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## RESOURCE DEGRADATION ON AGRICULTURAL LAND: INFORMATION PROBLEMS, MARKET FAILURES AND GOVERNMENT INTERVENTION\*

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**Information problems impede private contracting for the supply of many natural resource services. They are also likely to prevent the government identifying and achieving optimum levels of natural resource degradation on agricultural land. In particular, the distributional impacts of government intervention create incentives for strategic distortions of information by interested parties. Resource conservation measures which impose costs on beneficiaries, and which provide positive incentives for farmers to monitor resource degradation, may be superior because they reduce information problems.**

The general public's interest in the use of agricultural land and associated natural resources, such as soil, water, flora and fauna, has increased greatly during the past fifteen to twenty years. The immediate source of this concern is a perception that some of the natural resources associated with agricultural land are becoming increasingly scarce or degraded (for example, see Ministry for Conservation, Victoria 1983).<sup>1</sup> The economic causes of this concern are changes in the demand for and supply of rural land services, in particular, rapid growth in the demand for 'non-traditional' rural land services such as residential and recreational space, scenery, native flora and fauna, and pollutant absorption (Wills 1985). As market and non-market competition among present and potential users of rural land services has intensified in recent years, citizens in general have become much more concerned about others' land use.

Whether or not degradation of a particular natural resource constitutes an economic problem depends on whether the resulting losses are offset by the value of the products gained or other resources saved (McInerney 1976). Citizen concern about degradation of a particular resource implies a belief that the losses outweigh the gains.

In response to the increased public concern, federal and state governments have begun to change some of the traditional rules applying to agricultural land in Australia. Examples include the re-

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<sup>1</sup> In this paper, 'degradation' means quantitative reductions in the stocks of, and consequent service flows from, particular natural resources. 'Conservation' means less 'degradation'. When people speak of 'degradation' of natural resources, they are no doubt often thinking of qualitative as well as quantitative reductions in stocks and/or flows. However, as discussed below, unless changes in stocks and flows can be quantified, neither markets nor government will be able to achieve the socially optimal amount of resource degradation.

striction or prohibition of subdivisions of farmland, clearing of native vegetation, killing of native animals and birds, grazing in ecologically fragile environments, and destruction of aboriginal sites (Fowler 1984). Many of these restrictions have reduced farmers' incomes and the value of farm properties. As a result, farmers and rural communities oppose many of the new resource conservation policies. More importantly, because they see themselves as the losers, rural communities may be less than fully co-operative in the implementation of such policies.

This paper is concerned with the information problems which governments face in attempting to achieve optimal levels of natural resource degradation on agricultural land. The information problems which impede market contracting for the supply of many natural resource services are examined. The corresponding information problems faced by government if it intervenes in response to concerns about resource degradation are then considered. The third section examines the particular difficulties government faces in attempting to value and monitor resource degradation on farms, in particular, the incentives for strategic distortions of information which arise due to governmental power to change property rights. The final section of the paper considers possible governmental responses to strategic behaviour by interested parties. It is suggested that government's information problems can be reduced by structuring natural resource conservation measures so that the beneficiaries bear at least part of the costs imposed by intervention. Also, to the extent that farmers and rural communities can monitor resource degradation more cheaply than government, there is a strong case for giving farmers and rural communities positive incentives to do so.

### *Market Information Problems*

Private land use decisions, made in accordance with the traditional 'rules of the game' regarding land use and disposal,<sup>2</sup> may lead to what appears to be non-optimal resource degradation on agricultural land. However, where information costs are positive, the optimum level of degradation is not determined solely by the marginal social benefits and marginal social costs directly attributable to different levels of degradation. The real costs of private or public contracting to achieve different levels of degradation must also be considered in determining the optimum. These costs may not always be considered by parties concerned with the direct benefits and costs, leading to a perception of resource degradation problems where, by efficiency criteria, no problems exist. Henceforth, the term 'apparent optimum' is used to indicate circumstances where only direct benefits and costs are considered.

There are two major factors which prevent market prices accurately reflecting the true social values of benefits and costs resulting from land use decisions. The first, government intervention in markets, has recently been discussed by Blyth and Kirby (1985) and will not be dealt with here. The second, the non-existence of markets for some rural land

<sup>2</sup> Note that as far as actual land use is concerned, it is the rules of the game as enforced on farmers and other land users, not the rules as they appear on the statute books or in the regulations, which are important.

services, occurs because market contracting is too expensive for the private sector.

