

Summaries

Maximin: a direct approach to sustainability

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We revisit the problem of the weak sustainment of an economy, or the problem of intergenerational equity, in the original tradition of Robert Solow and John Hartwick. The objective is the *maximin* objective, to maximize the utility of the poorest generation.

Typically, the objective in optimal-control problems is to maximize the integral of discounted future utility using a given set of discount factors. Attempting to sustain an economy, however, is philosophically inconsistent with discounting the utility of future generations by any set of discount factors, be they exponential, hyperbolic, or more general. We devise a direct, general, optimal-control approach to the maximin problem. A generalization of Solow's model is presented as an example.

Not allowing discounting is not tantamount to having a discount rate of zero in a growth model involving an infinite utility integral. Rather, there is a unique correspondence between the maximin problem and a very special form of the problem of maximizing an infinite integral of discounted utility. The discount factors in this special form are equal to the shadow values of the maximin constraint in all time periods. The result provides insight into the meaning and limitations of solutions using discounted utility proposed by others.

Hartwick's rule, that the algebraic sum of net investments is zero when evaluated at the shadow prices of the maximin solution, is a necessary condition of our solution. If the economy is off the maximin path, the shadow prices have no meaning, and Hartwick's rule does not apply as a criterion of sustainment in any generation. This result calls into question the validity of using Hartwick's rule in conjunction with national-accounts statistics to evaluate whether a real economy is being sustained. If, as in a commonly used modification of Hartwick's rule, the value of net investments is positive, the economy is surely off the maximin path and, mathematically, the rule has no meaning for sustaining the economy.

A recasting of the maximin criterion is required for an uncertain world. The economic planner must recalculate the *expected* level of sustainable utility as stochastic events are realized. As generations pass, the actual level of utility provided may rise or fall. A stochastic generalization of Hartwick's rule can be interpreted as a type of precautionary principle.

Negatively correlated local and global stock externalities: tax or subsidy?

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Fossil fuel combustion generates both CO₂ and SO₂. CO₂ is the most important greenhouse gas; SO₂ can cause serious local pollution. SO₂ can alleviate the potential global warming because of negative radiative forcing. The relationship between CO₂ and SO₂ can be characterized as negatively correlated local and global stock externalities. In this paper, negatively correlated local and global stock externality provision is set up as an optimal control problem. The efficiency conditions for this problem are derived and discussed in the paper. In addition, several policy-related scenarios of negatively correlated local and global stock externality provisions are examined. Finally, possible applications of the theoretical results derived in this paper on economic analysis of multiple-gas issues in climate change are indicated.

A multi-period analysis of a carbon tax including local health feedback: an application to Thailand

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Using a multi-period cost/benefit framework for the case of Thailand, this paper assesses whether by capturing the local health effects of reduced conventional pollutants as an ancillary effect of greenhouse gas (GHG) mitigation and by allowing this benefit to feed back into the economy, the desirability of policies aimed at GHG mitigation changes from the standpoint of macroeconomic and welfare indicators. The paper finds that, by incorporating the local health effects of reduced conventional pollutants, the desirability of policies aimed at GHG mitigation does indeed change. Specific findings include: (1) average GDP growth with a carbon tax relative to the no-policy scenario turns positive when the health feedback is included, and (2) the negative welfare impact for households is reduced by a factor of two when a carbon tax scenario incorporates health feedback. The robustness of these main findings is confirmed after an extensive sensitivity analysis over 11 key parameters, with three parameters identified as the

most influential. The paper concludes that middle-income countries like Thailand are in a unique position to obtain large ancillary health gains from reduced local conventional pollutants when GHG is mitigated by curbing fossil fuel consumption.

Impacts of soil quality differences on deforestation, use of cleared land, and farm income

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In the Amazon Basin, forests continue to fall and agriculture to move in to a region with patchy (in terms of agronomic potential) yet broadly nutrient-poor soils. Regional planners continue to base policy action on perceived soil quality, despite the lack of soil maps with sufficient resolution to inform agricultural activities, and amid little evidence about how land use or farm household welfare varies by soil quality in a frontier setting. This paper uses a farm-level bioeconomic model to assess the impacts of soil quality differences on deforestation, use of cleared land, and smallholder income in the western Brazilian Amazon. Focusing on an archetypical area farm with reasonable market access but limited access to labor and credit, simulations show soil quality mattering more for income than for deforestation or land use, but with extremely cash-strapped farmers on poor-quality soils facing possible displacement. Once successfully established, farms on all soil types saw pasture dominating farm land use as farm forest disappeared within a generation. Good- and viable poor-quality soil farms had slightly slower deforestation rates than their medium-quality soil counterparts. On farms with richer soils, the slowdown in deforestation stemmed from small amounts of additional area shifted into annual crops rather than pasture, taking advantage of the extra soil nutrients. Annual cropping also uses more labor per hectare than pasture. With limited labor available, households that switch toward annuals also deforest slightly less than their medium-quality soil counterparts. On farms with poor-quality soils, even when farmers were well-off enough to start growing a herd and expanding pasture, lack of sufficient resources to clear and farm additional land meant less deforestation than in the medium-quality soil case. Farms with good soils could generate about 44 per cent more income than their viable poor-soil counterparts, but the lower income level still surpassed thresholds for meeting food security and other needs. At no combination of income level and soil quality explored did the (simulated) farmer find it worthwhile to purchase and apply chemical fertilizer; nutrients came

