

Summaries

Bioprospecting and biodiversity contracts

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Bioprospecting values have been both touted as the saviour of the world's biodiversity, and downplayed as being so small as to create no conservation incentive. However, *in situ* biodiversity provides a reservoir of robustness that will continue to be drawn upon in the search for new pharmaceutical products, and recent work has shown that, under plausible conditions, bioprospecting values can be large enough to support biodiversity conservation. In such circumstances, bioprospecting contracts have the potential to be key institutional mechanisms in providing incentives and distributing returns from biodiversity and biodiversity prospecting. An economic model of a biodiversity contract is developed and compared with a number of existing and proposed contracts.

The economic model is a dynamic principal agent model, in which the host country is the agent and a pharmaceutical company is the principal. The host country provides two inputs needed by the pharmaceutical company: a stock of biodiversity and a stock of information related to the pharmaceutical potential of its biodiversity. The host country can undertake conservation measures to build up or maintain its biodiversity. There are two different ways to characterize the information stock. It may be simply species information that is built up through the collection, screening, and identification of samples. Alternatively, it may be more complex, involving ecological data and ethno-botanical information.

There are two basic problems influencing the form of biodiversity contracts. The first is that the process via which the bioprospecting output is produced is not completely observable. The second is that host-country property rights are incomplete.

The generation of bioprospecting revenue is influenced by a random, state-of-nature variable. Host countries, typically developing countries, are viewed as risk averse, while the pharmaceutical-principal is assumed to be risk neutral. One might expect biodiversity contracts to exhibit full insurance through the use of up-front payments to the host. However, the process via which the bioprospecting output is produced is not completely observable, creating a moral hazard situation. The contract will reflect a trade-off between incentives and insurance. Comparing the two different characterizations of the information stock, including

ethno-botanical information increases the difficulties of observability in the drug discovery process.

Property rights may be incomplete in a number of ways. A host country may be unable to enforce property rights over its own resources. Even if it does enforce its own property rights, open access to substitute *ex situ* collections, or *in situ* collections in other countries, will reduce the value of a host country's *in situ* resources. Exacerbating the situation are developed country laws regarding intellectual property rights (IPR) (e.g. patent laws). They do not protect unmodified gene sequences or public-domain information regarding their use, but do protect improvements or innovations created by modern science. Ethno-botanical information is usually not patentable on either a stand-alone basis, or as part of a patent for an 'invented' product.

Five types of contracts are found to be in current use or proposed for use. These are the INBio-Merck contract, Biotics contracts, Shaman Pharmaceuticals contracts, agreements supported by the International Cooperative Biodiversity Groups Program, and the contracts proposed by the Iwokrama International Centre for Rainforest Conservation and Development in Guyana. All contracts acknowledge risk by providing some form of advance payment or sample fees, and the contracts all include some provision for royalties. Earmarking and transfers in kind are often used to encourage investment in the biodiversity stock or in information about it. Differences among the contracts are the result of different views of the drug discovery process, associated difficulties in monitoring, and incomplete or ineffective property rights. For example, Shaman's ethno-botanical view precludes the provision of sample payments. Instead Shaman attempts to invest in the conservation of *in situ* biodiversity and indigenous knowledge. Biotics is an outside collector, with links to suppliers in a number of host countries. Biotics pays a sample fee to the supplier, and a percentage of any royalties it obtains. Although the outside collector's contract may contain a provision for the sharing of royalties from biodiversity prospecting within the host country, it is unlikely to be enforced. If biodiversity contracts are to achieve their potential in providing incentives and distributing the returns from biodiversity prospecting, host countries must build up and sustain their own information and biodiversity stocks, and develop the capacity to negotiate, honour, and enforce their contracts.