There are no markets for many products of agricultural land use because creating a market would be too costly (Zerbe 1980). Markets are based on voluntary private contracts. Private contracting requires, among other things, measuring the quantity of the product changing hands, identifying the parties to the transaction, and excluding non-payers, which creates the incentive to reveal preferences. If one or more of these requirements is too expensive for the private sector, no market will exist for the product concerned. This is the case for many products of agricultural land use. Scenic amenity, odours, and contributions to subsurface salinity are examples of land use products which are impossible or expensive to measure. Identification of parties is often prohibitively expensive in cases of subsurface salinity and chemical pollution of streams, due to complex cause-and-effect relationships within agricultural land systems. There is no economic way of excluding non-payers who benefit from scenery or flora and fauna preservation. In a market system, production of such products, which incurs no financial reward or penalty, is neglected, except insofar as they affect users' profits from and enjoyment of land.

Some market-determined land use changes, such as land clearing, eliminate non-marketed service flows, such as those from flora and fauna. Largely because of this irreversibility, market determination of some land use changes is opposed not only by current users of non-marketed rural land services but also by those who anticipate becoming users in the future and by non-users who derive satisfaction from the continued existence of the resource in question. Involvement of the latter two groups in cases of irreversibility exacerbates the problems of private contracting for the provision of many rural land services. Identification of concerned parties and exclusion of non-payers become much more difficult and expensive when many of the parties are currently non-users. For example, one can envisage private contracts between land owners and present and (possibly) future hunters for the provision of animal populations, but contracting appears much less likely in the case of the preservationists who also benefit from habitat and species preservation.

### *Government Information Problems<sup>3</sup>*

The fact that market determination of agricultural land use will often result in what appears to be non-optimal resource degradation does not in itself justify government intervention to conserve particular resources. The efficiency of government intervention will depend on the ability of government to identify the direct benefits and costs of different levels of degradation, its ability and willingness to implement changes which lead toward the apparent optimum, and the costs of the whole process. Inaccurate determination of direct benefits and costs, bias, and high costs of intervention can all cause government inter-

<sup>3</sup> Government is defined broadly to include those who administer and enforce rules governing agricultural land use, as well as those who make the rules.

vention to be less efficient than permitting the continuation of market allocation of agricultural land according to the traditional rules.<sup>4</sup>

The information problems which plague government intervention are the very same problems which lead to the non-existence of markets for many products of agricultural land use. Consider the situation when government is altruistic and aims at efficient use of natural resources, taking account of the desires of all its constituents. In order to identify the apparent optimum amount of resource degradation, government has to measure the resource or service involved, and identify the concerned parties and their preferences. Government has no great advantages over private market participants in undertaking the first two of these activities. Measurement of quantities of the products of land use and identification of concerned parties require scientific and technical information about the nature of the product concerned, about cause-and-effect relationships, and about monitoring technologies. Once this information is available, measurement and identification can generally be as readily undertaken by private parties as by government. If no markets exist for the above information, government may have a role in creating incentives for the production of such information, as distinct from having a clear advantage over the private sector in its use.

Government does have an advantage if a product of agricultural land use is non-excludable, so that individual preferences will not be revealed. In these circumstances, it has the power to force all who benefit from the product to share its cost, thereby linking benefits and costs and encouraging preference revelation. In the absence of government imposed sanctions on non-cooperators, such products generally will not be provided (Mueller 1979, Ch. 2).

Government's advantages in dealing with natural resource degradation problems result from its police and fiscal powers, and, more generally, its power to change the traditional rules applying to agricultural land use. However, except in the case of non-excludable goods, these advantages can come into play *only after the information problems have been solved*. Armed with its coercive powers, government can take steps beyond the power of private market participants. For example, it can change liability rules in an attempt to facilitate voluntary negotiations between parties interested in agricultural land use or it can establish and enforce regulatory standards concerning land use, including the exclusion of non-payers, or it can use its fiscal powers to compel payment by land use beneficiaries. However, if government does not have the necessary information about magnitudes, identities, and preferences, it is quite possible that even an altruistic government can inadvertently leave the community as a whole worse off, rather than better off, as a result of intervention.

