not be in a position to potentially compensate losers (polluters) for the intervention. Observe that the final welfare impact of such a scheme would depend on how the public revenue obtained from it is used. This type of analysis leaves this issue unresolved. Furthermore, the equity question would remain of whether the victims of the water pollution should be fully compensated for their losses. In this case, even if emissions are reduced to x_2, victims of the pollution still suffer an economic loss equivalent to the area of triangle OBG and so the reduction in emissions from x_2 to x_1 does not fully satisfy them.

The economic efficiency of different institutional mechanisms for the management of natural resource use varies in their economic efficiency when account is taken of transaction costs. In addition, they often vary in their equity consequences and their political acceptability. For example, a system of tradable pollution rights may involve lower administration costs than a system of government charges on pollution emissions. However, both will involve administration costs. Furthermore, tradable permit systems can vary significantly in their nature (Tisdell, 2009, Ch.5) and therefore in their effects on economic efficiency and equity. For instance, if tradable pollution rights are auctioned, this will result in a transfer of income to the government but if they are allocated free of charge to existing polluters (a process known as grandfathering), polluters may end up with a windfall economic gain. In the latter case, they have a valuable asset which they may sell. Grandfathering can facilitate politically the introduction of government regulation of externalities.

8. The Political Acceptability of Economic Policies

Economic policies cannot usually be implemented unless they are politically acceptable. This means that the policies likely to yield to greatest economic benefits cannot always be implemented. What factors influence the political acceptability of policies?

Social values and ethics play a role in policy formulation. These change or evolve with the passage of time and are subject to influence by propaganda and other means. Secondly, institutional constraints may also impact on what is politically acceptable. Given these constraints, constituents will be limited in the ways in which they can object to political decisions and the costs that they must incur to try to change these decisions will also be affected. Such costs can result in passive acceptance of political decisions that may be unpopular. Therefore, those policies that are politically acceptable will vary with the historical background and institutional structures of nations.

While economists are often only concerned about the ultimate economic consequences of policies, political approaches tend to put much more emphasis on the procedures used for social decision-making. Some of these politically acceptable procedures (such as majority voting systems) can actually add to economic costs but constituents seem to be prepared to on occasions accept these in return for greater political or social involvement.

The type of conflict that can arise between preferences for political procedures and social economic benefits can be illustrated by Figure 6. There on the X-axis a set of political procedures are in theory valued from the least acceptable which are closest to its origin to the more acceptable which are further from the origin. For simplicity, these procedures are assumed to be continuous but need not be. The Y-axis indicates the social economic benefits from these alternative political procedures only one of which may be chosen. These social economic benefits may for example be for alternative possible policies relating to the regulation of environmental externalities in agriculture. Curve ABCD represents the frontier of possibilities, and W_1W_1 and W_2W_2 are social indifference curves of the Bergson type.

