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Summaries

Quasi-option value and hard uncertainty

MARCELLO BASILI

The environmental literature regarding intertemporal decision-making problems under irreversibility has drawn a clear distinction between the option value, which depends on risk aversion, and the so-called 'quasi-option value', which is independent of risk attitude and depends on prospects of learning. Both these notions of option value refer to rational behavior under risk. In fact, it is usually assumed that the described environmental states of the world exhaust the state space and individual beliefs are always represented by a unique, fully reliable, additive probability distribution. Environmental economics should be able to deal with both events that are very uncertain and information about the relative likelihood of evens that is imprecise, such as either the effect of fire on the Yanomani ecosystem, which has destroyed the primary rainforest in the Apiau region of Romania state (Brazil), or the consequence of the Sea Empress oil tanker disaster in South Wales. On the basis of some recent developments in decision theory, which stress the distinction between soft uncertainty (or Knightian risk) and hard uncertainty (or Knightian uncertainty), the paper examines the case in which the space of future environmental states of the world is misspecified. As a result the case of a decision-maker who has ambiguous beliefs and faces hard uncertainty is dealt with. The paper introduces the notion of intertemporal *h*-option value in order to extend the notion of quasi-option value, defined by Arrow and Fisher and Henry, to hard uncertainty. In this paper it is proved that in a decision-making model under hard uncertainty and irreversibility, the intertemporal *h*-option value always exists and it is non-negative. The intertemporal *h*-option value is the gain from being able to learn about future benefits that would be precluded by irreversible actions and represents a further correction factor that has to be introduced into the evaluation of feasible actions. When a decision-maker is to evaluate an investment opportunity or a development project, she/he had better consider the intertemporal *h*-option value, that is the uncertainty premium for preservation, to correct the total economic value or the net present value.

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How to substitute in order to sustain: knowledge driven growth under environmental restrictions

LUCAS BRETSCHGER

In a theoretical framework, this paper presents different substitution mechanisms which determine the conditions for long-term sustainable development. Using a one-sector approach and multi-sector endogenous growth models the accumulation and the substitution of man-made inputs for natural resources are analysed. It is shown that the one-sector approach, which has been used in many earlier contributions, can be misleading to study sustainability. This type of analysis neglects the fact that capital is an output of specific sectors in the economy. One-sector models are neither suited to express the fact than an economy adjusts not only in terms of the factor mix in production, but also in terms of the sector mix. Different sectors of an economy use the inputs with different intensities, so that a change in relative input prices has an impact on relative sector size. To deal with these issues appropriately, the substitution process leading to sustainable growth is studied in dynamic models with three sectors. Specifically, two different versions of an endogenous growth model with expanding goods varieties are presented to study substitution extensively.

In model *C*, the basic growth mechanism is a continuous expansion of varieties in the sector of so-called high-tech consumer goods. The second sector, which is research and development (R&D), provides the know-how for new varieties in the first sector. In the third sector, traditional goods are produced under constant returns to scale. Due to positive spillovers from research to knowledge capital, the growth rate of the economy is constant in the steady state. Primary inputs are labour and natural resources. In this set-up, the growth effects of changing input quantities hinge on the cost changes in the dynamic sector, which is R&D. It turns out that a decrease in the supply of the natural input harms the development of individual welfare, provided that the elasticities of substitution between labour and the natural input are larger than unity in both sectors of consumer goods. If elasticities are smaller, sustainable development is very likely. In model *K*, a second form of varieties is introduced. Here, varieties are capital components that are assembled to an aggregate capital input, which is called high-tech capital. Accordingly, the basic growth mechanism is a continuous expansion of varieties in the sector of high-tech capital goods. In this model, the growth effects of changing input quantities hinge on cost and demand effects in the R&D-sector. It is shown that in model *K*, a decrease in the supply of the natural input unambiguously increases the steady-state rate of growth, irrespective of the elasticity of substitution between primary inputs.

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In general, it emerges from both model versions that a decrease in the supply of the natural input has a major impact on welfare by changing an economy's sectoral structure. The prediction of a successful substitution of knowledge for natural resources, i.e., sustainable development, appears to be realistic, provided that the sectoral adjustment costs in the economy are not too high. This result contrasts with the one-sector approach, which predicts a non-sustainable development for similar parameter values.

