Departament d'Economia Aplicada

D O C U M E N T D E T R E B A L L

The Appraisal of Projects with Environmental Impacts. Efficiency and Sustainability

Joan Pasqual
Emilio Padilla

07.04

Universitat Autònoma de Barcelona

Facultat de Ciències Econòmiques i Empresarials

Aquest document pertany al Departament d'Economia Aplicada.

Data de publicació : **Setembre 2007**

Departament d'Economia Aplicada
Edifici B
Campus de Bellaterra
08193 Bellaterra

Telèfon: (93) 581 1680
Fax:(93) 581 2292
E-mail: d.econ.aplicada@uab.es
http://www.ecap.uab.es

The Appraisal of Projects with Environmental Impacts. Efficiency and Sustainability[1]

Joan Pasqual and Emilio Padilla

Department of Applied Economics, Autonomous University of Barcelona, 08193 Bellaterra, Spain.

ABSTRACT

It is usually assumed that the appraisal of the impacts experienced by present generations does not entail any difficulty. However, this is not true. Moreover, there is not a widely accepted methodology for taking these impacts into account. Some of the controversial issues are: the appropriate value for the discount rate, the choice of the units for expressing the impacts, physical or monetary units —income, consumption or investment— and the valuation of tangible and intangible goods. When approaching the problem of very long term impacts, there is also the problem of valuing the impacts experienced by future generations, through e.g., the use of an intergenerational discount rate. However, if this were the case, the present generation perspective would prevail, as if all the property rights on the resources were owned by them. Therefore, the sustainability requirement should also be incorporated into the analysis. We will analyze these problems in this article and show some possible solutions.

1. INTRODUCTION

Reviewing the literature on project evaluation it might be thought that, if all the impacts of a project affected present generations, then there would not be any difficulty in the evaluation of any project from a social perspective. However, the reality is quite different.

Arrow's impossibility theorem (Arrow, 1951) and the theorems of Gibbard (1973) and Satterthwaite (1975) show that, given a group of alternatives, it is not possible to arrange them or find the best choice from a social perspective if a minimum of logical properties is required to the result. This is a general result and affects any way of making social choices, including market and voting systems. In short, it is obvious that there is not any available procedure for public project evaluation—and it is not possible to design it—free of paradoxical results.

[1] The authors acknowledge the support of projects SEJ2006-4444 , 2005SGR-177 and XREPP.

Therefore, there is not a completely satisfactory system for public project evaluation. We are neither able to find a procedure superior to all the others. As a consequence, there have appeared numerous methods, which respond to different approaches, have different logical properties and tackle with greater or lower success different difficulties.

There is an obvious conclusion: it will be preferable one or other system depending on the specific case to solve and on the objective pursued. For example, Osborne and Turner (2007) conclude: "We find that a referendum leads to higher welfare than a cost benefit analyses in “common value” environments. Cost benefit analysis is better in “private value” environments".

Leaving aside the purely qualitative methods, there are several quantitative evaluation procedures incorporating in an explicit or implicit way a relative prices system. Not all of them are acceptable. Remer and Nieto (1995) present 25 quantitative procedures for measuring the desirability of a project, although most of them are not advisable at all. Twenty of them can be rejected because of their lack of rationality. Some give the same weight to impacts occurring in different moments of time, obviating the need for time discounting. Other methods compute costs and benefits following accounting criteria that, such as amortization or the imputation of general expenses, contradict the basic economic notions of cost and benefit. For any selected method it is necessary: a- identifying the relevant costs and benefits, b.- quantifying them; c- valuing them and d- weighting the impacts according to the moment they happen. Two problems will be examined below: time discounting and sustainability.

2. The Problem of Discounting

Let us assume that, such as in Cost-Benefit Analysis, it is possible to quantify and valuing all the impacts in all the years of a project. The aggregation of the flows in each year t, t = 0, 1, …, T, is done by means of the well-known Net Present Value function:

$$NPV = \sum_{t=0}^{T} a_t (1+r)^{-t} \qquad (1)$$

where r is the social discount rate. The NPV is a profitability measure in absolute terms. It measures the change of wealth in year 0 that is equivalent to undertake the project. Given a_t, the function depends on the value given to the social discount rate r.