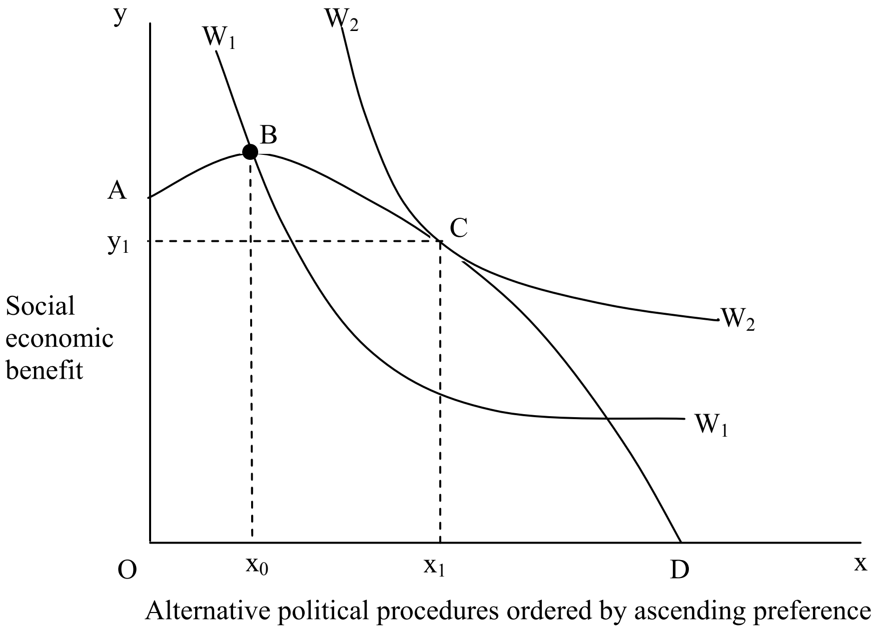

Figure 6: Policies that are economically efficient or create the greatest social economic benefit are not always politically acceptable. In this figure, curve ABCD shows the relationship between political procedures adopted and social economic benefits obtained. Political procedures corresponding to x_0 yield the greatest economic benefit but this combination of political procedures and the economic outcome is not socially ideal because preferences exist about the political procedures adopted in society for decision-making. Given the preferences represented by the social indifference curves W_1W_1 and W_2W_2, the ideal political procedure corresponds to x_1 even though it does not maximize social economic benefit.

Given the possibilities illustrated in Figure 6, the combination corresponding to point C is socially ideal. However, it does not result in the best ‘attainable’ economic outcome nor does it correspond to the most desired political procedure. Note that the ideal solution is Figure 6 corresponding to point C can change if the social indifference curves vary or if the ordering of possible political procedures alters, other things being constant.

Although the presentation in Figure 6 is more illustrative than definitive, it helps to support the view expressed by Hagedorn (1993) that agricultural economists should take account of the political acceptability of economic policies when they propose these. At the same time, it can be important (from a social point of view) for economists to point out economic benefits forgone by adopting politically acceptable procedures and policies that yield inferior economic results.

9. Property Rights in Agricultural Genetic Material and Externalities

It is often difficult to sustain property rights in agricultural genetic material, and in the past, genetic material was frequently taken from those originally possessing it without any payment being made for its use. This is still possible today but this possibility has now become more limited due to laws granting intellectual property rights to those who develop new plant varieties and patents or similar protection for those who create new genetically modified organisms.

The introduction of new organisms usually results in incompletely or unknown environmental risks. The more demanding is the screening required to determine these risks, the less profitable is it likely to be for enterprises to engage in such development. Furthermore, the greater are the environmental restrictions on the use of new organisms by the customers of their developers, the lower is the demand for these and the less incentive there is to develop them. For example, the more restrictions there are on the use of GM soya beans resistant to the herbicide glyphosate, the lower is the profitability of this innovation for Monsanto. Thus to some extent, a company, such as Monsanto, will profit from fewer environmental restrictions on the use of its GM seed. On the other hand, very loose regulations could result in serious environmental problems and in turn, this could generate a political backlash for developers of GM seed. It may be that the co-existence rules for the growing of transgenic crops and non-GMO crops provides an appropriate compromise between political acceptability and environmental risk (see Beckmann et al., 2006). Nevertheless, the appropriate level of environmental risk to take politically with new GMOs is uncertain.

On the other hand, public regulations ostensibly intended to protect the public against environmental risk often protect the party or parties that are the source of this risk. This is sometimes true of regulations that prescribe particular tests be carried out by those proposing to market a product for say use in agriculture. Provided the tests are conducted and show no problem, the seller may be free of further legal liability if a subsequent environmental problem emerges. The legal liability of the seller may be curtailed even further if a public body exists which authorises the use of the product (Tisdell,1993, Ch.5).

While intellectual property rights in new plant varieties and genetically modified organism could be justified on the basis that they provide economic incentives and rewards for research and innovation, the argument for property rights in existing natural genetic material (or that developed as a result of communities pursuing their own self-interest) appears to be more tenuous. Such rights might only be defensible on income distributional grounds or if the payment would result in conservation of the genetic material which otherwise would not be saved. If the conservation of the material would have occurred in any case, payment for it would not be compensation for supplying a service. In such cases the conservation of the genetic material is *Paretian* irrelevant. Apart from the huge transaction costs that would be involved if users of natural genetic agricultural material are required to pay the 'original' possessors of this material for its use, this might have little effect on the conservation of natural genetic material utilized in agriculture. Therefore, payment in such cases is essentially a rental payment. Consequently, it is surprising that the International Convention on Biological Diversity puts so much store on property rights in genetic material as a way of conserving biodiversity; a result that is widely believed to be environmentally desirable and to be favourable to sustaining economic development.

