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# Summaries

## Intertemporal flexibility in a tradeable $CO_2$ quota system

HEGE WESTSKOG

The paper compares the abatement costs in a $CO_2$ quota trading system where both banking and borrowing of quotas are permitted with the abatement costs in a system where intertemporal emission trading is restricted to banking of quotas. With banking of quotas, each agent can reduce emissions more than indicated by the quotas it holds. The excess quotas can then be banked for future use. With borrowing of quotas, an agent is allowed to increase its emissions in excess of the quotas it holds against future abatement of emissions. By comparing the abatement costs of these two intertemporal trading systems, an estimation of the efficiency loss by only allowing banking of $CO_2$ quotas in an agreement to reduce emissions of $CO_2$ is obtained.

The question of burden sharing between countries/regions is also raised in this paper. It is analysed how the costs of abating $CO_2$ emissions are distributed among different countries/regions in the two intertemporal trading systems discussed above. In the conducted sensitivity analyses, it is discussed how different ways of intially allocating $CO_2$ quotas between agents influence the distribution of abatement costs between countries/regions.

The study is conducted with the use of one energy-economy model, which is the model used by Kverndokk (1992). This model is built on the work by Manne and Richels (1991).

Three main conclusions can be drawn from this study:

- The design of an intertemporal trading system is important. When both banking and borrowing of quotas are allowed the maximum gain from an intertemporal trading system is obtained, and total costs of abating $CO_2$ emissions are reduced considerably compared to a system where intertemporal trading is restricted by only allowing quotas to be banked.
- The total cost of implementing a climate treaty will also be affected by which countries/regions reduce their $CO_2$ emissions. In this study it is initially assumed that the developing country parties do not make any efforts to reduce their $CO_2$ emissions until year 2050. However, a special

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case is studied where the developed countries, in order to reduce their costs of reaching a specific emission goal during the period from 2000 until year 2050, compensate the developing country parties in this period for participating in the $CO_2$ emission reductions. The compensation is given such that the developing countries' net costs of making emissions reductions after sale/purchase of quotas equal zero. It is shown that the total cost of implementing a climate treaty can be reduced in a banking system by this kind of compensation. However, in a banking and borrowing system total abatement costs are practically not reduced by this compensation. In practice, it is only the distribution of total abatement costs among different parties that is changed.

- The sensitivity analyses show that countries/regions have different preferences when choosing between allocation rules under the two systems studied here.

# Optimal soil depletion with output and price uncertainty

SVERRE GREPPERUD

This paper studies soil depletion incentives in a dynamic economic model. The focus is on the effects of risk-averse preferences as compared to risk-neutral preferences when farming decisions have implications for both expected short-run production and natural topsoil fertility. The paper concerns near-time revenue uncertainty, risks that matter for crop-season decision making, such as climatic variability and the occurrences of pests and plagues. In addition, crop price risk is considered.

The paper presents two models that vary depending on how soil degradation relates to changes in agricultural production. The first model assumes that soil degradation is output induced, since higher outputs in any crop season can only be achieved by more soil depletion and thus lower soil quality in future crop periods (the cultivation model). This model is most relevant for low-input farming systems. The second model assumes that soil conservation is output induced. Here higher outputs in any crop season are assumed to improve soil quality in future periods (the conservation model). This model is more relevant for high-input farming systems that apply soil conservation measures.

The analysis shows the importance of analysing risk preferences and soil depletion incentives in a dynamic model—even when near-time risks are the focus of attention. The reason for this is that crop-season decision

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making has consequences for the quality of soil available in the future periods. As long as the future quality of soil has an effect on the future variability of farm revenues, such considerations need to be addressed when the role of risk preferences and soil depletion incentives is analysed. In fact, this paper shows that the risk properties of the soil can be decisive for the conclusions arrived at.

A general finding of the analysis is that the presence of risk preferences is found to improve soil conservation incentives in agriculture. For the cultivation model this result matters for output uncertainty as well as for crop price uncertainty. The same conclusion is valid for the conservation model under output uncertainty. The only case for which soil conservation incentives are weakened due to risk-averse preferences is for the conservation model under crop price uncertainty. However, the conservation model does not seem to capture important characteristics of smallholder agriculture in developing countries, since such production systems can best be described as low-input farming systems for which soil depletion increases with agricultural outputs.

The conclusions arrived at under crop price uncertainty are the result of cultivation intensity and soil quality being risk-increasing production factors in agriculture. Such risk-properties are determined by the relationship crop prices has with the agricultural production. However, when output uncertainty is considered our conclusions depend on the assumptions made about the risk properties of the production factors. In this paper, it is argued that soil quality is a risk-decreasing factor in agriculture. If, however, soil quality is assumed to be a risk-decreasing factor in production, then indeterminate conclusions would follow from our model.