Before we tackle the controversial problem of choosing the appropriate methodology for determining the discount rate, it is necessary to decide whether we follow methodological individualism or, following a paternalistic approach, decide the discount rate value independently of individual preferences.

In any case, the discount rate r, can represent a- the social time discount rate STDR, b- the social opportunity cost of capital, or c- the minimum profitability that the decision maker expects to achieve in order to undertake the project. In ideal conditions both will lead to the same value for r. However, in practice, the result will substantially differ according to the methodology which is followed.

The time preference rate of an individual might include various factors: consumption impatience, survival probability, and the decreasing marginal utility of consumption if the individual expects having an increased consumption over time. However, it might be argued that discounting for impatience is not rational, and that individuals die, but not society, so these components should not be taken into account. In this case the STDR would be very low, around 0.5%, while if all the relevant factors at individual level are taken into account, this rate might be around 5%.

The opportunity cost of capital approach is not an easier way because there are very different alternatives. 1- The interest rate of capital markets. 2- The relative profit of the economy computed as the ratio between total benefit and capital stock. But this is an average value and we are looking for the marginal one. Moreover, there are definition and measurement problems with profit and capital stocks, especially in the public sector. Values around 20% are normal. 3- The marginal productivity of capital computed by means of the production function of the economy. This is a more rigorous method than the previous one, and gives similar values.

Other interesting approach is the shadow price of investment (SPI). The SPI computes the present value of the flows generated by a unit of investment with a rate of profitability *q* during a time T, which are discounted through the STDR. In its simple formulation it results:

$$PCI = \frac{q}{STDR} \qquad (2)$$

It is assumed that part of project flows is allocated to consumption and the rest is allocated to investment. The discounting of the flows is undertaken by multiplying the funds allocated to investment by the SPI.

The problem is choosing the most appropriate model for determining the shadow price of investment. As Souto (2002) shows, the result of the SPI computation is very sensible to the hypothesis of each model with respect to the duration of the investment and to the consideration of reinvestment possibility. In such a way that the SPI might be infinite, 2.5, 1.2 or -7.1 for the same project according to the model employed.

Paradoxically, the computation of the SPI does not use to include the so-called marginal cost of public funds (MCF). The MCF measures the marginal costs of the inefficiency caused in the economy when collecting funds by means of taxes or other distortionary instruments—see figure 2. There are also competing methodologies for the measurement of these costs—see Triest (1990) and Liu (2003)—and none of them is superior to the others, which makes more difficult their application. Obviating this component involves undervaluing the necessary costs for undertaking an investment. Actually, the MCF is much higher than the average cost, is roughly 0.2 per collected unit, and might achieve the high value of 0.5, which is the result of Sancho (2003)—see an example in Annex I. Moreover, administration and compliance costs should also be added to this welfare cost. It is not necessary to highlight that the debate on the MCF is not less important than the one on the STDR, with regard to its possible impact on the result of the measurement of the desirability of a public project.

After reviewing the issue, there is a clear conclusion: there is not consensus, not only on the best way of computing the appropriate discount rate, but also with respect to the factors that this rate should include. Consequently, it is not unusual the choice of a third way: directly choosing a reasonable value. Then, it would be convenient to achieve an agreement on which is the discount rate value to be applied in public project evaluation. However, there is not a unique notion of reasonable rate, so that it might happen that one public agency employed a discount rate of 3% while other public agency employed a discount rate of 12% for evaluating the same project. This happens in the real world, especially in international cooperation projects. This lack of consensus might lead to paradoxical results, as we show below.

Let A and B be two different agencies that apply $r_A = 3\%$ and $r_B = 12\%$ discount rates respectively. They have to evaluate projects I and II—see Figure 1. Under these conditions, it might happen that $NPV^I(r_A) > NPV^{II}(r_A)$ but $NPV^I(r_B) < NPV^{II}(r_B)$ so that agency A would choose project I and agency B would choose project II—see Figure 1. Of course, r_A and r_B values correspond to rates applied in real world valuation of public projects.