How labour organization may affect technology adoption: an analytical framework analysing the case of integrated pest management

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International donor agencies have placed high priority on sustainable agriculture and rural development among other objectives to enhance employment, create income, and protect the environment. An important component of sustainable agriculture is integrated pest management (IPM) where farmers are trained to improve their pest management skills. While IPM is a complex strategy with no exact definition, the main message is to reduce pesticide applications. The central element of IPM is the observation of the level of pests and diseases, and the application of pesticides only if necessary. The IPM strategy substitutes capital (expenses for pesticides) and low skill labour (time spent on spraying) with high skill labour (observation of pests and diseases). As IPM is a labour demanding plant protection strategy, labour market policies will have an impact on the adoption and the costs and benefits of IPM. If those policies are not congruent they could lead to an inefficient allocation of resources. Also, the impact is expected to differ among the various forms of labour organization. This paper focuses on the organization of farm labour and its relevance for the adoption of IPM, a topic which has been neglected in earlier studies. A simple model describes the circumstances in which an IPM strategy begins to promise more benefits than farmers' best practices. The organization of agriculture with respect to pest management is described and the different types of organizational structures are included into the model. The results of the model are compared with respect to labour costs and different forms of labour organization. The impact of labour market policies on IPM are discussed and specifically the question of the way in which labour market policies influence the chances of adoption of IPM and the extent to which this depends on the organizational structure of agriculture. The results show that under perfect substitution of labour or an owner-operated pesticide application an overall increase in labour costs decreases the competitiveness of IPM compared to FBP. This is a fairly obvious result in view of the known implications of labour market policies on the adoption of IPM. The results change if imperfect substitution of labour is assumed, an observation which is common in agriculture. Depending on the organization of agricultural labour, an increase in labour costs can increase the competitive advantage of IPM. Labour market policies that increase the minimum wage rate of hired farm labour will increase the probability of IPM adoption, while policies that increase the opportunities of the decision maker will decrease the

probability of IPM adoption. While under perfect substitution of labour, the impact of labour market policies in this case would be inversely related to agricultural and environmental policies. Also the possibility exists that under a differentiated organization of labour, agricultural policies, environmental policies, and labour market policies go hand in hand. Unfortunately, this will be more likely at a higher original level of pesticide use and hence a higher level of environmental deterioration.

Equilibrium pollution and economic development in China

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This paper analyzes China's experience with the pollution levy, an emissions charge system which covers hundreds of thousands of Chinese factories. Operation of the system has been well-documented since the mid 1980s, affording a unique opportunity to assess the implementation and impact of a pollution charge in a developing country.

The levy experience has not been studied systematically, but anecdotal critiques have created the impression that the system is arbitrarily administered and ineffective as a pollution control instrument. In this paper, the conventional critique of the levy system has been tested, using a province-level panel database for the period 1987–1995. It focuses on the water pollution levy because its implementation and impact are well-documented in the information available. There is no basis for judging whether the results are also valid for air pollution, solid waste, or emissions from facilities which do not report to provincial and national regulators (particularly township and village enterprises). However, water pollution has been the dominant focus of pollution regulation in China, and the database incorporates information drawn from many thousands of factories over a nine-year period which witnessed great changes in China's economy. It is therefore believed that the results provide some valuable new insights.

The econometric analysis of this paper focuses on explaining variations in two province-level measures: industrial emissions intensity (provincial emissions/output) for Chemical Oxygen Demand (COD), and the effective water pollution levy rate (provincial levy collections per unit of above-standard wastewater discharge). Contrary to the conventional wisdom, the results suggest that the water pollution levy system is neither arbitrary

nor ineffective. Across provinces and over time, variations in the effective levy rate are well-explained by proxies for local valuation of environmental damage and community capacity to enforce local norms. The results also suggest that the emissions intensity of Chinese industry was highly responsive to these increases.

The paper concludes that the water pollution levy has been more effective than previously supposed, although there is undoubtedly room for improvement. The results also suggest some important lessons for regulators in developing societies:

- Local enforcement of national standards will determine the effective 'price of pollution' in each area.
- The locally enforced price of pollution rises steadily with industrial development, because community damage valuation and enforcement capacity both increase.
- Early in the regulatory process, industrial emissions intensity is highly responsive to changes in the price of pollution.

An economic analysis of using crop residues for energy in China

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China produces about 605 million tons of crop residues per year, 60 per cent of which are used as cooking and heating fuels in rural households. Burning biomass results in no net increase in atmospheric carbon dioxide (CO₂) because the emitted CO₂ from biomass burning will be reabsorbed by new biomass growth. By burning crop residues for energy, one can thus displace coal and reduce carbon dioxide emissions. Crop residues currently provide 38 per cent of total energy use in rural areas of China. Most residues are currently burnt in inefficient brick-layered stoves.