The granting of property rights to entities developing new genetic material, such as new plant varieties and genetically modified organisms, has become of growing importance in recent decades. In agriculture, a major concern has been that this new genetic material might give rise to unknown or unanticipated negative externalities. There is considerable debate about how one can best balance the potential economic benefits from such genetic developments against the environmental risks and uncertainties they entail and about the institutional structures that might be best to address these problems. Different countries have developed different structures presumably influenced by their varying political backgrounds and evolutionary aspects of governance (Beckmann et al. 2006; Beckmann and Wesseler, 2007). Although an economic case exists for granting property rights to entities that develop new genetic agricultural material, there is a need to be more cautious about granting such rights in all extant natural genetic material to the region where that material has originated from. The economic argument for such property rights appears to be weak except in cases where these rights would result in the conservation of wanted genetic material that otherwise would not be conserved. The International Convention on Biological Diversity assumes that by the granting of such property rights in genetic materials originating locally to indigenous people, traditional farmers and similar entities, this will be effective for ensuring biodiversity conservation (thereby supporting sustainable development) and will also result in an equitable outcome. However, the transaction costs involved in implementing such a policy could be huge and could more than outweigh any economic benefit. While there could be some circumstances in which this property rights policy gives the desired results, success may be restricted to special cases. Furthermore, it was found from a sample survey in Australia that there was little public support for the sustainable use of wildlife as a strategy to conserve biodiversity, and therefore, this policy has limited political acceptability in Australia (Tisdell et al., 2007). The commercial (and subsistence) use of species was most strongly opposed in cases where their existence was endangered or they were believed to be vulnerable to extinction, presumably because proponents thought this would be an ineffective conservation policy.

Although the transaction costs involved in implementing public policy pose a formidable barrier to the practical application of the International Convention on Biological Diversity, these barriers can be reduced by institutional changes, such as the formation of farmers' and tribal co-operatives to secure payment from other users for genetic material conserved or developed in their area. The cost of the political momentum for implementing policy varies with institutional structures. As Hagedorn (1993, 2002, 2003, 2005) has emphasised social organizational structures are highly significant in determining the economics and the political prospects and practicability of implementing public policies to manage the supply of public goods. Hagedorn's approach therefore, has extended the contribution of Williamson (1975), which has concentrated on the economics of business management, to the wider sphere of public policy. This has resulted in new insights into processes involved in political economy.

10. Concluding Comments

Herbert Simon (1957, 1961) stressed the importance of bounded rationality as an element in administrative decision-making. This theme was extended and developed by Williamson (1975) who placed a high degree of emphasis on the importance of transaction costs in influencing the evolution and optimality of organizational structures. In Williamson's theories the assumption of rational behaviour is of central importance, as it is in neoclassical economics, whereas Simon (1957, 1961) was critical of this assumption. Hagedorn (1993, 2002, 2003, 2005) has extended the new institutionalist framework of Williamson to the analysis of public policy-making in relation to agriculture and the management of natural resources.

This paper has demonstrated that even ignoring transaction costs and equity considerations as well as other limitations, finding the efficient economic solution to the regulation of agricultural externalities can be much more complex than is commonly realized. This is because the mathematical functions that underlie such relationships are often not smooth and continuous everywhere, contrary to the assumptions of neoclassical economics. This complexity suggests that policy-makers are likely to be faced by the types of bounded rationality problems raised by Simon (1959, 1961). These 'irregular' functional relationships also raise new issues about the economic efficiency consequences of subsidizing favourable agricultural externalities as well as the equity of such policies. A further difficulty for the rational design of agricultural policy arises because the economic efficiency of resource use is not independent of the distribution of property rights in resources, as results from behavioural economics were used to show. This means that one has to consider what is the just distribution of rights in assessing agricultural policies in order to select the appropriate efficient economic policy.

However, the transaction costs involved in implementing agricultural policy cannot be ignored from an economic efficiency point of view. These costs vary with the institutional arrangements for policy implementation. In some cases, hybrid institutional systems may minimize transaction costs but not in all cases. Systems of tradable resource use and the issue of permits provide an example of such hybrid systems.

The political economy challenges involved in designing agricultural policy for regulating externalities and the supply of public goods are increased by the fact that such policies need to be politically acceptable if they are to have a reasonable chance of being adopted. As pointed out by Hagedorn (1993), it is possible to identify particular institutional structures that can facilitate the acceptability of proposed public policies. Political acceptability or practicality, therefore, is a constraint on the implementation of agricultural policies. It means that the most efficient policy from an economic point of view may not be able to be implemented because of political considerations. Similar constraints may also occur in relation to the implementation of agricultural policies that are considered to be equitable. Property rights in agricultural genetic material were discussed briefly in order to illustrate some of these issues.

11. Acknowledgements

I wish to thank Volker Beckmann and Martina Padmanabhan for their constructive comments on the first draft of this paper. The usual caveat applies.