Uncompensated government intervention which changes the rules of the game regarding land use and disposal in ways not anticipated by agricultural land owners and users may have significant effects on the incomes and wealth of various groups, particularly farmers. With concerned parties recognising that government intervention has distributional effects, self-interested behaviour by land owners and

<sup>4</sup> The possibility that what is economically efficient might be changed by government intervention is ignored. This is the case when intervention changes income distribution, which in turn changes prices, which in turn define what is efficient (Bromley 1982).

users, and by government itself, creates additional barriers to effective government intervention. Subject to the nature of the public choice process and mode of intervention adopted, interested parties have incentives to distort the information available to government. The most obvious avenue for distortion is misrepresentation of the preferences and profits which are the basis of government estimates of the social costs and benefits of natural resource degradation. To the extent that government relies on interested parties for information about levels of degradation, or cause-and-effect relationships, distortions of that information may also occur.

The efficiency of government intervention becomes still more problematic if the assumption of an altruistic government is replaced by the public choice assumption of a government composed of self-interested utility maximisers. Even if a self-interested government can identify optimum levels of natural resource degradation, it may deliberately aim to undershoot or overshoot the target in return for votes or financial support. This paper concentrates on the information problems faced by an altruistic government.

#### *The Difficulties of Valuing and Monitoring Resource Degradation on Farms*

Farmers are the dominant holders and users of agricultural land in Australia, and will remain so, given the competitiveness of most Australian agriculture in world markets. The major objective of government intervention aimed at altering natural resource degradation on agricultural land must therefore be to create incentives for farmers to vary the amount of degradation, while continuing to produce food and fibre for world markets.

In choosing whether and how to intervene, government needs to consider both the accuracy and the cost of information. Some of the required information, such as preferences, can be obtained only from interested parties. Other information, such as the quantities of various products of land use and identities of causal agents, can be obtained by government with or without the co-operation of other parties. However, co-operation with or obstruction of government information gathering may affect information costs. In particular, private monitoring by interested parties, if verifiable by government, may be less costly than government monitoring.

Government is likely to encounter two major problems in attempting to obtain the information it requires. First, the complexity of the land use relationships involved may make measurement of land use products and identification of concerned parties impossible, inaccurate or very costly. Second, where information is obtained from interested parties, they will generally have incentives to distort it to their advantage.

#### *Technical problems*

The role of land in linking other components of the natural environment, and as an input in a variety of human activities, means that changes in land use often have complex physical, biological and social ramifications. If cause-and-effect relationships within a rural land system are poorly understood, then government will not be able to

identify all the parties involved in a particular natural resource degradation problem or to measure the outputs of non-marketed products attributable to individual parties. This appears to be the case for problems such as subsurface salinity, phosphate pollution of streams and tree dieback.

Inadequate knowledge of causal relationships can also cause identification and measurement problems at the individual farm level. Farm production is subject to uncertainties of weather, pests, diseases, and human and animal behaviour. In monitoring on-farm resource degradation, government needs to distinguish between degradation due to the actions of the farmer, and that due to forces beyond the farmer's control. If all degradation is attributed to the farmer, and he is penalised accordingly, intervention is likely to be inefficient in that the farmer will have an incentive to devote excessive amounts of resources to the reduction or avoidance of naturally occurring degradation. Also, farmers are likely to perceive penalties incurred for naturally occurring degradation as unjust, which may prompt them to cease co-operating in the monitoring process, possibly raising monitoring costs.

Even if government has precise knowledge of cause and effect, it may still face formidable measurement problems. If the number of parties contributing to the problem is large, and/or contributions are variable over space or time, the cost of accurate monitoring can be very large. For example, this is likely to be the case when chemical pollution of streams is due to both farming and residence in a catchment, and both chemical use and river flow vary over time. Measurement is also difficult where no specific tangible agent is involved, as in the case of scenery.