The aim of this paper is to examine the amount of coal and associated CO₂ emissions that is replaced by the current use of crop residues for energy, and to calculate the marginal cost of replacing even more carbon by changing crops or using commercial village and central energy facilities. Based on the case study of a village in eastern China, we find that even without an official carbon mitigation program, crop residues already eliminate a substantial fraction (about 8 per cent) of China's total emissions. China could mitigate more carbon by growing corn, which produces more residues on a per hectare basis instead of rice, or growing trees on

cropland, or burning crop residues in commercial facilities rather than in home cooking stoves. However, the marginal cost of reducing additional carbon through these mitigation activities is surprisingly high. By burning residues at a centralized facility rather than in home cooking stoves, some additional carbon could be saved from the higher thermal efficiency, but it would cost \$77 per ton. Combining crop shifting and the centralized facility, even more carbon could be saved at a cost of about \$117 per ton. Burning crop residues at a village facility would cost almost \$200 per ton. Finally, growing trees on prime agricultural land would cost between \$350 and \$559 per ton carbon.

These results imply that there are few low cost options for China to get more carbon reductions from their crop residues than they already do. However, one important issue that was not considered in this study concerns indoor air pollution due to inefficient use of crop residues in rural households. The potential health benefits associated with air pollution control would make these carbon mitigation options more attractive. This study represents the first approximation of estimating the carbon benefits associated with use of crop residues for energy in China. Before China pursues a large-scale carbon mitigation program to use crop residues, a more extensive analysis should be undertaken to take into account the health co-benefits and to carefully examine many of the assumptions made in this initial analysis.

Technical efficiency in the Malaysian gill net artisanal fishery

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The paper examines the question of whether the focus of development assistance to the harvesting sector in artisanal fishing communities is appropriate. To address this issue, the study provides the first-ever estimates of technical efficiency, or the ability of individual vessels to produce maximal outputs from a given set of inputs, or artisanal fishers. The results indicate that most artisanal gill net fishers in a sample of fishers on the west and east coasts of Malaysia are near to the frontier, or maximum level of technical efficiency, and thus are close to achieving their highest possible outputs given their technology and input constraints. The estimated technical efficiency measures were also regressed on a number of vessel, skipper and crew characteristics to better understand the factors that con-

tribute to improved technical efficiency. These regressions suggest that the individual characteristics of captains appear to be more important on the more isolated and less-developed east coast, while vessel characteristics appear to be more important in explaining differences in technical efficiency on the west coast. The study suggest that development assistance to artisanal fisheries must be locally based and tailor-made to each region, and that targeting such assistance away from vessel and gear upgrades to other priorities is desirable.

Citizens' actions for protecting the environment in developing countries: an economic analysis of the outcome with empirical cases from India

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It is common to see citizens filing suits, or taking actions of civil disobedience, for protecting environment in developing countries. This paper makes a simple theoretical analysis of the potential outcomes of such citizens' actions in the context of the institutional weaknesses of these countries. For example, the long delay in getting conflicts resolved through courts can be shown to favor existing polluters, and work against new firms, projects or activities. This is so since existing firms can benefit from polluting till the court resolves the issue, where as new firm can start functioning only after getting court decision. Monetary compensation for pollution may not be reliable if a third party can bring the polluter again to the court, which is quite possible within the framework of Public Interest Litigation in India. In such a situation, people have an incentive to delay the starting of a new firm by using court proceedings.

The paper also analysed the impact of actions of civil disobedience, such as blocking the movement of raw materials or physically blocking the starting or functioning of a factory or project, which are less costly in developing countries due to poor law and order enforcement, and low opportunity cost of time. Such actions may impose a high cost on the party to which such actions are directed. The analysis with simple game structures depicting the interaction between citizens and a new firm, and an existing firm, show that socially efficient outcomes need not be produced. It should be noted that too little pollution (where in gains from more pollution exceeds the damages), and too much pollution (where in damage from more pollution is greater than the gains) are both socially inefficient

outcomes. The analysis of the paper shows that the combined effect of court delays and actions of civil disobedience is to make the starting of a new firm less likely (creating the inefficiency of too little pollution). On the other hand, the delay through court procedures causes the persistence of high pollution from existing firms (i.e., the inefficiency of too much pollution), and the impact of actions of civil disobedience in this case depends on whether these can impose a high cost on the polluter.