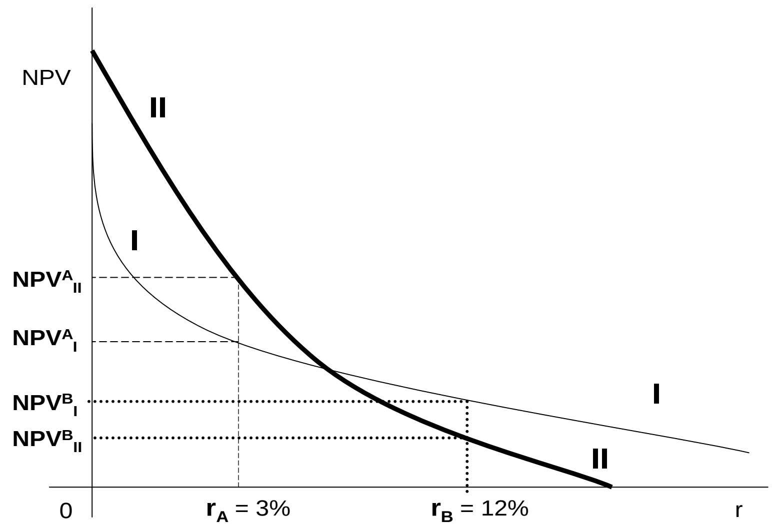


Figure 1

3. THE PROBLEM OF SUSTAINABILITY

With all its limitations, the conventional discount rate r shows the preferences of an individual on the availability of a good or resource today versus tomorrow. Under the immortality hypothesis—which is implicitly done in the conventional computation of the NPV—it is relatively easy to aggregate individual discount rates in order to get a social discount rate. But it is not possible to get an efficient result by means of this approach, because it does not take into account the preferences between own and descendants' consumption, or in other words, between present generations (PG) and future generations (FG). The result is a systematic bias in the NPV computation, which undervalues costs and benefits that occur in what is called long term—in human terms. The most important bias arises in the evaluation of the impacts that do not affect PG but have much importance for FG.

The problem when computing long term impacts is clear. With a discount rate of $r = 5\%$ the Net Present Value (NPV) of \$ 1,000,000 in 100 years is lower than \$ 8,000. However, for the generations that will live in 100 years, the impact will be \$ 1,000,000, *ceteris paribus* and, in any case, 100 years is an insignificant lapse of time for the planet. In the limit, PG would measure the value of a catastrophe for FG as a little cost that can be compensated with a small benefit. With the purpose of avoiding this kind of results, several proposals have been made.

The most straightforward proposal is extremely simple. If the problem worsens as the discount rate increases, then it might be solved employing a zero discount rate or might be alleviated with a sufficiently low rate—see Daly and Cobb (1989) among many others. A zero discount rate involves a practical problem: all the projects yielding a positive flow of net benefits for an unlimited time would lead to an infinite value for the profitability computation—unless the time scope is limited to a finite and arbitrarily low one. But this proposal also has serious conceptual problems. It is an *ad hoc* solution, because the discount rate is a data, a parameter, and not a decision variable. The rate which represents the preferences between present and future consumption of a generation is arbitrarily modified. Moreover, although the proposal is justified because it favors future generations, it does no take into account citizens' preferences between own and descendants' consumption.

There is a more appealing proposal, the proposal of a decreasing discounting over time. Heal (1997) suggests that a discount rate decreasing in a logarithmic way over time would be more appropriate than a constant rate. Weitzman (2001) proposes a similar approach: hyperbolic discounting. Weitzman starts from a survey in which the next question was asked "(…) what real interest rate do you think should be used to discount over time (expected) benefits and (expected) costs of projects being proposed to mitigate the possible effects of global climate change?". The data obtained fitted a gamma function, and in this way "even if everyone relieves in a constant discount rate, the *effective* discount rate declines strongly over time" - Table 1.

Table 1. "Approximate Recommended" Sliding-Scale Discount Rates

Period of years	1–5	6–25	26–75	76–300	> 300
Discount rate	4%	3%	2%	1%	0%

Source: Weitzman (2001).

The formal analysis is appropriate. However, some economic objections might be done:

a- The question mixes the costs—which are tangible and are pure private goods—with the benefits—which are intangible and are a pure public good in the Samuelson sense. Actually, environmental costs and benefits should be discounted through a different rate than the appropriate one for market goods (see Almansa and Calatrava, 2007).
b- It might be thought that the same data would adjust other functions and, under this hypothesis, the result would have been qualitative different.
c- It might be questioned if it had not been preferable asking directly about the appropriate rate for each period of time, without imposing the restriction of a constant rate.