12. References

Akerloff, G. (1970). The market for lemons: quality, uncertainty and the market mechanism. *Quarterly Journal of Economics*, 84, 488-500.

Anon (2008). Catastrophe theory. *Wikipedia*. http://en.wikipedia.org/wiki/Catastrophe_theory. Accessed 8/5/2008.

Arnold, V.I. (1992). *Catastrophe Theory*. Springer-Verlag, Berlin and New York.

Beckmann, V., Soregaroli, C. and Wesseler, J. (2006). Coexistence rules and regulations in the European Union. *American Journal of Agricultural Economics,* 88, 1193-1199.

Beckmann, V. and Wesseler, J. (2007). Spatial dimension of externalities and the Coase theorem: implications for coexistence of transgenic crops. Pp. 223-242 in W. Heijman (ed.) *Regional Externalities.* Springer, Berlin and Heidelberg.

Coase, R.H. (1937). The nature of the firm. *Economica*, New Series, 4, 386-405.

Coase, R.H. (1960). The problem of social cost, *Journal of Law and Economics,* 3, 1-44.

Galbraith, J.K. (1952). *American Capitalism: The Concept of Countervailing Power.* Houghton Mifflin Boston, USA.

Galbraith, J.K. (1967). *The New Industrial State*, Hamish Hamilton, London.

Hagedorn, K. (1993). Institutions and agricultural economics. *Journal of Economic Issues*, 27, 849-886.

Hagedorn, K., Artz, A. and Peters, U. (2002). Institutional arrangements for environmental co-operatives: a conceptual framework. Pp. 3-25 in K. Hagedorn (ed.) *Environmental Co-operation and Institutional Change: Theories and Policies for European Agriculture.* Edward Elgar, Cheltenham, UK and Northampton, MA. USA.

Hagedorn, K. (2003). Rethinking the theory of agricultural change in an institution of sustainability perspective. Pp. 33-56 in G. Van Huylenbroeck, W. Verbeke, I Lauwers, I Vanslembrouck and M. Dhose (eds.) *Importance of Policies and Institutions for Agriculture.* Academic Press, Gent.

Hagedorn, K. (2005). The dichotomy of segregative and integrative institutions and its particular importance for sustainable resource use and rural development. Paper presented at the Workshop in Political Theory and Policy Analysis Colloquium Mini Series, Bloomington, October 20.

Kahneman, D., Knetsch, J.L. and Thaler, R.H. (1991). The endowment effect, loss aversion and status quo bias. *Journal of Economic Perspectives*, 5, 193-206.

Knetsch, J.L. (1989). The endowment effect and evidence of non-reversible indifference curves. *The American Economic Review*, 79, 1277-1284.

Knetsch, J.L. (1990). Environmental policy implications of disparities between willingness to pay and compensation demanded. *Journal of Environmental Economics and Management,* 18, 227-237.

Pigou, A.C. (1932). *The Economics of Welfare*, 4th edn. Macmillan, London.

Posner, R.A. (1981). *The Economics of Justice.* Harvard University Press, Cambridge, MA and London.

Poston, T. and Stewart, I. (1978). *Catastrophe Theory and its Applications*. Pitman, London and San Fransisco.

Simon, H. (1957). *Models of Man*. John Wiley, New York

Simon, H. (1961). *Administrative Behavior*. The Macmillan Company, New York

Singleton, I., Wich, S., Stephens, S., Admoko, S., Leighton, M., Rosen, N., Taylor-Holzer, K., Lacy R. and Byers, O. (eds.) (2004). *Orangutan Population and Habitat Viability Assessment: Final Report*. IUCN/SSC Conservation Building Specialist Group, Apple Valley, MN, USA.

Swallow, B., Meinzen-Dick, R. and van Noordwijk, M. (2008). Localizing demand and supply of environmental services: intersections with property rights, collective action and the welfare of the poor. In V. Beckmann and M. Padmanabhan (eds.) *The Economy of Agriculture and Natural Resources.* Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Tisdell, C.A. (1970). On the theory of externalities: as relevant and as not. *The Economic Record*, 46, 14-25.

Tisdell, C.A. (1993). *Environmental Economics*, Edward Elgar, Aldershot, UK and Brookfield, VT, USA.