The technical problems of measurement and identification are amenable to advances in knowledge about rural land systems and monitoring techniques. Recent advances in remote sensing technology, involving aerial and satellite photography backed by computer assisted interpretation techniques, have clearly improved the ability to monitor many environmental changes without physical intrusion onto privately held land. However, they have yet to solve most monitoring problems for either the private sector or for government. One reason is cost. Discriminating down to the individual land user level is likely to be costly for environmental changes which are more subtle than, say, tree clearing or gully erosion. In particular, high per unit costs of remote sensing may continue to rule out private contracting for the production of some rural land services because of the small scale of operations of parties concerned. For example, weekend birdwatchers and hikers would find it far too expensive to contract with individual farmers for the maintenance of native flora. A second reason is the common lack of community and formal legal sanction for private or government monitoring of people's land use using modern remote sensing techniques, based at least in part on cherished values such as the right to privacy. Even if modern technology lowers government's monitoring costs in a narrow economic sense, they may remain unacceptably high in political terms.

### *Behavioural problems*

There are two reasons why government will find it difficult to obtain precise statements of concerned parties' willingness to pay for more or

less natural resource degradation. First, individuals may recognise that any revelation about willingness to pay implicitly concedes the initial property entitlements to the opposition, whereas the objective of any lobbying exercise is to acquire entitlements without compensation, via government action. Second, many products of resource conservation measures are non-excludable goods such as scenery, flora and fauna preservation, and reduction of salinity in streams. Hence, if individual beneficiaries of conservation believe that their contributions to conservation measures are likely to be linked to their estimates of benefits, they will have an incentive to understate benefits, in the hope of free-riding on the contributions of others.<sup>5</sup>

In the case of government monitoring, the land owner can, within the limits of the law, be either obstructive or co-operative, with consequent effects on monitoring costs. Such behaviour is likely to be related to the perceived distributional impacts of government intervention. More importantly, since economic monitoring of any behavioural rules within a community generally depends to a large extent on self and community policing, both the costs and accuracy of monitoring are affected by the degree of rural community acceptance of natural resource conservation policies.

#### *Possible Responses to Strategic Behaviour*

How might government deal with the information problems caused by strategic behaviour of interested parties? Where no market exists, the accuracy and costs of information may be affected by the public choice procedures used and by the mode of intervention. This leads to consideration of whether some choice mechanisms and forms of intervention are superior because they reduce government's information problems.

#### *Valuation of benefits and costs*

Consider first the need for information about the benefits and costs of different amounts of natural resource degradation on agricultural land. The first possibility is government intervention to reduce the costs of measurement, identification of parties, and exclusion from enjoyment of a resource to a sufficient extent that market exchange becomes economically feasible. True preferences can then be revealed in the exchange process. For example, if research can identify economical means of monitoring hunters, the creation of location-specific and time-specific hunting permits, sold by tender or auction, will reveal the benefits of hunting. However, many important degradation problems involve prohibitive exclusion costs, which rule out market creation. Circumstances where exclusion of beneficiaries is prohibitively costly include extensive natural phenomena such as bird and animal habitats and scenic vistas, mobile land use products such as birds, animals,

<sup>5</sup> Knetsch and Sinden (1984) point out another problem encountered in surveys and experiments designed to obtain individuals' valuations of changes in the availability of non-marketed commodities. The results of both surveys and experiments show large variations in the valuation of benefits, depending on whether the valuation is based on willingness to pay or compensation demanded. These findings suggest that valuations of benefits may depend on people's views as to who possesses the property rights.



air and water, and the spread of knowledge about natural resource degradation.

An alternative market-based approach is to estimate the benefits of non-marketed land use products indirectly, using information from existing markets for related goods which are marketed (Freeman 1979). These techniques depend on the existence of such related goods and an understanding of the relationships between demands for the marketed and non-marketed goods, such as travel and recreation experiences away from home.

In the absence of market data, governments must rely on non-market data such as surveys, voting or intensity of political pressure. Freeman (1979, Ch. 5) points out that when the benefits of a public (non-excludable) good are assessed using non-market data, a concerned individual will consider both the effect of his/her answer on the supply of the public good, and its effect on his/her expected money income, via any linkage between the answer and the imposition of costs resulting from a decision to supply the public good. If both effects apply, or are believed to apply, the individual considering a deliberate distortion of benefits must weigh up conflicting incentives which point in opposite directions. For example, overstating the benefits obtained from preservation of native bushland will marginally increase the likelihood of preservation, but will also marginally increase expected tax payments for that specific purpose. The overall incentive for distortion of benefits will be less if both effects apply than if either operates alone.