However, the result is reasonable and appealing. Actually, the proposal, with small variations in values and intervals, is included in Treasury (2003)—Table 2.

Table 2. The Declining Long Term Discount Data

Period of years	0–30	31–75	76–125	126–200	201–300	> 300

Discount rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%

Source: Treasury, http://greenbook.treasury.gov.uk/

The result alleviates the loss of importance of a very long term cost or benefit which would result from the application of a conventional rate. A hyperbolic rate of discount has also the advantage of simplicity. Therefore, it has clear virtues when comparing it with other more soundly based methods.

However, there is a serious criticism; it would be too daring to state that *one* hyperbolic rate is able to show *two* different preferences: time preferences with regard to citizens' own consumption and preferences on intergenerational allocation. The result is that the application of one rate cannot be efficient as far as it ignores, completely or partially, citizens' preferences and intergenerational externalities.

The problem, correctly exposed, consists in accounting and weighting the costs and benefits of a project in a model with overlapped generations, which is a relatively new and complex approach. First, it is necessary to take into account the conventional rate r, which shows the preferences of an individual between present and future consumption. Second, it is necessary to explicitly incorporate other rate R, which represents the preferences between own and descendants' consumption.

Kula (1988) determines the profitability of a project for each generation through the computation of the NPV with the conventional discount rate. These NPVs are aggregated giving the same weight to all generations. That is to say, with a zero intergenerational rate. Several authors, such as Collard (1981), Bellinger (1991), Pasqual (1999), Sumaila and Walters (2005) and Almansa and Calatrava (2007), among others, propose the use of two rates—r for computing each NPV and R for aggregating them—or what might be equivalent, the conventional rate r and an intergenerational weighting.

Therefore, there is a good theoretical basis for computing the costs and benefits of a project which affects several generations. But there is an applied problem, as there is still not a reasonable estimation of intergenerational weights (or discount rates), or of their order of magnitude.

The solution to the issue exposed above is only part of the problem. It might improve efficiency, but only consists in taking into account present generations' preferences. Thus, it might imply acting as if future generations had not any right. The use of two discount rates—intragenerational and intergenerational—might be appropriate, but does not guarantee the fulfillment of the sustainability requirement.

Padilla (2002) and Pasqual and Souto (2003), among others, highlight that, in order to fulfill the sustainability requirement, it is necessary to employ other instruments. There is not enough with the use of economic tools, it is also necessary to employ political mechanisms and to develop institutional innovations and reforms. The basic problem is simple, present generations (PG) have much and varied tools for passing on their preferences to future generations (FG), but the same does not happen in the inverse way. FG cannot communicate with PG and do not have any possibility of negotiating with PG. Then, FG will find the resources voluntarily legated by PG.

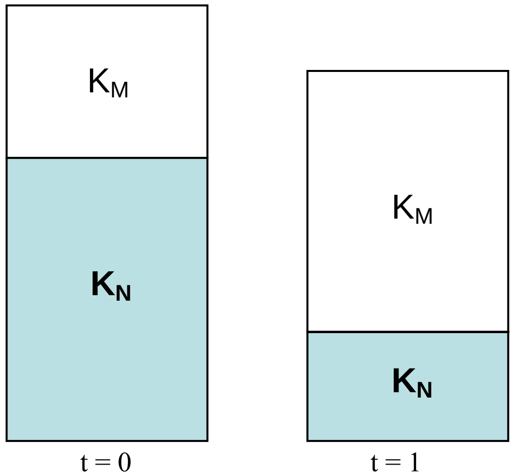
Each one of the successive PG acts according to the least efficient economic regime—the *open access* one—with respect to the following generations. Thus, it might be foreseeable a collapse of the system in a relatively brief period. However, this prediction would not be much realistic as it ignores important factors that act in opposite sense. As far as PG have well defined preferences on the welfare of FG—and there are the appropriate institutions—it would be possible that the behavior of PG led to a sustainable result.

