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Summaries

Valuation of biodiversity within a north–south trade model

FRANCISCO CABO

We first establish a model of international trade in which two regions, industrialized and developing countries, compete in classical markets. They produce and consume two different goods and use two inputs: capital and natural resources. The former is defined as an aggregation of both physical and human capital. The North exports a capital intensive good and the South exports goods intensive in natural resources. In equilibrium, it is easy to calculate the relative price between both goods and, consequently, all quantities and prices in the model.

Within this model we insert a new variable which represents biodiversity. We refer to it as the number of species whose conservation is not endangered by the current productive process. The production of the capital intensive good conserves more biodiversity than the resource intensive one. We assume that there exists a value of diversity function such that all species are ordered. Use and non-use value are considered. Taking this order into account, biodiversity enters into the utility function as a weighted sum of the value of all species. The weights are determined by an exponential distribution function. All species are considered, regardless of whether they are known or not. Putting the emphasis on non-use as opposed to use value, leads us to assume that a change in preferences to a more homogeneous distribution of weights among species is likely. Nevertheless, the lump sum of weights remains constant and thus, the global utility of an ecosystem. However, more species are needed to obtain the same utility. However, biodiversity conservation implies additional costs and hence a reduction in the supply of goods.

The main concern in this paper is to study the effect of biodiversity on the relative price, or terms of trade, which governs the North–South trade. Two questions arise: How is this price affected if both regions conserve more species? and: How would a change in preferences to a more homogeneous valuation of species modify the South's terms of trade.

Any region's terms of trade increases when it decides to produce in a way that conserves more species. Nevertheless, the rise in the South is stronger than in the North. Therefore, the South has a comparative advan-

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tage in conserving additional species. This intuition is straightforward; the South exports a resource intensive good which conserves less species than the North's. The marginal utility of species conservation is, then, greater in the South. A complete proof is given when solely the demand side is taken into account, and, simulation is needed when the supply side is also considered. At the same time, a change to a more homogeneous distribution of weights would lead to a lower terms of trade for the South. Since this shift is likely, the South is currently facing risk. The South will be better off conserving more biodiversity for two reasons: a higher rise in its terms of trade and a reduction in the risk associated with a more homogeneous valuation of species in the future.

Trade-offs on competing uses of a Malaysian forested catchment

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In this project, an attempt is made to estimate the costs and benefits of managing forested catchments in Malaysia. Three land use options are simulated for four selected catchments in the Hulu Langat Forest Reserves (HLFR), Selangor, Malaysia. These options are no logging or catchment protection (CP), reduced impact logging (RIL) and conventional logging (CL). The potential sedimentation impacts of each option on the dam and water intake ponds in the catchments are calculated. The benefits derived from logging, hydro-electric power (HEP) generation and the water regulatory dam for water treatment and the external costs emanating from the sedimentation under the three options are estimated. The computations were based on data collected from previous studies conducted in adjacent areas with similar hydrological parameters, secondary data from published reports by various departmental agencies and from on-site personnel surveys. Analysis at the compartment level suggests that the central issue of joint production in forested catchments is not the selection of which logging methods to adopt. Rather the point is which water use can be combined with timber production that can generate greater NPV than the status quo CP option. Under both logging methods, the returns from timber cannot meet that from the status quo production of treated water. Complementing water uses with logging in forested catchments is efficient in HEP catchments. The efficient choice among the two logging methods is the RIL option because of its higher returns and the lower

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externality imposed upon the status quo water user. However, despite the imposition of conservational measures, the RIL option still generates sediment load that imposes substantial external costs on the downstream water users. This analysis does not incorporate the effects of the alternative logging options on the other attributes of natural forests such as recreation, bio-diversity values and non-timber forest products (NTFP).

Why do farmers expand their land into forests? Theories and evidence from Tanzania

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The paper examines the causes of agricultural land expansion and deforestation in Tanzania. Tropical deforestation has become an issue of global concern, in particular because of the value of tropical forests in biodiversity conservation and of limiting the greenhouse effect. Reduction in forest cover may also have local effects such as accelerated soil erosion, decreased rainfall infiltration and other harmful influences that may contribute to a decline in soil fertility and crop yields.

