

Summaries

Modelling adoption of natural resources management technologies: the case of fallow systems

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Land degradation is one of the contributing factors to the agricultural crisis in Africa. An international evaluation of land degradation conducted in 1990 by the United Nations Environment Program showed that 1.2 billion hectares of land (11 per cent of world land cover) had been degraded by human activity between 1945 and 1990. In sub-Saharan Africa, 70 per cent of arable soils are classified as low-fertility. Estimates on the impact of the gross loss of soil report economic growth loss ranging from 0.5 per cent to 1.5 per cent in countries like Costa Rica, Malawi, Mali, and Mexico. These negative effects may lead to growth stagnation.

As the demand for greater food production becomes an ever-increasing need while land becomes scarcer and more degraded, the only option for African farmers is the intensification of agriculture. Technological options are available such as inorganic fertilisers. However their use remains limited mainly due to rising prices and inefficient marketing systems.

One option for avoiding a decline in soil productivity is to explore natural sources of fertilisers. One such fertiliser is the use of the cover crops such as *Mucuna* fallow used in West Africa. *Mucuna* Fallow is an emerging National Resource Management Technology used to restore poor soil fertility in southern Benin. It produces an organic biomass that may reach 6 tons per hectare, accumulating up to 160 kg of Nitrogen per ha over a vegetation cycle of about 240 days.

Despite the potential benefits associated with fallow systems, they are not without user and opportunity costs. Adopters have to support the clearing costs of fallow, the loss of crops during the fallow time, etc. Thus, the adoption of fallow systems implies a rational process of decision making – one that is currently not adequately modelled by the relevant literature. This paper presents an adoption model derived from a three-step decision process (information, adoption, and intensity of adoption). Comparative static theoretical results are derived, and field data are used to test them.

In this paper, theoretical results show that levels of technical parameters such as duration and regeneration rate of soil fertility by improved fallow are relevant for adoption. Nonetheless, economic and social factors also contribute as they are reflected in discount rate, risk, information and prices of inputs and outputs.

Results from empirical estimations from a 1998 survey of 580 farmers in Benin generally confirm the theoretical results. Results demonstrate that acquisition of information about resource management technologies is influenced by age of farmers and action by official extension services; the adoption decision is influenced by prior utilization, the bundle of land property rights owned, and the level of financial liquidity; and the intensity of adoption is influenced by the percentage of the farm that is degraded.

This paper suggests that any agricultural policy aimed at efficiently promoting adoption of a technology should encourage first utilization. This can be done by reducing adoption costs (free of charge seeds, purchase of harvests), promoting exchange of information among adopters and non-adopters, intensifying official extension effort, clarifying land property rights, and by encouraging the development of official and informal financial institutions.

Option valuation of Philippine forest plantation leases

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Plantation forests are playing an increasingly important role in meeting the world's growing requirements for wood and nonwood forest products. Several countries (for example, China, India, Indonesia, Brazil) have been successful in plantation forestry. However, over 60 per cent of the plantations in Asia and Africa have been assessed as being unsuccessful. This paper shows that the Philippines is one of those countries which has not been too successful in establishing forest plantations and investigates how timber price uncertainty could be one possible explanation for its poor performance.

Since 1977, the Philippines has had a programme for forest plantation development. However the performance of this programme has been disappointing: only 18 per cent of total area awarded has been planted. Even an Asian Development Bank project to provide a soft loan to the forest plantations sector was terminated after eight years with unsatisfactory results: only 36 per cent of loan allocation was disbursed and only 24 per

cent of the target area was planted. Considering that standard benefit–cost analysis shows that returns to plantation forestry are quite adequate and, moreover, become attractive with suitable financing, the slow development of plantations in the Philippines is a puzzle.

This paper argues that conventional investment analysis of Philippine forest plantations is misleading because it largely ignores the implications of timber price uncertainty and of irreversibility inherent in the sunk costs required to establish plantations. As a result, the planting behaviour of leaseholders is poorly understood. This poor understanding makes more difficult the formulation of appropriate policies to promote plantation development.