Tisdell, C.A. (1999). Economics, aspects of ecology and sustainable agricultural production. Pp. 37-56 in A.K. Dragun and C. Tisdell (eds.) *Sustainable Agriculture and the Environment.* Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Tisdell, C.A. (2005). *Economics of Environmental Conservation*, 2nd edn. Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Tisdell, C.A. (2009). *Resource and Environmental Economics: A Modern Approach.* World Scientific, Singapore, River Edge, New Jersey and London (forthcoming).

Tisdell, C., Swarna Nantha, H. and Wilson C. (2007). Biodiversity conservation and public support for wildlife harvesting: a case study. *The International Journal of Biodiversity Science and Management* 3, 129-144.

Tisdell, C.A. and Hartley, K. (2008). *Microeconomic Policy: A New Approach*. Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Van Huylenbroeck, G. and Durand, G. (2003). *Multifunctional Agriculture: A New Paradigm for European Agriculture and Rural Development.* Ashgate Publishing, Aldershot, UK and Burlington, VT, USA.

Van Huylenbroeck, G. and Verbecke, W. (2008). The possible role of hybrid governance structures in institutions of sustainability. Chapter 8 in V. Beckmann and M. Padmanabhan (eds.) *Institutions and Sustainability: The Political Economy of Agriculture and Natural Resources.* Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Vanslembrouck, I. and Van Huylenbroeck, G. (2005). *Landscape Amenities: Economic Assessment of Agricultural Landscapes*. Springer, Dordrecht.

Varian, H. (1987).*Intermediate Microeconomics: A Modern Approach*. W.W. Norton and Company, New York, and London.

Voltaire (1947). *Candide*, translated by John Batt. Penguin Books, Harmondsworth, Middx. UK.

Walsh, C. and Tisdell, C. (1973). Non-marginal externalities as relevant and as not. *The Economic Record,* 49, 447-455.

Williamson, E.O. (1975). *Markets and Hierarchies: Analysis and Anti-Trust Implications.* Free Press, New York.

Zeeman, E.C. (1976). Catastrophe theory. *Scientific American,* 234, 373-388.

PREVIOUS WORKING PAPERS IN THE SERIES
ECONOMICS, ECOLOGY AND ENVIRONMENT

For a list of working papers 1-100 in this series, visit the following website: http://www.uq.edu.au/economics/PDF/Clem_Tisdell_WorkingPapers.pdf or see lists in papers 101-140

101. Knowledge and Willingness to Pay for the Conservation of Wildlife Species: Experimental Results Evaluating Australian Tropical Species, by Clem Tisdell and Clevo Wilson, May 2004.
102. Antarctic Tourists, Wildlife and the Environment: Attractions and Reactions to Antarctica, by Clem Tisdell, May 2004.
103. Birds in an Australian Rainforest: Their Attraction for Visitors and Visitors' Ecological Impacts, by Clem Tisdell and Clevo Wilson, May 2004.
104. Nature-Based Tourism and the Valuation of its Environmental Resources: Economic and Other Aspects by Clem Tisdell, May 2004.
105. Glow Worms as a Tourist Attraction in Springbrook National Park: Visitor Attitudes and Economic Issues, by Clem Tisdell, Clevo Wilson and David Merritt, July 2004.
106. Australian Tropical Reptile Species: Ecological Status, Public Valuation and Attitudes to their Conservation and Commercial Use, by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, August 2004.
107. Information and Wildlife Valuation: Experiments and Policy, by Clem Tisdell and Clevo Wilson, August 2004.
108. What are the Economic Prospects of Developing Aquaculture in Queensland to Supply the Low Price White Fillet Market? Lessons from the US Channel Catfish Industry, by Thorbjorn Lyster and Clem Tisdell, October 2004.
109. Comparative Public Support for Conserving Reptile Species is High: Australian Evidence and its Implications, by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, October 2004.
110. Dependence of public support for survival of wildlife species on their likeability by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, October 2004.
111. Dynamic Processes in Contingent Valuation: A Case Study Involving the Mahogany Glider by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, November 2004.
112. Economics, Wildlife Tourism and Conservation: Three Case Studies by Clem Tisdell and Clevo Wilson, November 2004.
113. What Role Does Knowledge of Wildlife Play in Providing Support for Species' Conservation by Clevo Wilson and Clem Tisdell, December 2004.
114. Public Support for Sustainable Commercial Harvesting of Wildlife: An Australian Case Study by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, December 2004.
115. Endangerment and Likeability of Wildlife Species: How Important are they for Proposed Payments for Conservation by Clem Tisdell, Hemanath Swarna Nantha and Clevo Wilson, December 2004.
116. How Knowledge Affects Payment to Conserve and Endangered Bird by Clevo Wilson and Clem Tisdell, February 2005.
117. Public Choice of Species for the Ark: Phylogenetic Similarity and Preferred Wildlife Species for Survival by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, March 2005.
118. Economic Incentives for Global Conservation of Wildlife: New International Policy Directions by Clem Tisdell, March 2005.
119. Resource Entitlements of Indigenous Minorities, Their Poverty and Conservation of Nature: Status of Australian Aborigines, Comparisons with India's Tribals, Theory and Changing Policies Globally by Clem Tisdell, March 2005.
120. Elephants and Polity in Ancient India as Exemplified by Kautilya's *Arthasastra* (Science of Polity) by Clem Tisdell, March 2005.