The paper has two main objectives. The first one is to present two different approaches in explaining deforestation due to agricultural expansion: the *subsistence* and the *market approaches*. The subsistence approach assumes that peoples' objective is to satisfy their subsistence requirements, mainly from agricultural production. The economic problem is to minimize labour effort to satisfy this requirement. Whereas the subsistence approach focuses exclusively on the agricultural sector and population growth, the market approach draws attention to the rest of the economy. The spatial expansion of agriculture is determined by what farmers can earn from clearing forest compared to other income sources. The market approach points to the possible counter-productive effect on deforestation of agricultural intensification programmes that increase the productivity and profitability of agriculture.

In the light of these theoretical approaches, the second objective is to examine statistically possible factors encouraging deforestation and establish which of the approaches is more fruitful in explaining actual deforestation due to agricultural expansion. For this purpose we use a data set from the 19 regions of Tanzania for the years 1981 to 1991. The explanatory variables are: producer price indices of different agricultural crops, fertiliser prices, regional population, regional income per capita, and

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regional fertiliser use. As is often the case in this type of analysis, a general warning about data quality is in order, and the results should be interpreted with great caution.

With this reservation in mind, the major result of the statistical analysis is that producer prices, in particular of annual crops, are important factors behind agricultural land expansion. The economic behaviour of smallholders in Tanzania seems not to be as disengaged from the market as the subsistence approach may suggest. Instead farmers behave more in line with the market approach. Policy recommendations depend critically on the approach chosen. The subsistence approach seems to dominate the thinking on the causes and remedies of deforestation within the development aid community. A main policy recommendation according to this approach is agricultural intensification: increased productivity will reduce the deforestation pressure. The major conclusion from this study, however, is that increases in productivity and/or output prices in Tanzanian agriculture would most probably result in more forested areas being converted to agricultural land.

Recent economic liberalization has increased agricultural output prices, and the farmers' response has been to increase agricultural area and production. Thus there may be a conflict between forest conservation and increasing agricultural production and income. How to handle this apparent trade-off remains a challenge both for researchers and policy makers. Some general conclusions have emerged in the literature, for example, labour intensive technological progress in agriculture and technologies suitable mainly for land already under cultivation offer win–win opportunities.

Tanzania's soil wealth

KJELL ARNE BREKKE, VEGARD IVERSEN, and JENS AUNE

Many African countries are richly endowed with land, but the productive potential of the land base has been underutilised in farming systems with low intensity of external inputs and high intensity of labour. At the same time, mining and erosion of soils have been common features of rural Africa in the 1990s. National income, possibly of considerable size, has been foregone in countries with pervasive poverty. This paper studies the income and wealth from the agricultural sector in Tanzania, using a dynamic model.

We analyze the national soil wealth using two versions of the model. In the first version, only the nutrient content of the soil is used to describe soil

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quality. With this specification, we compute the wealth for the total agricultural sector. As nutrients can be replaced, this degradation is not irreversible, and the optimal policy is not dependent on initial conditions. The soil wealth estimates obtained using the soil-mining model suggest that the gains from better utilisation of Tanzania's land resources may be considerable. The magnitude of these findings are sensitive to assumptions about production functions and to the data we have used. The figures should thus be interpreted with caution.

In the second part of the paper, we introduce a two-dimensional description of soil quality which includes root depth in addition to content of nutrients in the soil. This version of the model is adopted and applied to study maize production in the Southern Highlands of Tanzania. We estimate soil wealth and shadow prices for soil under different assumptions about labour and output demands. The shadow price for root depth and hence the returns to land conservation investments are found to be highly sensitive to our labour market assumptions. We also find that the annual value of eroded soil amounts to 12–17 per cent of the income under different assumptions. In addition, as revenues will decline over time as the soil becomes increasingly eroded, the current cash flow exceeds income. To be able to sustain consumption, it is necessary to save 13–29 per cent of the contribution to GDP from maize production in the Southern Highlands.

Trade liberalization and the environment in Costa Rica

DAVID G. ABLER, ADRIAN G. RODRIGUEZ, and JAMES S. SHORTLE

There has been much interest in recent years in the environmental impacts of trade policy reforms in developing countries. In large part, this is because many developing countries have undertaken trade liberalization and major structural adjustment programs in recent years. These programs have had significant impacts in many cases on natural resource intensive sectors such as agriculture, forestry, fishing, and mining, which when taken together are usually a large part of the economies of developing countries.