Sustainable development might be defined as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs", WCED (1987). Let be R_{jg} the initial resources of type j that are available for generation g, which has population N_g. These resources might be exploited by generation g with a rate of return k_g, obtaining $(1+k_g)\cdot R_{jg}$. Let C_g and c_g, $c_g = C_g / N_g$, be the total and average needs of resource j for generation g, with $C_g = h_g(1+k)\cdot R_{jg}$, $h \in \Re_+$. In the same way, the following generation g+1 will obtain resources $R_{jg+1} = [(1-h_g)(1+k_g)(1+k_{g+1})\cdot R_{jg}]$ and *per capita* resources $r_{jg+1} = [(1-h_g)(1+k_g)(1+k_{g+1})\cdot R_{jg}]/N_g$. Sustainability with respect to the use of resource j by generations g and g+1 would be obtained if:

$$h_g \leq 1 \text{ and } C_{g+1}/ N_{g+1} \leq [(1-h_g)(1+k_g)(1+k_{g+1})\cdot R_{jg}]/N_g \qquad (3)$$

If $h_g > 1$, then the generation g needs exceed the resources available for them and it would not be sustainable for present generation g. The result, in terms of the size of the populations of g and g+1, depends on whether these needs are the subsistence ones or exceed this biological limit. If $h_g \leq 1$, then sustainability for generation g is achieved. Sustainability for generation g+1 would be more feasible the lower the populations (N_g and N_{g+1}) and the needs (c_g and c_{g+1}) and the greater the resources productivities (k_g and k_{g+1}).

If the conditions in (3) were widely fulfilled, then it would not be necessary to continue the analysis. It might be though that a path leading to this goal is being followed. The arguments for sustaining such opinion would be several and important changes that are happening. One of these changes is green national accounting. This consists in adjusting conventional accounting systems with the aim of properly including all the—tangible and intangible—costs and benefits in national accounting (Ahmad, Serafy, and Lutz, 1989). In this way the generation of wealth will not be mixed up with the simple transformation of natural capital (K_N) into manufactured capital (K_M)—Figure 2.



In moment t = 0 there are K_N units of natural capital and K_M units of manufactured capital. In the following period t =1, K_M has considerably increased, although the reduction of natural capital K_N is even greater. There has been a loss that green accounting would take into account while conventional accounting would interpret as spectacular growth.

Figure 2

Among the changes experienced, one might also highlight innovations and improvements in the methodology for the design of projects with great environmental impact. As an example, the concept of *habitat equivalency analysis* (HEA)—see Dunford, Ginn and Desvousges (2004) and Zafonte and Hampton (2007)—is attractive and relevant, both from a theoretical and from an applied perspective. The HEA procedure aims to compensate in terms of present value for the environmental damages in a habitat. The complete repairing of a damaged habitat would not be sufficient compensation: as a consequence of considering time discounting, in order to maintain the value of 1 unit lost today it is necessary to get (1+r) units tomorrow. In order to compute the compensation, the units that have been repaired and their relative value are taken into account, as well as the quantity of equivalent habitat that has been produced.

It is important to highlight that the compensation for an environmental impact by means of the HEA is undertaken with exactly the same kind of natural resources. This would avoid some logical problems, such as the Scitovsky reversal paradox (Scitovsky, 1941), as well as ethical ones, which might appear when monetary *compensations* are used.

Project evaluation methods have also been adapted to the new requirements of environmental quality—see e.g., EBRD (2006). These methods overcome the possibilities of classical procedures, such as Cost-Benefit Analysis. Among the new evaluation methodologies, the so-called social multi-criteria evaluation (Munda, 1996 and 2004) stands out due to its potentiality and flexibility.

It could not be denied that both the changes in the design of projects and the appearance of modern evaluation systems for taking into account environmental variables have more relevance for FG than for PG. The same might be said about much of the policies undertaken by governments that, such as some of the policies for mitigating climate change, are more favorable to FG than to PG.