instead from secondary forest fallow, whose area rose or fell in step with annual cropping area. The implications of these results for land-use zoning, forest conservation, poverty alleviation, and other policies are discussed.

Surviving from garbage: the role of informal waste-pickers in a dynamic model of solid-waste management in developing countries

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In both developed and developing countries, population growth, as well as production and consumption patterns, has increased rates of solid waste production, creating serious constraints to improvement of human environmental and health conditions. These constraints are aggravated in the developing world where lack of resources impedes the provision of the necessary facilities for adequate waste management and treatment. It translates into insufficient collection of the waste generated, as well as its improper disposal on the streets, vacant lots, and, at best, in municipal open lots.

In several developing countries, a non-negligible proportion of the urban poor are involved in waste collection and recycling as a source of income; they are known as scavengers or waste-pickers. Scavenging provides various social, economic, and environmental benefits: it reduces air and water pollution, saves energy, reduces waste from industrial processes, reduces production costs and use of virgin materials, and lengthens landfills' lifetime. It also reduces the cost of municipalities' solid waste management systems, and, in addition, represents an income-generating activity for the poorest in the developing world. Despite the significant contribution to waste recovery and recycling, the role of scavengers in solid waste management is still not properly acknowledged.

The purpose of this paper is to show that scavengers in developing countries generate a positive externality to society (lengthening of empty landfill space and natural resources availability) and, therefore, their activity should be encouraged through economic incentives in order to compensate the benefits generated and also to increase the amount of solid waste recovery up to optimal levels.

The role of waste-pickers is incorporated in an integrated dynamic model of production, consumption, disposal and recycling of waste. First, the model is used in the maximization of a social welfare function, which depends on consumption and an environmental quality index, the latter accounting for the effect of changes in the stock of empty landfill space

and natural resources used in the production of commodities. From this approach, the socially optimal levels of consumption, production, and recovery are defined. Second, the model is used to show how consumers, producers, and scavengers make decisions when they face actual competitive market prices. The two sets of outcomes are compared in order to detect for market failures and to identify the economic instruments needed to reach efficiency in this economy.

The results of this paper show that efficiency in this economy requires the implementation of a set of policies working simultaneously, rather than a single policy: a consumption tax per unit of recyclable good consumed and discarded, a subsidy to scavengers per unit of material recovered and saved from being disposed in the landfill, and a tax on firms extracting virgin resources instead of using recyclable inputs. It is shown that a policy aimed at recognizing the activity of waste-pickers in developing countries should be part of the necessary set of instruments required for efficiency. Some insights about implementation of these policies are discussed.

Specific functional forms are used to perform numerical simulation of the model and illustrate the impact of the policy instruments on the key variables.

Public intervention in a 'take-it-or-leave-it' transaction situation under varying interests of the intervening body

MARGRETHE AANESEN

There are economic arguments for subsidizing the implementation of environmental projects. One of these is that such projects in most cases have effects for people beyond those involved in their implementation, and these effects are normally not taken into consideration by the negotiators. Other arguments are market power for the seller, which will increase the price of the project, and private information to the buyer, which implies a probability for the project not to be implemented though it is profitable. On the other hand, there are also political arguments for implementing environmental projects. Examples are to promote national industrial interests, environmental concern, or to gain popularity with 'green' groups in order to remain in power by pretending to have environmental concerns. The presence of political interests implies that both the supplier of the project and the government will act strategically when deciding upon the optimal project size (i.e. abatement level) and its price, and the optimal subsidy.

We assume that the government has both industrial and environmental (green) interests. Then the optimal subsidy to offer increases with the

abatement level, as long as the seller has high costs or the buyer has a low valuation of a given project, whereas it decreases with the abatement level when the seller has low costs and/or the buyer has a high valuation of the project. On the one hand, such a subsidization scheme is favourable as it offers the highest subsidies when the probability of trade is at the lowest. On the other hand, it 'rewards' the inefficient suppliers and the low-valuation buyers, and thus provides 'wrong' incentives, in that the seller knows that the higher the costs it has the more subsidies will be offered to a given project. The abatement level is higher the higher the environmental interests of the government, but is independent of the industrial interests.