The objective of this study is to examine the environmental impacts of trade liberalization in Costa Rica. To do this we construct a computable general equilibrium (CGE) model of the Costa Rican economy. A CGE

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model can be thought of as a system of mathematical equations that describe all economic activity in an economy by firms, households, and the government. As part of our CGE model, we include eight environmental indicators. The indicators cover deforestation, pesticide usage, overfishing, hazardous wastes, non-hazardous inorganic wastes, non-hazardous organic wastes, greenhouse gases, and urban air pollution.

This study is relatively unique in two respects. First, it explicitly recognizes and models uncertainty regarding the values of the economic parameters in the CGE model. Rather than picking one or a small number of sets of 'reasonable' parameter values, this study treats the economic parameters of the model as random variables drawn from prespecified distributions. Evaluation of each policy option takes the form of a Monte Carlo experiment in which a large number of random samples of the parameters are drawn, thereby generating an entire distribution of results rather than a single set of estimates.

Second, unlike most other studies of trade policy of other economic policies in developing countries, this study permits technology to change in response to trade liberalization. These changes in technology, in turn, lead to changes in economic activity and the environmental indicators. For developing countries, the principal effects of trade liberalization on technology are likely to arise through imports of machinery and equipment embodying new technologies.

Four major conclusions emerge from our results. First, the directions of environmental impacts of the trade liberalization scenarios considered here are generally negative – most of the environmental indicators worsen. Second, even though the directions of impacts are generally negative, the magnitudes of impacts tend to be small relative to the base-period values of the environmental indicators, in the sense that most indicators change by less than 5 per cent. We take this to mean that the economic benefits of trade liberalization should not be sacrificed for the sake of protecting the environment. Third, the positive environmental impacts of the trade policy changes considered here are also generally modest, in the sense that indicators which improve all do so by less than 10 per cent. This means that free trade cannot be counted on in and of itself to significantly reduce environmental problems. Fourth, the results for the case where technology is constant do not change substantially when technology is allowed to vary in response to trade liberalization. Nevertheless, the results differ in some cases, which suggests that it is important to model the response of technical change to trade.

Dealing with air pollution in Latin America: the case of Quito, Ecuador

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Located in a high Andean valley with frequent temperature inversions, Ecuador's capital city suffers from severe air pollution, emitted by manufacturing plants as well as by a rapidly expanding motor vehicle fleet. Existing data allow only for cursory estimation of a few of the costs incurred because of poor air quality. Elevated levels of total suspended particulates (TSP) results in at least $25,000,000 in morbidity costs and $1,500,000 in premature mortality costs each year. Annual spending on the treatment of children who have been exposed to unhealthy amounts of airborne lead exceeds $2,500,000.

During the 1990s, several initiatives to improve air quality have been pursued. Manufacturers' responses to voluntary technology transfer initiatives have been positive, mainly because production technology put in place when energy and water were artificially cheap has been rendered unprofitable by recent subsidy reductions.

More ambitious is a four-year-old program to cut emissions from diesel-fueled buses and trucks. Any vehicle violating exhaust norms, as indicated by an opacity meter reading, is fined and detained until a bond has been posted. The bond is returned only after engine repairs needed to bring the vehicle into compliance have been made. Furthermore, approximately 1,000 buses that had been operating for twenty or more years have been removed from the streets.

The cumulative cost of the bus and truck program, including engine repair expenses, payments to the owners of confiscated vehicles, and expenditures on air quality monitoring, is approaching $7,000,000. This amount is probably less than the resulting public health benefits since, in a high-altitude city like Quito, diesel-fueled vehicles are the source of a large portion of the finest, and therefore the most respirable and damaging, suspended particulates.

Bus and truck owners complain, with justification, that action on their part is not enough to bring their vehicles into compliance with environmental laws. Fuel quality has to be improved and mechanics need to be trained. Also required is the development of diesel engines that function powerfully with minimal pollution at high altitudes. Quito's municipal authorities are involved in international efforts that address this concern.

The bus and truck program has been effective, notwithstanding opposition from vehicle owners and operators and a lack of cooperation from the national police; atmospheric concentrations of fine particulates are no longer increasing and the percentage of buses and trucks in compliance

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with exhaust norms has risen dramatically. Complementary air quality initiatives in the Ecuadorian capital focus on industrial sources and gasoline-fueled automobiles. For practically the first time in Latin America, economic instruments are being employed to encourage manufacturers to reduce emissions. In addition, a program to reduce lead emissions from cars is being introduced.

As the scope of Quito's pollution control initiatives expands, the city's commitment to improved environmental quality will be put to the test.