From a less optimistic—or more exigent—perspective the current evolution of methods and policies appears as clearly insufficient. It might be thought that there is still much to be done and that it is urgent to pursue environmental sustainability as a top-priority goal and to determine specific lines of action. In the words of Goodland, Daly and Serafy (1993):

> "Environmental sustainability can be approached by implementing four priorities: first, by using sound microeconomic means; second, by using sound macroeconomics to differentiate between use and liquidation of natural capital by means by environmental accounting; third, by using environmental assessment to incorporate environmental costs into project appraisal; and fourth - until the first three become fully achieved - by following operational guidelines for sustainability".

It might be not enough with correctly incorporating the preferences and the point of view of PG. It might be necessary to explicitly admit that PG do not have all the property rights on the Earth but that, at least in part, these rights also belong to FG. Under this hypothesis the goal is to advance in the design of new institutions with the aim of representing and defending the interests and rights of FG.

Actually, any PG has the capacity of modifying and abolishing institutions, laws and norms. For this reason, it is necessary to build up a protecting network before the formulation of any reform proposal in favor of the interests of FG. In short, this might start with a constitutional amendment in order to difficult the derogation of legal dispositions to be established in favor of FG. Protected natural spaces would be a typical example.

Of course, in order to protect a maritime zone placed in international waters an international agreement would be necessary. The same applies for an appropriate management of strategic resources and of some residuals. The solution implies the creation of specialized international agencies, such as a World bank of natural and environmental resources and an International bank of radioactive residuals.

Besides legal protection, the market incentives might also be used. Fiscal incentives might be used by entities and foundations whose goal was the purchase of natural spaces for their effective preservation.

Last, it would be useful to create the figure of the FG representative. The goal of this agency would be monitoring the use of the resource wealth belonging to FG. In case of conflict, it would claim in markets and in front of the administration or political system an adequate compensation.

Annex I. The Marginal Cost of Public Funds. An Example.

Let $C' = 20$ be the marginal cost of production of a consumption good and $p = 100 - 20X$ the inverse demand function—see Figure 3. A perfect market would lead to an allocation of $X_0 = 4$ with a price $p_o = 20$.

If X was charged with a specific production tax $T = 10$, then the quantity would be $X_1 = 3.5$, and consumer price would be $p_1 = 30$ while producer price will remain at p_0. Tax collection would be $R_1 = (p_1 - p_0)X_1 = 35$, (area ①+② in the figure). The inefficiency caused by the price distortion, measured through the excess burden, is $W_1 = (X_0 - X_1)\cdot(p_1 - p_0)/2 = 2.5$, (area ③) while the excess burden per unit of collected resources would be $\underline{w_1} = W/R_1 = 7.14$ %.

Let us assume that the tax is increased by 10% for financing a project. The tax is now $T' = 11$ and the new equilibrium is $X_2 = 3.45$, $p_2 = 31$, while the producer price remains at p_0. Tax collection increases to $R_2 = (p_2 - p_0)X_2 = 37.95$ (area ①+④ in the figure) and the excess burden is now $W_2 = (X_0 - X_2)\cdot(p_2 - p_0)/2 = 3.025$, (area ②+③+⑤) which in the next percentage of total tax collection, $\underline{w_2} = W/R_2 = 7.97$ %.

The result of the 10% increase in the tax T charged on good X leads to an increase in collection by $\Delta R = 2.95$, (area ④-② in the figure) with the corresponding excess burden increase $\Delta W = 0.75$, (area ②+⑤). The marginal cost of public funds is then $MCF = \Delta W/\Delta R = 25.42$ %, (area [②+⑤]/[④-②]).

