¿POR QUÉ NO UN MUNDO SOSTENIBLE?
LA CIENCIA ECONÓMICA VA A SU ENCUENTRO

XVII Acto Internacional de Barcelona
Real Academia de Ciencias Económicas y Financieras

La realización de esta publicación
ha sido posible gracias a

Generalitat de Catalunya
Departament
de Justícia

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

con la colaboración de

Fundación "la Caixa"

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Publicaciones de la Real Academia de Ciencias Económicas y Financieras

Real Academia de Ciencias Económicas y Financieras
¿Por qué no un mundo sostenible? La ciencia económica va a su encuentro. / Real Academia de Ciencias Económicas y Financieras.

Bibliografía
ISBN- 978-84-09-48026-5

I. Título II. Gil Aluja, Jaime III. Colección

1. Economía 2. Sostenibilidad 3. Ecosistema

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(Art. 41 del Reglamento)

Editora: ©2023 Real Academia de Ciencias Económicas y Financieras, Barcelona.
www.racef.es
Fotografía portada: www.freepik.es
Académica Coordinadora: Dra. Ana Maria Gil-Lafuente

ISBN- 978-84-09-48026-5

Depósito legal: B 3260-2023

Impreso y encuadernado en España por Ediciones Gráficas Rey, S.L.—c/Albert Einstein, 54 C/B, Nave 12-14-15
Cornellà de Llobregat—Barcelona
Impresión Febrero 2023

Esta publicación ha sido impresa en papel ecológico ECF libre de cloro elemental, para mitigar el impacto medioambiental

REAL ACADEMIA DE CIENCIAS ECONÓMICAS Y FINANCIERAS

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IRREVERSIBILITY AND IRREPRODUCIBILITY:
A COMPLEX APPROACH TO RESOURCE ECONOMICS

Domenico Marino[1]

Miembro de la Barcelona Economics Network de la Real Academia de Ciencias Económicas y Financieras

1. Introduction

The purpose of this paper is to attempt to construct a taxonomy of possible economic policies in the presence of negative pollution externalities. Public and private remedies to externalities have very strong validity if they are applied under conditions of certainty, in the absence of transaction costs, and with reversible effects

The presence of irreversibility and uncertainty changes the situation substantially and determines different conditions with which the public decision maker must deal. Our point of view in the economic analysis of the environmental problem will have the concept of irreversibility as a starting point. In fact, when, the negative effects on the environment can be corrected by future interventions then the decision problem can be brought back to a simple cost-benefit analysis, where the social cost of environmental degradation is compared with the social cost associated with eliminating the damage. Certainly, a microeconomic problem remains, related to the correct assessment, for example with the use of shadow prices, of the social cost of the externality,

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but once a sufficiently accurate estimate of the harm has been achieved, then the decision problem appears extremely simple.

One way to define externality is to assume that the social cost diverges from the private (production) cost, or the social benefit diverges from the private (consumption) benefit. There is, thus, one of the forms of market failure that the economics literature calls externality.We speak of externality as market failure in the sense that individuals' choices are made on the basis of prices and costs that do not reflect the actual value of the resources exchanged. It is clear that the social cost may be higher or lower than the private cost. It will be higher in the hypothesis that not all production costs are borne by the producer and, consequently, the producer in determining its supply curve will not take these costs into account. Conversely, the private cost will be higher than the social cost in the assumptions in which the enterprise in determining its supply curve will consider the costs incurred that are not closely related to production.

Consumption externalities relate specifically to the demand curve and arise from a comparison between the social benefit and the private benefit. In assumptions where the social benefit is greater than the private benefit the demand curve does not reflect the benefits that the community derives from the consumption of that particular good or service, when, conversely, the benefit of the individual consumer is greater than the social benefit the demand for the good will be greater than socially efficient.

The approach based on aspects of irreversibility ultimately allows a more efficient analysis to this issue. Indeed, the difficulties in estimating shadow prices can be attributed to the inefficiency of the monetary metric to measure aspects that have dimensions of intangibility. The value of health or rather the (IRREVERSIBLE) cost of damage caused by pollutants is difficult to estimate precisely because of the irreversibility content it possesses. In fact, one way to define irreversibility is to consider an infinite restoration cost. If we are faced with infinite restoration costs then, the risk of adverse effects must be treated with great care.

Coase's theorem that forms the basis of modern treatment of externalities loses its value. Indeed, the attempt to internalize social costs and transform stochastic fluctuations into a deterministic model of market values fails in the case where irreversibility is present.

2. Economic growth and nonrenewable resources: a survey

2.1. The neoclassical approach

The neoclassical approach consists of describing a growth model with a composite good in which the production function depends on a nonrenewable resource available in finite quantity. If the average productivity of the resource is limited, there is a finite limit for production, and a positive level of consumption and production cannot be sustained indefinitely. However, since the average productivity of the resource is a function of technology, and the availability of other inputs technical progress and resource substitution can increase the productivity of the nonrenewable resource.