The effect of environmental good scarcity on own-farm labor allocation: the case of agricultural households in rural Nepal

PRISCILLA A. COOKE

The relationship between the natural environment and agricultural households is a very close one in many developing countries. This is particularly true in the hill region of Nepal where small-scale agricultural households rely on environmental goods they collect from the natural environment to meet daily fuel and livestock feed requirements. For example, wood is the primary cooking fuel in the region and collected leaf fodder and grasses are fed to livestock. When these products become more costly for households to collect due, for example, to the degradation of the natural environment, households spend more time in their collection. Of concern is whether this reallocation of household time comes from agricultural production. Empirical evidence of such a labor allocation link between the environment and agriculture would highlight the serious consequences of environmental degradation for subsistence level agriculturalists, and would perhaps increase the perceived benefits of polices to improve forest resources.

Evidence from a sample of hill households has shown that the households, and women in particular, spend significantly more time collecting environmental goods such as fuelwood, leaf fodder, grass, and water when the cost of collection per unit increases. This paper explores whether increasing labor burdens for environmental good collection are leading these households to reallocate household labor away from own-farm agricultural work. Overall, the results of this study give little clear support to the claim that households, and women in particular, will spend less time farming when it becomes more costly to collect environmental products such as fuelwood. It appears that seasonal factors, household landhold-

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ings, household composition, and traditional gender roles in agriculture exert more influence on household agricultural labor allocation decisions than does an increase in the cost of collecting environmental products.

It is quite conceivable that agriculture is such a high priority for these subsistence farmers that sacrifices will be made in leisure or other less crucial activities before agricultural labor time is reduced. Given this explanation, the fact that there is some small amount of evidence for labor reallocation away from agriculture indicates that the environmental goods are extremely important and have become costly enough to significantly tighten household labor constraints. Perhaps most interestingly, although fuelwood is a vitally important good for rural Nepalis, it appears that the tightening of labor constraints imposed by higher collection of costs of leaf fodder and grass for livestock feed may pose more of a problem for rural households. This would suggest that polices geared toward relieving the burden of collection activities for rural households, and for women in particular, should focus more on livestock feed issues than on fuelwood.

Valuing mangrove resources in Kosrae, Micronesia

ROSAMOND NAYLOR AND MARK DREW

Mangrove ecosystems provide a wide range of market and non-market benefits to coastal communities in the developing world, yet they remain undervalued and overexploited in most regions where they are found. In this paper, we analyze the use and value of mangroves in Kosrae, Micronesia, where the population is largely dependent on the swamps for fuelwood, mangrove crabs, and other ecosystem services, such as erosion control, storm protection, and nutrient flows to shoreline fisheries. We use primary survey data from 1996 to estimate the net market value of mangrove products for the local population (a revealed preference estimate) and the value that residents would be willing to pay through a tax or permit system for protection and indefinite use of mangrove ecosystem services in the future (contingent valuation estimates). There have been no contingent valuation studies to our knowledge that focus specifically on mangrove resources in the developing world, yet understanding values from a local perspective is critical for designing and implementing public policies to protect mangrove ecosystems in the future.

Our results show that mangroves on the island are worth between $666,000 and $1 million per year (1996 prices) based on the net value of

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marketable products alone. The dynamics of the system are such that this value could fall precipitously, however, if the ecosystem were destabilized by excessive fuelwood harvesting or land development. Under such circumstances, mangrove crab populations would decline, as would the abundance of fish in the coastal zone. Similarly, the development of export markets for mangrove crabs and coastal fish could lead to unsustainable catch levels and a consequent drop in marketable value.

At current levels of use, our results indicate a high correlation between direct use values and the population's stated willingness to pay for the sustained use of mangroves. Household survey data suggest that the local people collectively are willing to pay $1 million through a regulated permit system for mangrove use. Alternatively, they are willing to pay $1.26 million per year through a tax system for preservation of mangroves with limited use. The fact that people are willing to pay a higher amount for a tax system than a permit system suggests that they attach a premium on non-market ecosystem benefits, such as storm protection and flood control.

Valuation analyses using revealed preference and contingent valuation methods lead to additional conclusions regarding the distribution of benefits. Poor households obtain more direct benefits from—but are willing to pay less to protect—mangrove ecosystems. The progressive nature of direct mangrove use on the island suggests that the government needs to worry about the potential transition in employment and incomes that could result from the end of the Compact Agreement between Micronesia and the US in 2001. At this time, it is likely that many jobs on the island will be lost, incomes will fall, and the local population's dependence on mangrove ecosytesms for subsistence and short-run economic gain will increase.

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