The theoretical insights of the paper are then verified with 25 cases of such citizens' actions from Kerala. It shows that such actions led to the abandonment or the continuing delay of the majority of new firms or projects against which such actions are directed. On the other hand, such citizens' actions could not make much impact on more than two-thirds of existing firms and they continued with high level pollution or environmental degradation. This insignificant impact of citizens' actions on existing firms is partly due to the long delay in getting court decisions. Moreover citizens could not impose a high cost on the firms through actions of civil disobedience, probably because these firms derived support from some other sections of the society (probably by those who derive employment benefits).

In this context, it may be interesting to know which firms come to exist without encountering citizens' actions. In order to analyze this issue, a sample of 239 existing firms of Kerala were surveyed. The analysis shows that around 95 per cent of these firms that came to exist were not viewed as potential polluters. These include furniture units, hotels, software firms, etc. Fifty per cent of the remaining firms are more than two decades old, probably due to the fact that environmental awareness was not that widespread in those times. The majority of other firms (i.e., potential polluters) which came to exist within the last two decades are in locations such as industrial estates, where much larger polluters were already existing. In this case, people did not see the new firm as a threat since its pollution is somewhat invisible because of the high pollution created by the already existing firms. In essence, new firms which are potentially polluting find it difficult to establish in a normal location even if they plan to start with pollution control.

The paper argues that both the abandonment of new firms and the continued pollution by existing firms create social losses. Thus the basic policy insight of the paper is that such citizens' actions may not compensate for the laxity in environmental enforcement, and thus the need for getting institutions and law and order enforcement right.

Eco-labels for credence attributes: the case of shade-grown coffee

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Credence attributes are characteristics of, or information on, the products that consumers buy but they cannot directly observe or learn about through inspection and/or consumption. In food and beverage industries, information on agricultural methods used to produce the item are often the source of credence attributes. Are there pesticide residues on this item? Were agricultural workers paid fairly during production and harvesting? Was wildlife habitat destroyed, or water pollution generated, during production and processing?

Eco-label programs have developed to provide information to consumers on credence attributes of products. For example, this paper considers the case of an eco-label for 'shade-grown' coffee. While coffee bushes were traditionally planted under a canopy of shade trees because they could not tolerate direct sun in tropical growing conditions, 'sun-tolerant' varieties were developed that can be grown in direct sun. While yields and profits have been higher using sun methods in many areas, it has become recognized that shade-coffee plantations also provide important benefits in terms of wildlife habitat. While a consumer cannot know by consuming how the coffee was produced, a 'shade-grown' label provides such information to consumers. By providing this information, it is hoped that an eco-label will stimulate demand for the labeled item and create a price premium for the labeled item in the market.

Using the case of shade-grown coffee, this paper examines the market impacts of 'eco-labels' for credence attributes. The Mattoo and Singh (1994) test is conducted in section 2 to investigate the market impacts of a shade label. An eco-label will pass this test when, given the current price, existing supply of shade-grown coffee is greater than 'potential' demand if a label existed. Based on existing information, section 2 concludes that a shade label could pass this test but the market impacts are likely to be minor. Section 2 also shows how to use estimates of supply, potential demand, and price elasticities of demand and supply to predict eco-label premiums.

Given the importance of consumer demands for eco-label impacts, and since the theoretical foundations of demand for eco-labeled items are not well developed in the literature, section 3 takes a closer look at the microeconomics of labels and consumer demand. A commonly used utility function is adapted to the issue of eco-labels and then is used to derive theoretically consistent demands for the eco-labeled item (shade coffee in this case). A numerical simulation shows how relative prices and consumer preferences for the credence attribute and variety are both important factors in demand creation of labeled items.