Application of the above logic to conflicts of interest over the use of agricultural land suggests that choice mechanisms and forms of intervention should be structured so that both effects apply. Both farmers and the beneficiaries of measures to reduce resource degradation should anticipate, when providing information to government, that they will bear at least part of the costs which any resulting government action imposes on other community members.<sup>6</sup> The aim of such a procedure is to ensure that both the major beneficiaries of reduced degradation (members of the general public) and the major losers (farmers) consider not only the marginal cost curve which affects them directly but also costs borne by others as the level of degradation changes. To the extent that the latter costs offset the former, the incentive to distort information supplied to government will be reduced.<sup>7</sup>

The obvious problem with the above procedure is that government does not have reliable information about either of the marginal curves. However, it is likely to have sufficient information to establish minimum (non-zero) levels for both curves. The point is that any reliable information about the costs of more or less natural resource degradation should be incorporated into the decision making processes of the would-be beneficiaries. The argument here is analogous to the argument for the use of taxes or subsidies when government has accurate information about one of the marginal curves. In those

<sup>6</sup> Note that the argument requires that consequential costs be obvious to beneficiaries and not buried in the general tax burden.

<sup>7</sup> In requiring the beneficiaries of interventions to bear costs resulting from those interventions, the government does not have to decide, on ethical grounds, which distributional outcome it prefers. In principle, at least, the costs of more or less degradation can be reflected to concerned parties using either taxes or subsidies.

circumstances, government can reduce its information costs by making the parties whose marginal benefits are unknown subject to a tax or subsidy schedule set equal to the known marginal cost curve (Chisholm, Walsh and Brennan 1974).

Resource conservation on privately operated agricultural land in Australia is achieved almost exclusively by uncompensated regulatory measures such as land use zoning, environmental protection regulations and restrictions attached to leases. As regulation is currently practised, groups arguing for more or less resource degradation need consider only the benefits of their proposals to themselves, ignoring the costs which those proposals would impose on others. The incentives for distortion of information supplied to government are obvious. Thus uncompensated land use regulation in Australia appears likely to be destructive of the technical and attitudinal information required to determine optimal levels of resource degradation on agricultural land.

### *Monitoring*

Regardless of whether its intervention involves subsidies or taxes, or compensated or uncompensated regulation, government has to measure on-farm resource degradation, and reward or penalise farmers and other land users accordingly. Depending on the monitoring technology available, and the administrative and legal processes by which rewards or penalties are applied, the behaviour of farmers and local rural communities may have a major effect on the effectiveness and costs of monitoring.

In monitoring, as in agricultural land use itself, it is in principle possible to induce the desired behaviour by either rewards or penalties. However, our society does not normally define failure to report one's own actions, or the apparently illegal actions of others, as a crime. Also the burden of proof is normally placed on government rather than the individual accused of illegal behaviour. In these circumstances, the costs of inducing the desired monitoring may be lower if the incentive is positive than if it is negative.

Wills (1985) suggested that, in the case of a dispute between the landholder and government over the landholder's resource degradation performance, the location of the burden of proof could have an important effect on government's monitoring costs. In the case of regulatory standards, or of taxes on degradation, it would seem likely that the burden of proving the extent to which the landholder has despoiled rural scenery, destroyed natural flora and fauna, or permitted excessive runoff or erosion would be on government. On the other hand, if the landholder is claiming a subsidy from government for preventing such resource degradation, it would seem normal for him to provide the evidence to support his case for the subsidy, thereby relieving government of some of its information burden. Thus, in situations where landholders can monitor more cheaply than government, there is a strong case for tailoring government intervention so as to give landholders a positive incentive to do a good job of monitoring.<sup>8</sup> Positive

<sup>8</sup> Economists have generally favoured emissions taxes over subsidies as instruments in pollution control, because of the difficulty in determining the base level of emissions on which the subsidy is to be calculated (for example, see Parish 1972; Walsh and Brennan

incentives may also increase rural community acceptance of policies, leading to more effective community monitoring of natural resource degradation.

