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Summaries

Environmental controls with corrupt bureaucrats

RICHARD DAMANIA

A growing body of evidence suggests that corruption is one of the major causes of environmental damage in developing countries. Some striking examples include: the illegal burning of forests in Sumatra and the consequent pallor of smog over parts of S.E. Asia, the banned though thriving trade in tiger organs and rhinoceros horns, both of which are demanded for their presumed therapeutic values, and illegal deforestation in the tropics. Thus, an understanding of policies which foster corruption and of ways to control it is of considerable importance in designing effective environmental regulations.

The existing literature on environmental compliance appears to have largely ignored the consequences of corruption on environmental outcomes. This paper investigates the implications of corruption for the design of optimal environmental regulations. A number of novel results are suggested by the analysis. For instance, it is demonstrated that even if corruption can be deterred, the fact that it may occur impedes the ability of a regulator to control environmental damage. Moreover, the optimum policy depends critically upon the efficiency (and honesty) of the judiciary. If the judiciary is highly inefficient, the commonly proposed expedient of resorting to harsher penalties for corruption is shown to be counterproductive. More generally the results emphasize the need for multifaceted policies which tackle problems of corruption and environmental degradation simultaneously and systematically. This contrasts with the approach taken by policy makers who usually deal with problems of corruption and environmental damage separately and on an *ad hoc* basis.

The environmental Kuznets curve and satiation: a simple static model

CHRISTOPH M. LIEB

The environmental Kuznets curve (EKC) is a hypothesis stating that pollution rises with income at low levels of income but falls at higher ones. In this article we show that satiation in consumption might be an important driving force behind the EKC.

To do so we analyse a simple static model in which an aggregate consumption good and environmental quality are both normal goods. Pollution is generated by consumption and can be abated. By relaxing some assumptions in the existing literature we are able to show that two conditions on the pollution function are crucial for the behaviour of pollution: first, the condition that consumption becomes ever less polluting with rising income, if we allocate additional income to consumption and abatement such that pollution stays constant, and, second, the condition that abatement becomes ever more expensive with rising income if pollution stays constant.

With this simple model we show that at low income levels abatement expenditures are zero, and, if income rises exogenously, pollution increases. Once abatement expenditures are positive, the behaviour of pollution depends on satiation and the two conditions on technology mentioned above. If both conditions are violated, pollution declines as soon as abatement expenditures are positive and will finally be zero at high income levels if zero pollution is technically feasible. Thus we find an EKC. However, for standard functional forms both conditions are satisfied. Then, we show that while satiation is always sufficient to generate an EKC, a tendency to satiation is even necessary to obtain an EKC. We argue that saying that there is a tendency to satiation is equivalent to stating that environmental quality is a normal good. Therefore for an EKC to exist it is necessary that environmental quality is a normal good. Without a sufficiently strong tendency to satiation, pollution could become constant at a positive pollution level or it might even increase monotonically.

The intuition is that approaching the satiation level we can easily dispose of some consumption almost without lowering utility. Therefore additional income is better used for abatement such that pollution falls. Satiation is not as implausible as it might seem: in richer countries a tendency to satiation in the demand for agricultural goods, industrial goods, and services has been observed. Furthermore, most economists would subscribe to the assumption that environmental quality is a normal good which is equivalent to a tendency to satiation.

Finally, the results of two related models in the literature are reconsidered. In the first the results are interpreted incorrectly: we verify that there

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is no simple relationship between the income elasticity of demand for environmental quality and the EKC. In the second model the author finds satiation without noticing it. Furthermore, we show that these two models are both special cases of our general model.

Technology transfers in the Clean Development Mechanism: an incentives issue

KATRIN MILLOCK

The Kyoto Protocol specifies binding emission reduction targets for anthropogenic greenhouse gas emissions for industrialized countries listed in its Annex B. The Protocol includes three flexible mechanisms: emissions trading (article 17), joint implementation, JI, (article 6), and the Clean Development Mechanism, CDM (article 12). Whereas emissions trading and JI apply to signatory countries with quantified emission reduction targets, the CDM aims at involving developing countries in global climate change mitigation policies.