The consequence of this is that an economy can sustain a positive level of consumption and can grow over time even in the presence of nonrenewable resources The neoclassical approach is based on a growth model in which the output of production depends on the availability of a nonrenewable resource. This approach makes it possible to identify the key factors that determine the ability of an economic system to be self-sustaining. If the average productivity of the resource is limited, then certain levels of resource consumption and production cannot be sustained forever. However, the productivity of the nonrenewable resource can be increased as a direct result of technical progress or the process of resource substitution.

Taking into consideration technical progress and the possibility of capital substitution, it is possible to consider positive levels of resource consumption and production if the ratio of the growth rate of technical progress affecting the scarce resource to the growth rate of population is greater than the share of resource output (Stiglitz, 1974).

If, moreover, the elasticity of substitution of the nonrenewable resource for the renewable resource is greater than 1 there can exist a growth path of the economic system that is characterized by a nondecreasing level of consumption (Dasgupta, Heal, 1974).

Ultimately, the optimality of sustainable growth in a neoclassical approach would be determined by the level of "patience" inherent in the economic system, namely the social rate of time preference.

In the presence of technical progress, the growth rate in per capita consumption is positive if the ratio of the rate of technical progress on the elasticity of the resource to output is greater than the discount rate (Stiglitz, 1974). In the case where there is substitution between capital and resources, the economy must be willing to accumulate capital to compensate for the decline in resources. In the case of a Cobb Douglas-type production function, the limit value of marginal productivity is zero so that the social rate of time preference must be zero to allow the economy to find its sustainable path. The time preference rate then determines the asymptotic growth rate of the economy but not the level of welfare.

It is interesting to study the case of the constant consumption path. In the previous case in the absence of population growth and technical progress this path is possible if the share of output over capital is greater than the ratio of output to resources (Solow, 1974). Hartwick's (1977) rule states that a steady consumption path does not require net investment, that is, it is sufficient to reinvest within the economy the return that comes from exploiting the nonrenewable resource. Dixit, Hammond and Hoel (1980) extend the rule to the case where there are many resources and many capital goods.

2.2. The evolutionary ecological approach.

The neoclassical approach succeeds in describing the case of renewable goods well, but in describing an economy in which resources are nonrenewable it denotes some critical issues. From the critique of the neoclassical approach, a strand has developed that is called ecological economics.

This approach takes its cue from the critique of the neoclassical approach and the definition of a more stringent concept of sustainability. Even on the name evolutionary ecology there is no agreement in the literature. For example, Costanza (1989) also includes within the evolutionary ecological approach the neoclassical paradigm, Dasgupta (1995) extends the term to encompass the entire field covering the disciplines of resource and environmental economics. In our understanding we will consider evolutionary ecological approach that approach which emphasizes the role played by the elasticity of substitution between reproducible capital and natural capital, intergenerational equity, and the uncertainty and irreversibility inherent in environmental aspects. A fundamental assumption of this approach is that the decision maker's focus should not so much be on the conservation of a single nonrenewable resource, but rather to protect the environmental ecosystem as a whole (Ayres, 1996). A common criticism of the neoclassical approach is surely the consideration of reproducible capital and natural capital as complements rather than substitutes in the production process. The limit to substitutability is the fundamental concept that determines sustainability. It is distinguished in the literature between strong and weak sustainability. Weak sustainability tends to keep the productive capacity of the economy intact by including the endowment of natural resources. This result is nothing more than the aforementioned Hartwick rule.

Strong sustainability aims to leave natural capital intact. If the natural capital has a high value added, the optimal results of the decision will be coincident both by making use of the concept of weak sustainability and the concept of strong sustainability. If, in fact, ensuring the well-being of future generations is a policy goal and the preservation of natural capital is critical to the achievement of this outcome, there is no need to impose any other type of constraint

(Dasgupta, 1995). However, it is not possible for all natural resource values to achieve this result. Therefore, in the absence of intervention capital will be overconsumed. In addition, if instead of the concept of allocative efficiency used so far, intergenerational equity is taken into consideration, sustainability becomes a clearer concept (Howart, Norgaard, 1991). Another difference between neoclassical and evolutionary ecological models is as follows: in neoclassical models the social rate of time preference determines the asymptotic growth rate of the economy. In evolutionary ecological models, on the other hand, it is the social discount rate that is a key element of sustainability.

A crucial point of the sustainability concept that there can be degradation of environmental quality and resource depletion even if the social rate of time preference is low and private capital is available to compensate future generations. A low rate of time preference that increases the welfare of future generations does not necessarily increase the endowment of natural resources (Krautkraemer, 1986). The presence of uncertainty and/or the irreversibility of processes are two aspects that introduce additional elements of complexity within the sustainability problem. The principle that becomes cogent in the case of high levels of uncertainty and irreversibility is the precautionary principle, while for intermediate levels of uncertainty and irreversibility it is sufficient to resort to the principle of conservation of minimum standards. Krutilla (1967) approaches the problem of environmental sustainability in terms of option demand on future resource preservation in a context characterized by a risk-averse decision maker. Uncertainty and risk aversion can lead to negative value for the option.