# Natural resource sustainability and poverty reduction

CHRISTOPHER HEADY

There is clearly a link from resource degradation to poverty: people who rely on a natural resource for their livelihood can fall into poverty if that resource is degraded. This observation adds to the more commonly used arguments for natural resource conservation, especially if it is thought that poverty itself is a cause of resource degradation because poor people are unable to moderate their use of the resources upon which they depend. This second link, from poverty to resource degradation, is less well established but leads to the possibility of a vicious spiral of poverty and resource degradation.

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Either of these links between resource degradation and poverty is sufficient to establish the need for management strategies that maintain the sustainability of resources while alleviating poverty. The problem is that the two aims of resource sustainability and poverty reduction appear to conflict: reduced resource use can be expected to worsen the poverty of the people who rely on it. However, there are possibilities of improving resource sustainability and reducing poverty if the resource management strategy concentrates on helping the poor, while reducing the demands on the resource from the non-poor. The opportunities to follow such an approach depend on the specifics of any particular situation. Therefore, this paper analyses the particular case of an inland fishery in Bangladesh.

This fishery contains fishermen with a wide range of incomes. The poorer fishermen are poor partly as a result of restricted access to the fishery, which is controlled by leaseholders. They also tend to use more labour-intensive fishing gears than the richer fishermen. This suggests that a management policy that encourages greater access to the fishery and the use of more labour-intensive gears could improve the position of the poor fishermen without harming the sustainability of the fishery. The more labour-intensive gears would mean that more employment can be provided without increasing the total number of fish caught.

In order to investigate this possibility, a numerical model of the fishery was developed, which incorporated the decisions made by the leaseholders over the amount of fishing to be allowed and the gears that were to be used. This was based on a detailed study of the fishery and the communities around it. The model was calibrated so that, with no management intervention, it replicated the observed fishing pattern in the fishery. The results of various policy changes were then simulated with the model.

First, the effect of reducing the rate of interest was analysed, as the argument that poverty leads to resource degradation is usually formulated in terms of the higher discount rate that poor people are presumed to have. This simulation showed only a small effect on the total catch from the fishery, and so suggests that this link from poverty to resource degradation is weak for this particular fishery.

Second, the effect of improving sustainability by increasing the number of fish left at the end of the fishing year was simulated. This showed a reduction in fish catch and a more than proportional reduction in employment. This illustrates the harmful effects on poverty that some conservation measures can have.

Third, the effect of using an employment subsidy to increase access to the fishery and encourage the use of labour-intensive gears was analysed. The effect on employment depended on the extent to which gears could substitute for each other, but was appreciable although there was some reduction in catch. The problem with employment subsidies, of course, is their cost and it is interesting to consider an alternative policy which involves regulation. Therefore, the final simulations involved banning the two most capital-intensive gears. This had a similar effect to the employment subsidy policy, although its magnitude was smaller.

The overall conclusion is that it is possible to design policies that can

reduce poverty without harming resource sustainability, provided that the detail of the resource and how it relates to poverty within the community is known. The approach presented here for analysing the design of policies to reduce poverty and maintain or enhance sustainability can be applied to a wider range of natural resources.

# Sustainability criteria and cost–benefit analysis: an analytical framework for environmental–economic decision making at the project level

DIRGHA N. TIWARI

The concept of sustainability has been widely debated in the recent years. The focus of the debate has mainly centered on how to incorporate sustainability concerns into development decision making. Past studies have mainly focused on introducing environmental sustainability criteria as a constraint in the case of multiple projects with the assumption that loss in natural capital stock in one project may be compensated for by the gain from the other. The theoretical foundation of CBA is embedded in optimization of social welfare, and, in general, if a project is found optimal in the view of society, it may not necessarily be optimal for the individuals that are affected by the project. The design and implementation of the mechanism for paying them for compensation in such a case again is considered a way of maximizing total welfare. However, in practice, such compensation, both among the projects and within a project case, is never truly designed and applied. For this reason, both the theoretical principles underlying CBA, and practical applications using CBA, need to be revisited in the light of growing concerns for sustainability which is now considered a fundamental measure of societal welfare.

This paper provides an analytical framework for CBA with considerations of ecological sustainability criteria, local people's preferences, natural resource scarcity prices, and environmental costs in the case of a single project in conjunction with the application of geographical information system (GIS) techniques. Sustainability critera at the project level are briefly discussed and an analytical framework for cost–benefit analysis using GIS techniques at different levels of the computation process is presented. The developed framework is applied in the case of a lowland irrigated agriculture system located in the Northern Plains of Thailand.