Notwithstanding the ratification problems of the Kyoto Protocol, it is worth studying the CDM as a mechanism for global climate change policy, in particular since there are precursors in the pilot phase of Activities Implemented Jointly. Furthermore, private sector initiatives are undertaken with the aim to qualify as CDM projects under a ratified Kyoto Protocol. In a bilateral project-based mechanism, such as JI or the CDM, the use of private information to extract rent decreases the potential for abatement cost savings (Hagem, 1996). Wirl, Huber, and Walker (1998) and Janssen (1999) proposed some mechanisms and institutions to provide correct incentives for JI projects when there is asymmetric information between the investor and the host party. It is argued here that the problem is somewhat different under the CDM, which consequently modifies the conclusions on the impact of incomplete information on CDM contracts. First, the host party does not have a binding emissions target. Second, the commercial potential of a CDM project could outweigh its direct emission reduction benefit. And, third, the goal of the CDM is not only to obtain efficient emission reductions but also to contribute to sustainable development in the host country. In this context, the paper will argue that it is necessary to include technology transfers for a full analysis of the CDM. I will show that technology transfers are not only a matter of equity, but can help to solve some of the incentive problems of implementing a bilateral CDM when there is incomplete information between the parties.

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The method used in the paper is contract theory, under which the investing party is treated as the Principal with the objective of implementing certain emission reduction abroad. The host country (Agent) objective is to maximize the income earned from the emission reduction project, net of costs. The basic assumption of the paper is that there is asymmetric information on an abatement efficiency parameter between the two parties of the CDM transaction. In order to contain the incentives to overstate emission reduction costs, the principal should then transfer the abatement technology (capital) to the agent who should be free to exploit the capital for other revenue-producing options. This is an application of the theory of countervailing incentives (Lewis and Sappington, 1989). By transferring control of the productive resource to the host country, the agent will have stronger economic incentives not to misrepresent its private information. In practice, this involves real technology transfer. Alternative institutional organizations of the CDM, such as the Prototype Carbon Fund of the World Bank, may also alleviate the information problems discussed in this paper.

Measuring the cost of environmentally sustainable industrial development in India: a distance function approach

M.N. MURTY and SURENDER KUMAR

The environmental standards fixed by the regulator constrain the demand for the environmental services by the industry to the level determined by the waste assimilative capacity of environmental media. The cost of meeting these standards to the industry can be regarded as the cost of environmentally sustainable industrial development. For a competitive firm, this cost has to be estimated by studying its behaviour in making decisions regarding pollution loads and the choice of pollution abatement technologies. In response to regulation, firms may adopt three types of technologies: substituting more polluting inputs for less polluting ones, changing production processes to reduce emissions, and finally investing in end of pipe treatment plants. In practice, a firm may adopt a mix of these methods. If a firm has a resource constraint, the opportunity cost of meeting the environmental standards is in terms of its reduced output. The methodology of the output distance function in the theory of production can be used to estimate this opportunity cost for a firm using all or some of the above-mentioned pollution abatement technologies.