To improve understanding of forest planting behaviour in the Philippines, this paper uses a real options approach to studying investment. This approach allows one to price the forest plantation lease and to calculate optimal rules for managing the investment project. The plantation lease is viewed as an ongoing opportunity to invest, which does not disappear if not taken immediately. The leaseholder has the flexibility to decide not only whether to plant, but also when to plant. This flexibility is valuable because establishing a plantation requires investment costs that cannot be fully recouped if the project is abandoned. Under conditions of ongoing uncertainty and gradual arrival of information, waiting has positive value. As long as the opportunity to plant remains available, a later decision can be a better one. This paper argues that Philippine leaseholders who have not planted could be exercising optimally their option to plant. The value of the option can be large enough that waiting and keeping the option alive may be the better decision than planting immediately.

This paper also uses real options analysis to evaluate two policies intended by the Philippine government to hasten forest planting: a specified project gestation period and a threat to cancel leases. We show that shortening the gestation period and threatening to cancel the lease could encourage planting. However, we also demonstrate that waiting would still be valuable for leases with short lives or under cancellation threats. We thus argue that these policies may not be fully effective in speeding up planting.

Consumption pattern, trade, and greenhouse gas leakage in India

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The emissions of Greenhouse Gases (GHGs) may affect the state of economic well being of all the countries by causing global warming. The GHGs

include gases like carbon dioxide (CO₂), methane (CH₄), nitrogen oxides (NO_x), chlorofluorocarbons (CFCs), and hydrocarbons. Almost every sector of an economy contributes to their emissions, and every country of the world is responsible for climate change to a greater or lesser extent. It is also well recognized that in the problem of management of common resource, like global atmosphere, a co-operative solution can enable the world to arrive at its sustainable use and management. The main issue involved in this context is how should the share of global GHG emissions, for which a country is responsible, be determined? The conventional approach has been to make the actual emissions of GHGs occurring at the sources within the geographical boundary of a country as the basis. Such an approach does not take account of the pattern of final consumption in a country, which is the ultimate determinant of the GHG emissions. A country may continue to enjoy the benefits of the same consumption by changing the trade and the production pattern, that is importing products that are GHG emission-intensive and reducing their production and thereby reducing the GHG emissions as calculated by the conventional approach. Any such reduction of emissions by one country does not amount to reduction in global GHG emissions. Thus for determining the share of global GHG emissions for which a country is responsible we need to calculate the share of global emissions that can be imputed to the consumption pattern of the country. It may appear that this estimate would be the total emissions of GHGs occurring within the geographical boundaries of the country, plus the emissions arising in the rest of the world for producing the imports of the concerned country, less the emissions arising within the country for producing its exports. But correct estimation needs also to take into account the variation in emissions that would be implied by the change in the level and pattern of investment that the pattern of consumption would require in a no trade situation. In other words, we require estimation of the GHG emissions that would have been involved for meeting a given consumption demand of a country in the hypothetical situation of autarky. The excess of this estimate over the actual one in the presence of trade would yield the estimate of the amount of the GHG leakage from the country.

This paper defines the methodology for estimating the true GHG responsibility of a country and estimates the effect of trade on the net leakage of carbon dioxide and methane from India using a multi-sector input-output model. It shows a significant net leakage of carbon dioxide from India for the observed consumption pattern in the 1990s. Although non-availability of regularly updated information on input-output tables makes the application of the concept as defined in this paper somewhat difficult, the estimates of GHG responsibility of nations behind their respective consumption can provide an ethical and normative basis for global cost sharing for any global co-operative programme of GHG emission control. The results of the paper also suggest the necessity of policy to influence globally the preference structure of the people in favour of ecofriendly consumption patterns and lifestyle.

An empirical study on effective pollution enforcement in Korea

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According to Harrington (1988), extra incentives for firms' compliance with pollution regulations would be created under state-dependent enforcement, in which an environmental regulatory agency's policy depends upon the firm's past performance. The basic idea is that firms are assigned to two groups, group 1 and group 2, based on their previous compliance status. Firms found to be in compliance up to the last inspection are placed into group 1, and firms found to be in violation are placed into group 2. Group 2 is subject to a tougher regulatory system, which includes more stringent standards, a higher probability of inspection, and more severe penalties, than group 1.

The extent of the overall improvement in compliance, however, is expected to be different according to the pollution control costs and industrial structures of any given country. In this paper we empirically examine, for the first time, the effectiveness of an imposition of higher fines for repeated violations, and state-dependent enforcement in terms of a reduction in violation days, by simulating emitting behavior for 65 sub-industries in the Korean manufacturing industry over the period 1987–89. In particular, we classify the data set into 12 mid-industries to grasp the response of individual industries to different regulatory systems.