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The next present value (NPV) is calculated by incorporating the economic price of irrigation water obtained from both the direct and indirect economic valuation approaches. Seven sets of alternatives were designed based on the land capability and suitability analysis, water availability and local people's preferences, and additional three sets of alternatives representing existing cropping patterns and the worst case of no cultivation during the dry season. The existing and potential environmental costs of irrigated agriculture were also estimated and incorporated into the analysis. The results indicated that sustainability criteria could well be incorporated into the CBA in a single project case by addressing local people's concerns, resource scarcity values, and ecological sustainability criteria with the use of spatial analysis techniques, such as GIS. The use of GIS facilitated the integration of information for use in CBA at different levels of the computation process. The analysis carried out, using the extended cost–benefit framework, indicated that the ranking of available alternatives can change significantly, when the economic value of unpriced resources and some quantifiable environmental costs are included with considerations of ecological and social sustainability criteria.

## Valuation of community forestry in Ethiopia: a contingent valuation study of rural households

ALEMU MEKONNEN

Community forestry projects in Ethiopia, particularly in the late 1970s and 1980s, have been largely initiated and controlled, and the benefits used by non-members of the community. It is argued that this form of management and use of community plantations may have contributed to the failure of most of these projects. Moreover, given the limited literature on household valuation of community forestry in developing countries, it is important to identify factors that contribute to the acceptability and feasibility of community plantations. In this study, we use the contingent valuation method to examine the determinants of willingness-to-pay for community forestry in rural Ethiopia, when the plantations are established, managed, and used by communities themselves.

We used discrete questions with open-ended follow-up as the value elicitation format, which is closer to the market scenario our respondents are familiar with compared, for example, with the single discrete choice format. From a methodological point of view, unlike most other studies,

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we use a tobit model with sample selection in the empirical analysis of the bid function to correct for the effect of excluding invalid responses (protest zeros, outliers, and missing bids) from the analysis. The data used are from a rural household survey conducted in 1996.

The results indicate that household size, household income, distance of homestead to proposed place of plantation, number of trees owned, and sex of household head are significant variables that explain willingness-to-pay. We also find that there are significant differences in willingness-to-pay across sites.

# The influence of mineral exports on the variability of tropical deforestation

WILLIAM D. SUNDERLIN AND SVEN WUNDER

Previous studies of deforestation have focused on agriculture, population and migration, timber exploitation, macroeconomic policies, and geographic factors to explain the variability of forest cover loss among countries. This study tests the hypothesis that countries with a high proportion of petroleum or non-petroleum mineral exports in total exports experience a relatively low deforestation rate because of macroeconomic 'Dutch disease' effects. This hypothesis is the logical extension of two common assumptions—that is (1) that rapid growth of agriculture is one of the main causes of deforestation and (2) that Dutch disease tends to slow the growth of the agricultural sector in developing countries.

Bivariate and multivariate analyses of 67 country cases give preliminary, but inconclusive support for the hypothesis. There is a statistically significant chi-square correlation when 'high' and 'low' mineral countries are measured against countries with 'high' and 'low' rates of deforestation. Means tests show significant differences between 'low' and 'high' mineral export countries with respect to socioeconomic indicators such as agriculture and industry as a proportion of total population, and degree of urbanization. Replication of Rudel and Roper's (1997) multivariate analysis of the 67 country cases suggest minerals may be a relatively strong predictor in comparison to other independent variables, but the results are not definitive.

Although these analyses are a step forward in understanding the variability of tropical deforestation, there are notable weaknesses to these approaches. Chief among these weaknesses are that the analyses do not adequately distinguish among various Dutch disease effects that go

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beyond the exchange rate mechanism and that produce contradictory effects on forest cover. For example, a booming mineral sector may decrease pressure on forests by increasing the real exchange rate, by depressing growth of the agricultural sector, and by encouraging rural to urban migration. Yet the same booming sector can increase national purchasing power for agricultural and forest products, and can produce surplus state revenue enabling the government to build rural roads—processes that are often associated with forest cover loss.

Future advances in understanding the relationship of the mineral sector to the variability of tropical deforestation must examine the various areas in which mineral export income exerts its contradictory effects on forest cover. These areas include: levels of government funding for agriculture, roads, and directed settlement; agricultural protectionism policies; levels of rural poverty, urbanization, and consumer demand; whether mineral extraction takes place inside or outside forested areas; and the variability of state autonomy.