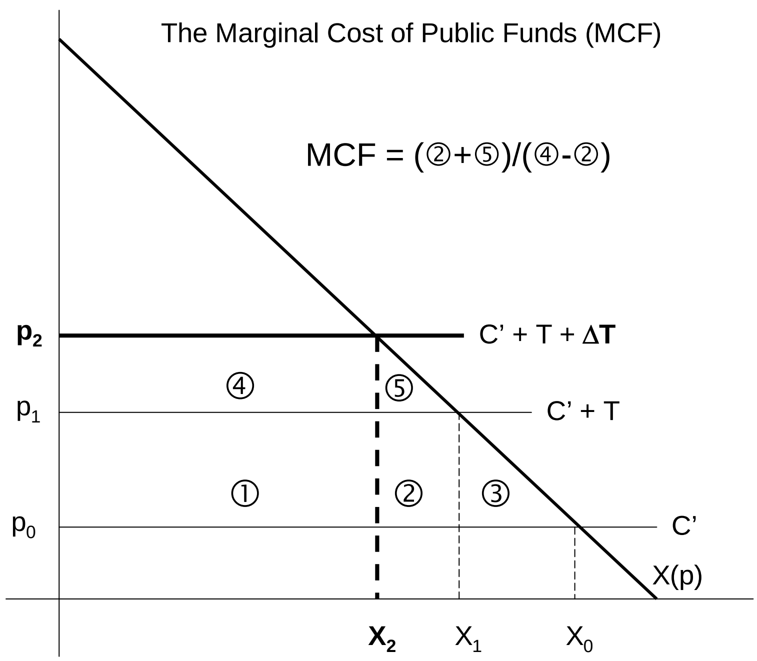


Figure 3

REFERENCES

Ahmad, Y. J., Serafy, S and Lutz, E. (1989) *Environmental accounting for sustainable development.* World Bank, Washington, D.C.

Almansa, C. and Calatrava, J. (2007) "Reconciling sustainability and discounting in Cost-Benefit Análisis: A nethodological proposal". Ecological Economics, 60, 4:712-725,

Kenneth J. Arrow and Hervé Raynaud (1986) *Social Choice and Multicriterion Decision-Making*, MIT Press., Bellavance, F., Dionea and Lebeau, M (2006) "The Value of a Statistical Life: A Meta-Analysis with a Mixed Effects Regression Model". *Cahier de recherche/Working Paper 06-46*, Centre interuniversitaire sur le risque, les politiques économiques et l'emploi

Bellinger, W. K. (1991) "Multigenerational value: modifying the modified discount method" *Project Appraisal. 6:101-108.*

Coase, Ronald, (1960), "The Problem of Social Cost," Journal of Law and Economics, 3:1-44,

Collard, D. (1981) *Altruism and Economy.* The Pitman Press, Bath.

Daly, H. B. and Cobb, J.B. Jr. (1989) *For the common good: redirecting the economy toward community, the environment and a sustainable future*. Beacon Press, Boston.

Dunford, R. W., Ginn, T. C. and Desvouges, W. H. (2004) "The use of habitat equivalency análisis in natural resource damage assessments" *Ecological Economics,48: 49-70.*

European Bank for Reconstruction and Development (2006), *Sustainability Report 2005 - Working towards a sustainable future*. EBRD, London.

Gibbard, A. (1973), "Manipulation of voting schemes: a general result", *Econometrica,* 41: 587-601

Goodland, R, Daly H, Serafy, S. (1993) "The urgent need for rapid transition to global environmental sustainability" *Environmental Conservation, 20:44,* 297-309.

Heal, G. M. (1998). "Discounting and climate change". *Climate Change, 37: 335-343*

Hong-Kyun Kim (2007 "productivity effect of air pollution"Applied Economics Letters, *14: 385–387.*

Kula, E. (1988) "Future generations: The modified discounting method", *Project Appraisal, 3:85-88.*

Liu, L (2003) "A marginal cost of funds approach to multi-period public project evaluation: implications for the social discount rate" *Journal of Public Economics, 87: 1707-1718*

Osborne M. J. and Turner M. A. (2007) "*Cost benefit analysis vs. referenda*" Working Paper 286, University of Toronto, Department of Economics

Munda, G. (1996) "Cost-benefit analysis in integrated environmental assessment: some methodological issues". Ecological Economics 19, 2:157-168.

Munda, G. (2004) "Social multi-criteria evaluation: Methodological foundations and operational consequences" *European Journal of Operational Research,158, 3: 662-677.*

Navrud, S. (2002) "The State of the Art on Economic Valuation of noise". Report to the European Comisión, DG Environment.

Padilla, E. (2002) "Intergenerational equity and sustainability" Ecological Economics, 41:69-83.

Pasqual, J. (1999) *La evaluación de políticas y proyectos.* Icaria editorial y UAB. Barcelona.

Pasqual, J. and Souto G. (2003) "Sustainability in natural resource management" *Ecological Economics*, 46, 1: 47-59.