Estimates of total cost and the marginal cost of pollution abatement functions are needed for designing the environmental policy, especially the economic instruments. Since industrial pollution, air or water, is normally expressed in terms of a vector of pollutants, an estimate of the marginal cost of abatement for each pollutant is required. Considering that a polluting firm produces good outputs and bad outputs (pollutants) jointly, the methodology of the output distance function enables one to estimate the marginal costs or shadow prices of pollutants. The estimation of the output distance function requires data about outputs, inputs, and pollution loads of different pollutants for a sample of polluting firms. Using the data for a sample of 60 water polluting firms in India, the output distance function is estimated. The estimates of shadow prices of a ton of Bio oxygen demand (BOD), and Chemical oxygen demand (COD) for the water polluting industry obtained using the parameters of the estimated output distance function are respectively given as Rs. 0.246, and 0.077 million at 1994–1995 prices. These shadow prices can be interpreted as the opportunity costs in terms of value of output foregone by the industry to reduce the pollution load by a ton. A negative relationship between the index of non-compliance (ratio of effluent load to sales value of a firm) and the firm-specific shadow prices or marginal costs of pollution abatement is found, implying raising marginal cost with respect to reductions in pollution concentration. Also, a negative relationship between the shadow prices and pollution load reductions by the firms is observed, indicating the presence of scale economies in water pollution abatement. These results confirm the findings of earlier studies on industrial water polluting abatement in India. The estimate of the output distance function shows technical efficiency of the order of 90 per cent for the water polluting industry as a whole. The estimates of economies of scale show the presence of decreasing returns to scale to the extent of 0.823. In an economy in which industries are meeting the pollution standards fixed for the sustainable use of environmental resources, the shadow prices of pollutants estimated using the methodology of the distance function could be used to estimate the cost to the industry of maintaining the environmental standards. This can be a methodology that can be potentially used for estimating the environmentally corrected GDP by making use of the maintenance cost version of the United Nations methodology of 'Integrated Environmental and Economic Accounting'.

Do public works decrease farmers' soil degradation? Labour income and the use of fertilisers in India's semi-arid tropics

MARRIT VAN DEN BERG

Inadequate replenishment of removed nutrients and organic matter has reduced fertility and increased erosion rates in India's semi-arid tropics. Declining soil quality on smallholder soils initiates a process that ultimately leads to poverty, hunger, malnutrition, and further environmental degradation. Fertiliser use, along with other complementary measures, can help reverse the downward spiral of environmental degradation in several ways. First, fertiliser use can provide much-needed nutrients and hence increase crop yields and food production. Second, higher yields imply more biomass, which helps maintain soil organic matter and vegetative cover. Third, by increasing crop production in high-potential areas, fertiliser use can reduce the pressure to clear forests for crop production. In addition, fertiliser use can help reduce global warming by enhancing sequestration of carbon in soil organic matter.

In a high-risk environment like India's SAT, there may be a strong relation between off-farm income and smallholder fertiliser use. Farmers can use the main source of off-farm income, wage income, to finance external inputs like fertilisers. Moreover, wage income guarantees a certain minimum household consumption. Households earning wage income may, therefore, increase the riskiness (and profitability) of their agricultural activities. Consequently, the introduction of public-works programmes in areas with high dry-season unemployment may affect fertiliser use.

Despite the potential importance of off-farm income for agricultural decisions, few researchers cover this topic. Non-farm income is sometimes included as an explanatory variable in regressions of farm decisions. However, this does not shed light on the workings of the underlying decisions and constraints. Off-farm income is an integral part of the household's decision-making process, which concerns all income generating activities and consumption. Only within this context can we expect to reveal the impact of off-farm income on fertiliser use.

Hence, this paper develops an analytical model that shows the rationale behind household decisions regarding fertiliser use and off-farm activities under risk and credit constraints. From this model, we derive a decision function for fertiliser use, which allows for distinction between the effects of risk and credit constraints. We estimate this function for two villages in India's SAT. Our estimates confirm the relevance of risk for decisions regarding fertiliser use, but we do not find evidence of short-term credit

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constraints. Moreover, the estimates reject the possibility to use public works or other employment policies to stimulate fertiliser use. Public works even decrease the use of fertiliser in the survey setting.

Measurement and sources of technical efficiency of land tenure contracts in Ethiopia

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The effect of alternative land tenure arrangements on agricultural productivity is still unresolved. While some researchers argue that tenancy arrangements such as sharecropping result in inefficient allocation of resources, others contend that factors other than the type of land tenure are more important determinants of agricultural productivity. Hence, whether alternative tenure arrangements constrain agricultural productivity remains an empirical question, which depends on the specific economic and policy environments under which farm households operate.

