Summaries

Does high indebtedness increase natural resource exploitation?

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Environmentalists fear that high indebtedness induces developing countries to plunder their natural resources and engage in unsustainable resource harvesting. The argument is that highly indebted countries are desperate to raise money in order to pay for the interest or capital on the outstanding debt. This is called the debt-resource-hypothesis. Despite its popularity, there exists mainly anecdotal, but little systematic quantitative evidence supporting the hypothesis. Also, most of the evidence relates to deforestation, whereas the debt-resource-hypothesis applies more generally to a whole range of natural resources.

This article's analysis tests the debt-resource-hypothesis systematically and comprehensively. First, it estimates the effect of various indicators of indebtedness on a whole range of natural resources. These include mineral and fuel resources, such as bauxite, copper, gold, hardcoal, iron, lead, lignite, natural gas, nickel, oil, phosphate, silver, tin, and zinc. Also covered are agricultural crops produced for export, so-called cash crops, namely bananas, cashew nuts, cocoa beans, coffee, cotton, natural rubber, soybeans, sugar cane, tea, and tobacco. Second, our research design deals with a range of methodological problems. Using panel data, we can control for country-specific unobserved or latent fixed effects that do not vary over time. In order to mitigate potential omitted variable bias, we include the lagged dependent variable. Year-specific dummy variables control for effects, which affect all resource extracting countries equally, such as temporary changes in world demand for specific resources.

The estimation results fail to confirm the debt-resource-hypothesis for all resources and all indicators of indebtedness. The results are robust to a whole battery of changes in model specification and estimation technique. This suggests that the results are not sensitive to the particular research design chosen. There is no systematic empirical evidence that highly indebted developing countries exploit more their subsoil fossil fuel and mineral resources or produce more cash crops for exports than other countries. This puts the validity of the debt-resource-hypothesis into great doubt. It does not prove the hypothesis wrong, however. In particular,

because of lack of data we cannot directly test whether highly indebted countries switch to more unsustainable patterns of resource harvesting unless this is accompanied by higher resource extraction. Also, we do our best to mitigate potential omitted variable bias, but cannot exclude the possibility that some bias remains. These qualifications notwithstanding, our results clearly warn against accepting the validity of the debt-resource-hypothesis too readily.

Reassessing the interaction between investment and tenure uncertainty

ELIZABETH J.Z. ROBINSON

This paper revisits an old question, but within a new context: whether uncertainty over land tenure should be expected to result in less or more investment than would occur with secure property rights. Whereas much of the traditional literature on tenure uncertainty concludes that uncertainty leads to less than the efficient level of investment, the separate literature on squatting suggests that the opposite may be true, that is, that individuals strategically 'over-invest' to increase their chances of not being evicted. This paper demonstrates that a single model can accommodate each of the different investment strategies, using, as an example, the specific problem of common land encroachment and the subsequent conversion of this land for private cultivation. That is, the distinct literatures concerning investment and uncertainty that have been developed independently can in fact be considered special cases of a more general model, and so the various strands of the existing literatures are shown to fall within a single framework.

Farmers with insecure rights to land exhibit many different types of investment behaviour. Some farmers avoid investing, fearing that they might be evicted in the future. Rather than prepare the land properly, removing stones and levelling, they simply scatter seeds and harvest whatever grows. Yet other farmers make significant sunk-cost investments, such as clearing trees, planting perennial crops, sinking wells, or even building a dwelling, believing that the government is unlikely to evict them, since it would be wasteful of resources. Hence, farmers exhibit both under-investment and over-investment relative to the types of investment that would be expected on land to which farmers have secure tenure.

Governments that own the land choose in turn whether to do nothing and permit encroachment to occur unchecked, to allocate funds towards

detecting encroachment and attempting to evict the encroaching farmers, or to regularize the encroachment, thereby giving permanent and transferable rights to the encroacher.

A common feature of farmers' investments on encroached land is that they improve the private income of the individual farmer, but benefits to society are lost. The worst outcome for the government is if the land is encroached, but not formally regularized, in which case the common land and all its benefits are lost and the government receives no income from the land in the form of taxes. Further, the government knows that farmers who are not evicted, and also society, would be better off if these farmers made privately efficient investments. The best outcome from a social welfare perspective is if the land is not encroached in the first place, since much of the common land provides additional benefits to the community such as groundwater recharge in addition to considerable benefits to the poor such as access to fuelwood and grazing land for cattle. Hence the government often faces a dilemma. It would prefer the conversion of the land not to occur, but would also prefer farmers to invest efficiently if the encroachment cannot be prevented.

The game-theoretic model developed in this paper recognises explicitly that whereas any investment made by an encroaching farmer is sunk and hence credible, the policy choice made by the government over how much to spend on eviction may not be credible if it is announced before, but enacted after, the encroaching farmers have made their investments. Hence, the model accommodates the possibility that the government updates its choice of enforcement effort after any investments by the encroachers have been made.