We conclude that state-dependent enforcement will be more effective than an imposition of higher non-compliance fines for repeated violations in terms of the number of sub-industries exhibiting persistent non-compliance. However, interestingly enough, the number of fully complying sub-industries would be slightly larger under an imposition of higher non-compliance fines for repeated violations than under state-dependent enforcement. This finding empirically supports Viscusi and Zeckhauser (1979) in that, as a regulatory system is made more strict, a portion of compliant industries tend not to comply. These industries include those producing leather, fur, textiles, and other chemicals.

Most sub-industries in such industries as primary metals, fabricated metals and machinery, and industrial chemicals will continue to choose the maximum violation days despite a shift to the more effective enforcement system. For these industries, tougher regulatory systems are recommended. Therefore, in Korea, a uniform introduction of state-dependent enforcement would not necessarily produce the best outcomes in improving compliance performance. Rather, based on our results, it would be desirable to discriminate against certain industries with enforcement systems of a different intensity.

Governance, economic policy, and the environmental Kuznets curve for natural tropical forests

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The environmental Kuznets curve is an inverse U-shaped relationship between indicators of environmental deterioration and economic development. The EKC hypothesis holds that during initial stages of development some form of environmental degradation appears inevitable, but subsequent income increases will produce incentives to improve environmental quality. The major implications of EKC studies for global environmental policy are to identify potential policy programs in developing countries that move the economy to a sustainable development path. Prudent policy can minimize the damage done to environmental systems during the development process, thus keeping environmental damage within safe limits.

This study provides an empirical evaluation of the EKC hypothesis using the deforestation rate of tropical forests as the indicator of environmental quality. The use of recently available data from the World Resources Institute that measure natural forest cover in developing countries distinguishes this study from others on the topic. The empirical model employed in this study includes agricultural productivity growth, macroeconomic factors, population, and institutional structure, as well as income to explain the change, over time, in deforestation. This relationship is examined for 63 countries from the tropical regions of Latin America, Africa, and Asia during the period 1980–1995. Observations of forest cover for each country are available for 1980, 1990, and 1995. The data set is composed of information from 20 countries in Latin America, 31 in Africa, and 12 in Asia that fit the geographical restriction and for which consistent and comparable data for natural forest cover are available for each of the three time periods.

This study hypothesizes that economic development is first accompanied by deterioration of environmental quality, but once societal income reaches a sufficiently high level environmental quality will improve. Deforestation is considered here as the indicator of environmental degradation. It is assumed that increases in income are accompanied by improvements in socio-political institutions and better allocation of environmental resources, which are generally public goods. Hence, it is further hypothesized that underlying institutional and policy conditions affect the relationship between deforestation and income. This study adopts the same empirical procedures employed by others, but with the addition of institutional factors and broad level macroeconomic variables hypothesized to affect the income-deforestation relationship.

Previous empirical studies of the global EKC for deforestation provide mixed evidence of the validity of the deforestation EKC relationship. This study confirms the EKC for deforestation in tropical developing countries and asserts that quality of institutions plays a vital role in the protection of forest resources.

Results of this study should be interpreted cautiously since the estimated models do not represent any specific country or locality where deforestation activities are taking place. However, the results from cross-national analysis are useful for validating or refuting some of the controversial theoretical issues discussed in the literature. This cross-country empirical analysis provides information for global policy recommendations as well as input for further theoretical exercises on the subject. The results in this study provide confirmation of the global environmental protection concept embodied in the EKC.

The EKC model for natural forest confirms that quality of governance is a critical determinant of tropical deforestation. Among the macroeconomic policy factors selected for the EKC models, increases in economic growth and decreases in foreign debt reduce deforestation of tropical natural forests.

Despite the emphasis given to local population pressure, shifting cultivation, and slash and burn agriculture in the literature on the economics of deforestation it appears that local population pressure is not a primary driving force for the depletion of natural forests. However, overall population growth does have a positive impact on deforestation. The change in cereal yield and secondary school enrolment – proxies for technology change in the agrarian sector and human capital development, respectively – were both found to deter the deforestation process. These results are consistent with the basic concept of the EKC hypothesis, which suggests that economic development is consistent with improved environmental quality. Improvements in education provide opportunities for off-farm employment, facilitate technology adoption, and improve public participation in the democratic process. Thus, the empirical evidence from this study demonstrates that both technological and social development will have favourable impacts on the conservation of natural forests.