This paper attempts to investigate the technical efficiency of alternative land tenure arrangements in Ethiopia, a country where land markets and land policy are critical issues for agricultural development due to the high population pressure on land. Prior to 1974, land tenure in Ethiopia was predominantly based on a feudal system where land essentially belonged to the Emperor. After the revolution of 1974, land was declared the collective property of the people and land was distributed to tillers. Land sale was outlawed and any forms of tenancy relationships were prohibited. Since 1991, land lease has been allowed, but rural land remains state property. Different forms of tenancy (sharecropping, fixed rental, and borrowing) are now being practiced throughout the country, providing an ideal context to study the efficiency effect of alternative tenure arrangements.

Results are based on data generated through a survey of 161 households operating 477 plots in the Arsi zone of the Oromia region in 1994. While 115 households had their own land (received land from the government through redistribution), the rest were operating leased land. Data were collected on inputs and output, plot characteristics, wealth status and demographic characteristics of the household, input and output prices.

The average value of output per hectare was Ethiopian Birr 2,478 (about US$ 300.00), and the highest return was obtained from owner-operated land. Average returns from gift plots were significantly lower than those from owned and rented plots. Average returns from sharecropped plots and gift plots were not significantly different from each other.

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Plots under the different tenure forms received significantly different amounts of planting and weeding labor, where rented and sharecropped plots received less than half of the labor input on owner-operated plots. However, the use of seed, inorganic fertilizer, and herbicides did not vary by land tenure. There was no significant difference in land quality by tenure. Rented and sharecropped plots are mainly planted with wheat, a principal cereal crop in the area.

Farmers in the study area attain 71 per cent efficiency on average, indicating that an improvement in the technical efficiency of farmers can result in an increase in crop income of 29 per cent on average. We find that the type of land tenure affects technical efficiency significantly. Sharecropped, and gifted/borrowed plots are significantly less efficient than owner-operated and rented plots.

Climate variability, vulnerability, and effectiveness of farm-level adaptation options: the challenges and implications for food security in Southwestern Cameroon

ERNEST L. MOLUA

Agricultural production depends on climate variables such as temperature, precipitation, and light. Farm households' ability to grow enough food to feed themselves and their animals is determined to a large extent by the weather. Climate variability influences not only crop and livestock production, but also input supplies and other components of the agricultural system. The risks associated with increasing climate variability pose technological and economic challenges to societies which are dependent on agriculture for their livelihood. Potential global climate change may present risks to future livelihoods. Shifts in temperature and precipitation are, therefore, important parameters for agrarian societies.

In Southwestern Cameroon the natural variability of rainfall and temperature contributes to variations in agricultural production and to food insecurity. Inter-annual and intra-seasonal rainfall variations have rendered the prevailing farm management methods, food storage facilities, transportation infrastructure, agricultural and food marketing, insufficient to buffer household entitlements from failure. An important question that needs to be answered is: What farm-level and policy adaptations are necessary to take advantage of the benefits and to minimize the negative

impacts of short-term climate variability and long-term potential climate change on agricultural production and food security in the region? This paper explores the impact of climate variability in Southwestern Cameroon on food availability. It examines the vulnerability of farm households to climate and reviews the interplay of climate, agriculture, and prospects for food security in the region. An income equation directly relates farm gross returns to precipitation and adaptation methods employed by farmers, in order to econometrically estimate the significance of farm-level adaptation methods. Precipitation during the growing season and adaptation methods through changes in soil tillage and crop rotation practices have significant effects on farm income.