### *Summary and Conclusions*

Government intervention to remedy apparent natural resource degradation problems on agricultural land is commonly associated with the non-existence of markets for some products of land use. However, like private markets, government has to measure the product or service involved, and identify the concerned parties and their preferences, if the benefits and costs of different levels of degradation are to be correctly identified. If these tasks are very costly, or can not be performed accurately, then government intervention can leave the community worse off.

Government faces major information problems due to: (a) imperfect knowledge of relationships within rural land systems; and (b) strategic distortions of information by parties attempting to influence government intervention in their favour. The former can be overcome by advances in scientific knowledge and monitoring techniques. The economically plausible initial role for government in this area is to provide incentives for the production of the required scientific and technical information which is likely to be underproduced by the private sector.

Distortions of information supplied to government have to be dealt with by the design of public choice procedures, and associated modes of intervention, which minimise the incentives for such behaviour. It is contended that uncompensated regulation of agricultural land use is likely to create major incentives for distortions, with consequent adverse effects on the efficacy of government decisions. There is a need for empirical studies of current public choice procedures to attempt to discover the nature and seriousness of the information deficiencies and biases involved. In the absence of such empirical work, two changes are proposed in federal and state governments' resource conservation policies which seem likely to increase the benefits and decrease the costs of such policies. First, public choice and intervention should be designed so that the beneficiaries of intervention, be they conservationists or current land users such as farmers, can anticipate bearing some of the costs which intervention imposes on others. Second, in cases where effective government monitoring would be very costly, farmers and other land users should be given positive incentives to police their own levels of resource degradation — in effect, paying them to produce or maintain non-marketed products such as attractive scenery, native flora and fauna, and aboriginal sites.

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1979). This is reflected in 'moral hazard' problems, with polluters producing more environmental degradation in order to collect more subsidy. However, note that the source of the preference for taxes over subsidies is our superior ability to monitor something which is done as opposed to something which is not done. If reducing degradation involves doing something, for example, planting native trees, and a base level can readily be established, the argument may favour subsidies.

### References

- Blyth, M. and Kirby, M. (1985), 'The impact of government policy on land degradation in the rural sector' in A. J. Jakeman, D. G. Day and A. K. Dragan (eds), *Policies for Environmental Quality Control*, Centre for Resource and Environmental Studies Monograph 15, Australian National University, Canberra, pp. 105-25.
- Bromley, D. W. (1982), 'Land and water problems: an institutional perspective', *American Journal of Agricultural Economics* 64(5), 834-45.
- Chisholm, A., Walsh, C. and Brennan, G. (1974), 'Pollution and resource allocation', *Australian Journal of Agricultural Economics* 18(1), 1-21.
- Fowler, R. (1984), 'Property rights of farmers', *Australian Farm Management Society, Conference Proceedings*, 11th National Conference, Roseworthy Agricultural College, February, pp. 179-97.
- Freeman, A. M. (1979), *The Benefits of Environmental Improvement*, Johns Hopkins, Baltimore.
- Knetsch, J. L. and Sinden, J. A. (1984), 'Willingness to pay and compensation demanded: experimental evidence of an unexpected disparity in measures of value', *Quarterly Journal of Economics* 94(3), 507-21.
- McInerney, J. P. (1976), 'The simple analytics of natural resource economics', *Journal of Agricultural Economics* 27(1), 31-52.
- Ministry for Conservation, Victoria (1983), *Conservation in Victoria: A Discussion Paper on a State Conservation Strategy*, Ministry for Conservation, Melbourne.
- Mueller, D. C. (1979), *Public Choice*, Cambridge University Press, Cambridge.
- Parish, R. M. (1972), 'Economic aspects of pollution control', *Australian Economic Papers* 11(18), 32-45.
- Walsh, C. and Brennan, G. (1979), 'Economic analysis and public choice perspectives of environmental policy: damage taxes, regulations and standards', in Department of Science and the Environment, *Environmental Economics*, AGPS, Canberra, pp. 55-62.
- Wills, I. (1985), 'Agricultural land use, environmental degradation, and alternative property rules' in Department of Arts, Heritage and Environment, *Conservation and the Economy: Conference Papers and Proceedings* (microfiche), AGPS, Canberra, pp. 202-20.
- Zerbe, R. O. (1980), 'The problem of social cost in retrospect', *Research in Law and Economics* 2, 83-102.