Land tenure and conflict resolution: a game theoretic approach in the Narok district in Kenya

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The Narok district in Kenya has witnessed increasing levels of land degradation over the last decade. Over the same period of time, poverty has increased among the pastoral communities living in the district.

This study sets out to investigate if there is a relationship between the environmental degradation and the poverty and to identify some plausible policy responses to reverse the trend.

A game theoretic model was developed to study the inter-dependencies among the three main communities – the pastoralists, the commercial farmers, and the subsistence farmers – living in the district. The dynamics of the system were as follows. The pastoralists owned a major portion of the land in the district but these were categorized as group ranches (trust land) whereby land was collectively owned by a group of families. The subsistence farmers owned small patches of land, while the commercial farmers primarily leased land from the pastoralists.

The objective of each group within the game model was to maximize profits. For the pastoralists, revenue could come from livestock or lease of land. The commercial farmers' revenue stream was primarily from wheat farming, while the subsistence farmers relied on a combination of on-farm products as well as off-farm labor. The three groups were linked through the environmental impacts their activities had on land. For example, intensive farming by the commercial farmers would cause land degradation in the form of lower carrying capacity which in turn would imply lower carrying loads for pastoral activity when these lands were returned at the end of the lease term.

Our intention in this study is to analyze how income levels for the three groups change under varying levels of information asymmetry and under different property regimes. Information on land prices, crop prices and levels of environmental degradation were found to play a critical role in determining group choices and subsequently group income. The first interesting result from the model is that the subsistence farmers play a limited role in the game and the real inter-dependency and a plausible explanation for the deteriorating conditions in the district could be traced to the pastoralists and commercial farmers.

We ran six simulations with the model. The first experiment was run under present institutional and information conditions. We then ran the remaining five under varying conditions of information asymmetry and property regimes. We were able to demonstrate by comparing across these simulations why the pastoralists have seen their income levels drop and the land they own degraded. The results also caution against the full privatization of the present land tenure system. It is shown in one of the simulations that full privatization will only produce a temporary wealth effect for the pastoralists who will see this effect dissipate very quickly over time. One simulation also highlighted the fact that the present revenues given to the pastoralists by the ecotourism industry for reserving some of their lands for wildlife were significantly below the market value of those lands. This finding suggests that some form of a global fund be established in order to compensate the pastoralists for maintaining wildlife in the area.

The policy prescription we suggest is that a hybrid land tenure system be put in place whereby individual land titles be given to each family within the present group ranch system but with clauses that govern the transfer or sale of land explicitly drawn up by members of the family. It was also shown in the simulations that information on soil quality on the part of the

land owners goes a long way towards reducing land degradation through the introduction of environmental lease contracts. In this regard, sharing and exchange of information was found to be critical in elevating poverty as well as reducing land degradation.

Politics of institutional reforms in the water and drainage sector of Pakistan

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Recent reforms in the water and environment sectors in many countries address institutional arrangements that may result in redistribution of power and welfare among stakeholders, and this may create considerable political opposition that slows, diverts, or even stops the reform process. Therefore, policy makers, who are engaged in designing such reforms, would benefit from being able to assess the likely outcome of reforms prior to their implementation and to prepare mitigating actions.

In this paper we develop an approach, based on the Delphi technique, to assess the likelihood of success of institutional reforms, and apply it to a package of reforms in the irrigation and drainage sector of Pakistan. We review relevant literature on institutional reforms, and analyze the political process in Pakistan that accompanied the reform process, starting with the initiation of the reform and ending with the agreed-upon package of reform components. We assess the likely outcome of several components in the National Drainage Program project reform in Pakistan, using a Delphi framework. The results of our Delphi analysis suggest that of the five major reform components that we analyzed, the decentralization of provincial irrigation departments into autonomous area bodies has high–very high chances for medium achievement level; the transfer of responsibilities for management of the systems at the minor and distributary level and small drains to farmer organization has medium chances for medium achievement level; the awarding of contracts to the private sector for carrying out operation and maintenance of irrigation and drainage has high–very high and medium chances for medium and high achievement levels, respectively; the establishment of water rights and formation of a water market has medium–high and medium chances for low and medium achievement levels, respectively; and defining the operational jurisdictions of various institutions in the water sector has medium chances for medium achievement level. Although it might be too early, we conclude the paper by comparing our assessment with what actually happened in the country several years along the reform path, and by discussing the implication of our approach for policy purposes.