Remer, D. S. and Nieto, A. P. (1995) "A compendium and comparison of 25 project evaluation thecniques " *Internacional Journal of Production, 42; 79-96 and 101-129.*

Sancho, F. (2003) “Una estimación del coste marginal en bienestar del sistema impositivo en España. Working papers; 592.03 Fonaments de l'Anàlisi Econòmica Institut d'Anàlisi Econòmica.

Satterthwaite, M.A. (1975), “Strategy-proofness and Arrow's conditions existence and correpondence theorems for voting procedures and social welfare functions”, *Journal ofEconomic Theory,* 10: 187-217.

Scitovsky, T. (1941) "A note on welfare propositions in economics" *Review of Economic Studies,9, 1: 77-88.*

Souto, G (2002) “El descuento social”. Hacienda Pública Española / revista de Economía Pública, 165: 99-126.

Sumaila, U. R. and Walters, C. (2005) "Intergeneracional discounting: a new intuitive approach" *Ecological Economics, 52:135-142.*

Treasury (2003) *The Green Book, Appraisal and Evaluation in Central Government.* H.M. Treasury, London.

Triest, R (1990) “The Relationship Between the Marginal Cost of Public Funds and Marginal Excess Burden” *The American Economic Review*, 80, 3: pp. 557-566.

WCED (1987) *Our common future.* Oxford University Press, Oxford.

Weitzman, M. L. (2001) Gamma discounting. *American Economic Review, 91, 1: 260-271.*

Zafonte, M. and Hampton, S. (2007) "Exploring welfare implications of resource equivalency analysis in natural resource damage assessments", *Ecological Economics,61:134-145.*

Últims documents de treball publicats

NUM	TÍTOL	AUTOR	DATA
07.04	The Appraisal of Projects with Environmental Impacts. Efficiency and Sustainability	Joan Pasqual Emilio Padilla	Setembre 2007
07.03	La evaluación de proyectos con impacto ambiental. Eficiencia y sostenibilidad.	Joan Pasqual Emilio Padilla	Juliol 2007
07.02	ANÁLISIS INPUT-OUTPUT Y EMISIONES DE CO2 EN ESPAÑA: UN PRIMER ANÁLISIS PARA LA DETERMINACIÓN DE SECTORES CLAVE EN LA	Vicent Alcántara	Juliol 2007
07.01	Commuters' valuation of travel time variability in Barcelona	Javier Asensio, Anna Matas	Gener 2007
06.06	The short and long-run determinants of the real exchange rate in Mexico	Antonia Lopez Villavicencio, Josep Lluís Raymond	Octubre 2006
06.05	Real equilibrium exchange rates. A panel data approach for advanced and emerging economies	Antonia Lopez Villavicencio	Octubre 2006
06.04	El nuevo mapa de los distritos industriales de España y su comparación con Italia y el Reino Unido	Rafael Boix, Vittorio Galletto	Setembre 2006
06.03	SPRAWL. Definición, causas y efectos	Ivan Muñiz, Miquel Angel García, Daniel Calatayud	Juny 2006
06.02	Análisis de los factores determinantes de las desigualdades internacionales en las emisiones de CO2 per cápita aplicando el enfoque distributivo: una	Juan Antonio Duro Moreno, Emilio Padilla Rosa	Febrer 2006
06.01	An input-output analysis of the "key" sectors in CO2 emissions from a production perspective: an application to the Spanish economy	Vicent Alcántara, Emilio Padilla	Febrer 2006
05.15	The relevance of Post-Match LTC: Why has the Spanish labor market become as volatile as the US one?	Hector Sala, Jose I. Silva	Octubre 2005
05.14	Sistemas Locales de Trabajo y Distritos Industriales Marshallianos en España	Rafel Boix Domenech, Vittorio Galletto	Setembre 2005
05.13	The spatial effect of intra-metropolitan agglomeration economies	Miguel Ángel García López, Ivan Muñiz	Juny 2005
05.12	Decentralisation, integration and polycentrism in Barcelona	Ivan Muñiz, Anna Galindo, Miguel Ángel García	Juny 2005
05.11	Employment decentralisation: polycentric compaction or sprawl? The case of the Barcelona Metropolitan Region 1986-1996	Miguel Ángel García López, Ivan Muñiz	Juny 2005