The critical issue with an option-value approach is that policy guidance cannot be obtained. The application of the precautionary principle and/or minimum standards fails to translate into operational aspects but remains only the logical consequence that follows from the presence of irreversibility and uncertainty. For this reason, in the paper the problem of sustainability and its relationship to policy is approached from a stochastic optimal control model, which allows for the construction of a taxonomy for policies, i.e., it allows us to identify some indications that derive from the very nature of irreversibility and uncertainty.

3. A Taxonomy for Policies.

Economic processes in which nonrenewable resources, such as environmental resources, play a cogent role are strongly influenced by elements of uncertainty, related to the impacts of individual and collective behaviors in the resources themselves, and irreversibility, related to the fact that the impacts of individual and collective behaviors on the resources may be permanent.

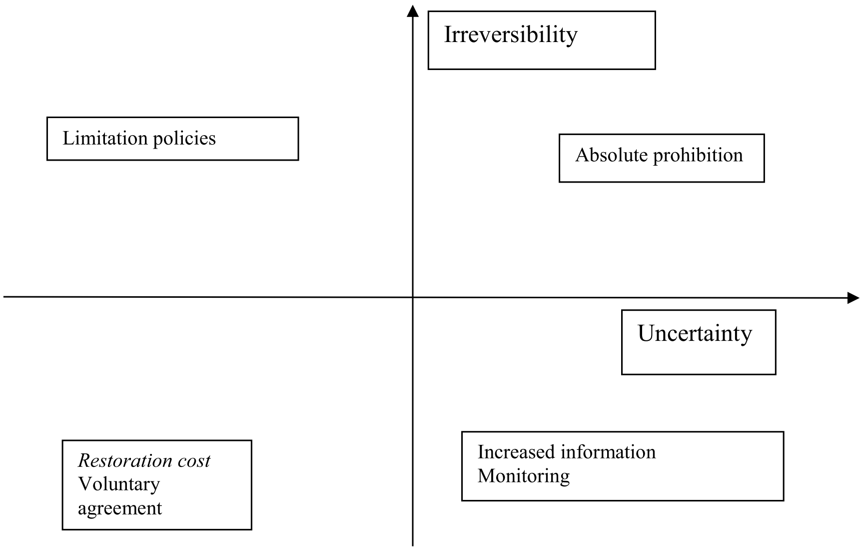

Fig. 3.1. Taxonomy of policies in the presence of pollution-generated externality.

If uncertainty and irreversibility are low, then the optimal policies are those based on voluntary agreements or restoration cost. The externality can in this case be efficiently managed with internalization policies. On the other hand, when irreversibility and uncertainty are high, then it is the precautionary principle that plays the main role in policy making. The only optimal policy in this case is an outright ban. In the case of low irreversibility and high uncertainty the optimal policy becomes one based on increasing available information, while in the case of high irreversibility and low uncertainty the optimal policies are restriction and standard-setting policies. The following graph shows the effect of the presence of uncertainty on the optimal path to achieve environmental quality The presence of uncertainty causes changes in the optimal level of environmental quality achievable using a given policy.

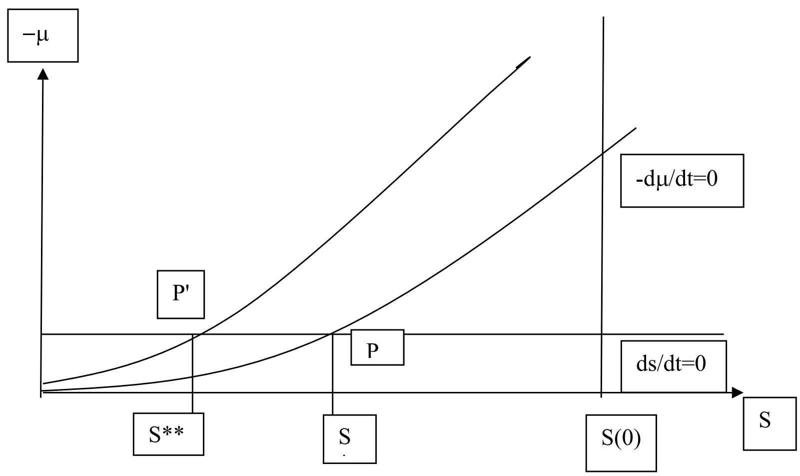

Fig. 3.2. Effect of the presence of uncertainty on the optimal path to achieve environmental quality.

Ultimately, as shown in the graph, we get that in equilibrium there is a higher level of environmental quality with a higher social cost.

4. Some concluding remarks

The problem of limiting the negative externalities from pollution and the optimal policies to be used turns out to be a complex problem that can be addressed in correct terms only by having recourse to the concepts of irreversibility and uncertainty. The presence of these elements has very strong consequences for optimal policies, so much so that it is necessary to diversify interventions in relation to the varying degrees of uncertainty and irreversibility found within the economic system.

Using a model based on stochastic optimal control theory, conditions were identified that allow a taxonomy for optimal policies to be constructed. The result that emerges is that the presence of irreversibility and uncertainty necessitates a higher level of protection, so that under these conditions, higher environmental quality is achieved at a higher social cost

The result that emerges is that there is in equilibrium a higher level of environmental quality with a higher social cost.

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