Two strategies are shown to be available to a farmer to avoid the downside risk of investing when she does not have secure tenure over the land. She can postpone investment, thereby taking advantage of the option value of waiting to invest until the government has made its eviction decisions. Or she can invest to the point at which it is not worthwhile for the government to evict her. The optimal strategy for the farmer is highly sensitive to the particular costs and benefits from encroaching and enforcement and so cannot be predicted without calibration of the model.

Several extensions to the model would make the paper more relevant to a less-developed country context where credit constraints, risk aversion, and exogenous shocks are facts of life for many rural squatters and tenants. If each of these three factors is taken into account, the specification of the model presented in this paper will change and different equilibrium behaviour will be predicted. Farmers who are credit constrained might not be able to make the significant investments necessary to prevent eviction, while richer individuals could. A strategy in which those who are unable to invest in the land are more likely to be evicted might be more efficient, both in terms of enforcement costs and in terms of the land use from a social perspective. However, such a strategy would raise equity issues and over the long-term could encourage the destruction of areas of common land by richer villagers.

Biodiversity and nature-based tourism at forest reserves in Uganda

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Integrated conservation and development projects (ICDP) combine profitability of local environmentally based industries with the maintenance of biodiversity as dual goals, and have become a standard approach to sustainable development in many tropical countries. Nature-based tourism is often a key component of ICDPs in developing countries. Because nature-based tourism is a non-consumptive activity that should rely on intact natural resources to generate revenue, it is regularly viewed as a "win–win" situation for conservation and sustainable development.

Assumptions regarding nature-based tourism, the conservation of biodiversity, and community welfare are not supported by empirical research, however. There is little evidence to suggest that tourists are interested in biodiversity *per se*, rather than spectacular landscapes, attractive lodging facilities, or a few charismatic species, when visiting a protected area. Relying on nature-based tourism to conserve biodiversity may therefore be a risky venture if tourists are not particularly concerned about biodiversity. To predict whether nature-based tourism can lead to protection of biodiversity and increased welfare of local residents through ICDPs, we must investigate the relative preferences of tourists in the context of protected area visitation. If nature-based tourism is to be an effective means of conserving biodiversity, tourists' behaviour must lead to elevated revenues for areas rich in biodiversity. This would then provide an incentive to maintain protected natural ecosystems that contain high levels of biodiversity.

We addressed these issues in Uganda, an east African country high in biodiversity with a small but growing nature-based tourism industry. We focussed on Mabira Forest Reserve, a forest reserve in the south of the country, and two other comparable forest reserves. All three protected areas are mostly tropical lowland forest, and are well-known for their diversity of forest birds. Birds are an appropriate taxonomic group to use in the context of tourist preferences for biodiversity, because they are conspicuous, easily identifiable, and international birdwatching tours are increasing in popularity. In addition, birds are a good surrogate for overall biodiversity levels in Ugandan forests, hence high levels of avian biodiversity are indicative of biodiversity-rich areas across many taxonomic groups.

We presented travellers at the international airport with a choice experiment designed to elucidate their preferences for biodiversity relative to other protected area attributes that may be important to them. Respondents

were asked to choose from the three protected forests mentioned above, assuming a trip originating in the country's capital, Kampala. Attributes defining each destination were entrance fee, travel time, lodging facilities, tour packages, landscape features, and number of bird species likely to be seen. We quantified preferences for all of these attributes by means of statistical models derived from the choice experiment data. We assessed the hypothesis that individual respondents may have different underlying preferences for attributes such as number of bird species seen using random parameters logit (RPL) models. We calibrated these statistical models to actual tourist data at the three forest reserves, and used this model to simulate scenarios with varying levels of entrance fee and number of bird species seen at Mabira Forest. From this, we estimated the maximum amount of revenue that could be generated from tourist visitation at this site.

We found that RPL models fit the data much better than conventional multinomial logit models. This emphasizes the underlying preference heterogeneity that tourists have for certain attributes of protected forests. Most of the attributes included in the choice experiment were significant contributors to respondents' utilities from visiting a site. Entrance fees, packaged tours, and the presence of secondary forest had negative effects on a tourist's utility. Cabins, luxury lodges, the presence of both primary and secondary forest, and the chance of seeing large wildlife were viewed as positive factors associated with visiting a protected area. Most importantly, the number of bird species likely to be seen was a strong positive explanator of where a tourist chose to visit, even after controlling for these other factors.

Revenue to Mabira Forest was maximized at an average entrance fee of $47.53 (2001 US dollars); a fee of this size resulted in average revenue flows of $29,919. The number of bird species seen was a strong determinant of revenue flows. When tourists expected to see 20 bird species, revenue flows at the maximum entrance fee were $18,032. When the number of bird species likely to be seen was 80, maximum revenue flows were $40,423, for an average difference of $22,391, or 7.4 cents per bird species per tourist. Regardless of entrance fee levels, increased amounts of revenue can be generated by allowing tourists the possibility of seeing greater numbers of bird species at Mabira Forest. However, at a current entrance fee of $3, we estimate that nature-based tourism in Mabira Forest Reserve generates only approximately $7,000 in revenue per year. Entrance fees at Mabira Forest are therefore severely underpriced, compared with what tourists appear willing to pay.