121. Sustainable Agriculture by Clem Tisdell, April 2005.
122. Dynamic Processes in the Contingent Valuation of an Endangered Mammal Species by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, April 2005.
123. Knowledge about a Species' Conservation Status and Funding for its Preservation: Analysis by Clem Tisdell, June 2005.
124. Public Valuation of and Attitudes towards the Conservation and Use of the Hawksbill Turtle: An Australian Case Study by Clem Tisdell, Hemanath Swarna Nantha and Clevo Wilson, June 2005.
125. Comparison of Funding and Demand for the Conservation of the Charismatic Koala with those for the Critically Endangered Wombat *Lasiorhinus krefftii* by Clem Tisdell and Hemanath Swarna Nantha, June 2005.
126. Management, Conservation and Farming of Saltwater Crocodiles: An Australian Case Study of Sustainable Commercial Use by Clem Tisdell and Hemanath Swarna Nantha, August 2005.
127. Public Attitudes to the Use of Wildlife by Aboriginal Australians: Marketing of Wildlife and its Conservation by Clem Tisdell and Hemanath Swarna Nantha, August 2005.
128. Linking Policies for Biodiversity Conservation with Advances in Behavioral Economics by Clem Tisdell, August 2005.
129. Knowledge about a Species' Conservation Status and Funding for its Preservation: Analysis by Clem Tisdell, August 2005.
130. A Report on the Management of Saltwater Crocodiles (*Crocodylus porosus*) in the Northern Territory: Results of a Survey of Pastoralists by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, September 2005.
131. Crocodile Farms and Management of Saltwater Crocodiles in Northern Territory: Results of a Survey of NT Crocodile Farmers Plus Analysis of Secondary Information by Clem Tisdell, September 2005.
132. The Environment and the Selection of Aquaculture Species and Systems: An Economic Analysis by Clem Tisdell, October 2005.
133. The History and Value of the Elephant in Sri Lankan Society by Ranjith Bandara and Clem Tisdell, November 2005.
134. Economics of Controlling Livestock Diseases: Basic Theory by Clem Tisdell, November 2006.
135. Poverty, Political Failure and the Use of Open Access Resources in Developing Countries by Clem Tisdell, November 2006.
136. Global Property Rights in Genetic Resources: An Economic Assessment by Clem Tisdell, November 2006.
137. Notes on the Economics of Fish Biodiversity: Linkages between Aquaculture and Fisheries by Clem Tisdell, November 2006.
138. Conservation of the Proboscis Monkey and the Orangutan in Borneo: Comparative Issues and Economic Considerations by Clem Tisdell and Hemanath Swarna Nantha, March 2007.
139. Economic Change and Environmental Issues: Policy Reforms and Concerns in Australian Agriculture, by Clem Tisdell, April 2007.
140. Institutional Economics and the Behaviour of Conservation Organizations: Implications for Biodiversity Conservation by Clem Tisdell, March 2007
141. Poverty, Policy Reforms for Resource-use and Economic Efficiency: Neglected Issues by Clem Tisdell, May 2007.
142. The State of the Environment and the Availability of Natural Resources by Clem Tisdell, May 2007.
143. Economics of Pearl Oyster Culture by Clem Tisdell and Bernard Poirine, July 2007.
144. The Economic Importance of Wildlife Conservation on the Otago Peninsula – 20 Years on by Clem Tisdell, November, 2007.
145. Valuing the Otago Peninsula: The Economic Benefits of Conservation by Clem Tisdell, November 2007.

146. Policy Choices about Agricultural Externalities and Sustainability: Diverse Approaches, Options and Issues by Clem Tisdell, November, 2007.
147. Global Warming and the Future of Pacific Island Countries by Clem Tisdell, November 2007.