To help the agricultural sector in Cameroon cope with climate variability and future changes in climate, government policy must address and increase farmers' prospects for adaptive responses. Effort should therefore be made towards the development and strengthening of institutional capacity for mitigating the impacts of erratic weather conditions. This should be linked with increased farmer access to appropriate technologies, climate information, measures to improve the marketing and distribution networks and access to credit facilities. Access to credit and micro-finance has the potential to smooth income and consumption of poor households. The paper concludes strongly that an essential precondition for food security and overall agricultural development in Cameroon and most of sub-Saharan Africa is a dynamic agricultural sector brought about both by a steady increase in agricultural production and by greater efforts in farmer support, to enable farm households to take advantage of the opportunities and minimize the negative impacts of climate variation on agriculture.

Implications of a dynamic target of greenhouse gases emission reduction: the case of Argentina

VINCENTE BARROS and MARIANA CONTE GRAND

The increase of anthropogenic greenhouse gases (GHG) emissions is one of the greatest challenges of the new century. The Kyoto Protocol (KP), adopted in 1997 at the Third Conference of the Parties (COP 3) of the United Nations Framework Convention on Climate Change (UNFCCC), establishes different reduction rates for the period 2008–2012 with respect to the 1990 emissions for developed countries and those with economies in transition.

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According to the KP, developing countries have no quantified commitments with respect to their emissions. However, their future GHG emissions will be almost double the possible reductions projected for developed countries for the period 2008–2012. Consequently, the KP alone cannot accomplish the objective of the UNFCCC of stabilizing GHGs in the atmosphere at the levels that will not endanger the climate system. In this framework, Argentina's announcement at COP5 of a target aimed at reducing greenhouse gas emissions has been an innovative event since it is the only developing country to make a decision of this kind.

An additional novelty of Argentina's target is that it is related to GDP. In fact, according to the UNFCCC, all parties share common but differentiated responsibilities. But, the restraining of emission growth is not equally feasible because GHG emissions are more critically related to economic growth in developing countries than in the developed world. Decisions regarding emission targets in these countries must take into consideration economic and social development. Then, one of the possible ways to meet this need is to develop dynamic GHG emission targets related to GDP or to other indicators of economic activity.

The purpose of this paper is to discuss the GHG emission target adopted by Argentina. It contains a summary of the process that led to the formulation of the emission target, including GHG inventories, macroeconomic and sectoral projections, and mitigation options. Fixed and dynamic indexes such as the Carbon Intensity Index are discussed, concluding that the latter is not appropriate for most developing countries. This is the case, in particular, for countries such as Argentina, whose GHG emissions are not totally dependent on GDP growth, but also on other variables, such as international prices and market conditions for their agricultural products. The index recommended for Argentina was based on the square root of GDP. It went a step further by producing a positive relation between GDP and allowable emissions, but also a relation of the same sign between GDP and emission reductions.

If this target is accepted by the COP, Argentina will contribute to facilitate negotiations for the entry into force of the KP, but will derive domestic economic benefits. Those will arise from its participation in all KP mechanisms (attracting investments, having better access to technology and increasing possibilities of participation in international emission trading markets), from the reduction in local pollutants achieved through the GHG mitigation measures adopted, from the freedom to determine a target that is compatible with its domestic priorities and growth needs, and from the opportunity of taking advantage of the less-costly mitigation options in order to comply with its commitment.

Investing in soils: field bunds and microcatchments in Burkina Faso

HAROUNAN KAZIANGA and WILLIAM A. MASTERS

This research uses field-level data from Burkina Faso to ask what determines farmers' investment in two well-known soil and water conservation techniques: field bunds (barriers to soil and water runoff), and microcatchments (small holes in which seeds and fertilizers are placed). Survey data for 1993 and 1994 are used to estimate Tobit functions, compute elasticities of adoption and intensity of use, perform robustness tests, and estimate alternative models. Controlling for land and labor abundance and other factors we find that those who have more ownership rights over farmland, and who do more controlled feeding of livestock, tend to invest more in both technologies. The result suggests that responding to land scarcity with clearer property rights over cropland and pasture could help promote investment in soil conservation, and raise the productivity of factors applied to land.

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