These results provide direct evidence that biodiversity *per se*, i.e. the number of different species in a given situation, contributes to nature-based tourism by enhancing the attractiveness of a protected area to tourists. This study therefore upholds one of the most-cited yet poorly quantified benefits of ecotourism, i.e. that biodiversity is a main reason why tourists visit protected areas, and hence the maintenance of critical biodiversity habitat can provide economic returns. At least for forested parks in Uganda, the positive relationship between probability of visitation and bird biodiversity

is a compelling reason for management scenarios that maintain or enhance the possibility of large numbers of bird species being seen during a tourist's visit.

Assuming appropriate revenue-sharing mechanisms can be developed, the analyses presented here show that biodiversity conservation does have the potential to contribute economically to sustainable development by providing incentives to maintain natural ecosystems. However, the magnitude of these benefits relative to the local farmer's opportunity costs and the reliability of the revenue distribution system must be considered as part of the full evaluation of such a scheme.

Bt cotton and pesticide use in Argentina: economic and environmental effects

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The broader impacts of genetically modified (GM) crops are still a matter of controversy, especially with respect to social ramifications and environmental sustainability. In this article, we empirically analyze the effects of insect-resistant *Bacillus thuringiensis* (Bt) cotton on pesticide use and agricultural productivity in Argentina. Based on farm survey data from two growing seasons (1999/2000 and 2000/2001), we show that the technology leads to a considerable decline in pesticide application rates. On average, adopting farmers use 50 per cent less insecticides on their Bt plots than they use on plots grown with conventional cotton. Almost all of these reductions occur in highly toxic chemicals, with concomitant positive effects for the environment. Moreover, Bt adopters benefit from significantly higher yields. This is due to insufficient pest control in conventional cotton. In an international comparison, Argentine farmers use relatively small amounts of pesticides, so the yield gains of Bt cotton are higher than in many other countries.

So far, only a small number of large-scale farmers have adopted Bt cotton in Argentina due to a substantial technology fee charged for GM seeds. To obtain a broader picture of potential technological effects, we predict the impacts of Bt on different types of current non-adopters. As pesticide use is positively correlated with farm size, potential savings are bigger for large than for small farms. For cotton output, however, the opposite is true. Many smallholders do not use insecticides at all, so they suffer significant pest-related yield losses. Potential yield effects of Bt are higher for this group of farmers. While the net yield gain is predicted at 17 per cent for average large-scale growers, for small producers the gain could be around

42 per cent. Also, total gross benefit per hectare of Bt cotton is predicted to be higher for smaller than for larger farms. Therefore, promoting wider technological diffusion at reasonable prices would not only extend the aggregate economic and environmental advantages, but could also entail desirable social effects. These findings should also be of interest to other developing countries, which are considering the commercial approval of pest-resistant GM crops.

The durability of benefits is analyzed by simulating the development of Bt resistance in different pest populations. For this purpose, biological models have been calibrated with agroecological and entomological data from Argentina. Scenario results demonstrate that rapid resistance buildup and associated pest outbreaks are unlikely if minimum non-Bt refuge areas are preserved. Apart from conventional cotton, other host plants of Bt target pests are commonly grown in the local setting and might contribute to the dilution of resistance. These results suggest that the economic and ecological advantages of Bt technology in Argentina could be maintained also in the medium to long run. Nonetheless, some caution is warranted with respect to far-reaching generalizations. More research is needed into the complex interactions with environmental systems and farmers' longer-term behavior in preserving refuges, before conclusive statements about the technology's sustainability can be made.

The impact of sea level rise on Singapore

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It is believed that global climate change will cause the sea level to rise in the future. Sea level rise will potentially inundate coastal lands causing substantial economic losses. This paper estimates the economic impact of sea level rise on market land in Singapore. We examine whether it is less expensive to inundate or protect threatened land by building sea walls high enough to keep back the sea each decade.

Singapore has exceptionally valuable land because it is heavily industrialized with a large population in a relatively small island state. Given these high land values, the cost of protection is significantly lower than the cost of inundation. The lowest cost strategy for Singapore is to protect its entire coastline against sea level rise. The annual protection cost of the coastline depends upon the sea level scenario. Protection costs increase substantially as the sea level rises. The annual protection cost for the entire country for a 0.2 m rise scenario is 0.3 million US$ in 2050 and 0.9 million US$ in 2100. For a 0.86 m rise scenario, the annual cost by 2050 is about US$ 6 million, and by 2100 it is US$ 17 million. The present values of the costs

for these two scenarios over the next century are 0.2 and 3.1 million US$ respectively.

A game model of people's participation in forest management in Northern India

WIETZE LISE

The role of people in forest management in India has been low. This paper argues that such a marginal role is not justified, given the potential of people to participate voluntarily. A higher level of people's participation may well result in a better quality of the forest, which is both beneficial for people living nearby and the State.

A situation is studied where villagers can participate voluntarily in village organization for managing an adjacent forest. Villagers derive benefits in the form of access rights to forest resources in return for their participation. This paper tries to quantify the likelihood of villagers to keep on participating. This is verified for three organizations which are located in three Indian States. It turns out that each organization provides incentives for villagers to keep on participating voluntarily. This is also the case in 23 of the 32 studied villages.