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Ranking transport projects by their socioeconomic value or financial internal rate of return? ☆

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Abstract

This paper discusses the choice by the public authority of the most efficient programme of infrastructure investments. More specifically, it studies the optimal ranking of project implementation when these projects are partially self-financed by their own revenues such as tolled highways. In this case, the optimal investment programme must be defined under a constraint of annual subsidies. This paper demonstrates that the optimal ranking is not necessarily the ranking of decreasing socioeconomic IRR.

This counter-intuitive result can be demonstrated by a general approach. Analytical calculations are not useful in this discrete problem because each programme is an ordered subset of projects. Therefore, there is no continuous variation linking the various programmes and the usual tools of optimization, such as differential calculus, are useless. Thus, we adopt here a discrete optimization analysis based on standard techniques in the physics area, such as Monte Carlo sampling.

Introduction

For most of the last century, the roles of private and public actors in the transport sector were clear. For instance, public authorities were generally in charge of financing and building new infrastructures. Nevertheless, an inflexion was observed during the 1990s with a significant development of public–private partnership (PPP). This is paradoxical since the most profitable lines were already service and the subsequent projects show a financial IRR below the self-financing level. The paradox of the appearance (or reappearance) of the PPP in these circumstances has already been explained by Bonnafous (2001, 2002) who deals with the formalization of the need of subsidies we will propose in paragraph 3.

This paper deals with the new issues raised by the PPP system or, more generally, by any system in which the new infrastructure is partially financed by its users. Is there, in this case, a new economic rationality of

public authorities? Particularly, is there an optimal way to rank projects?

Section snippets

The encounter of public and private investors

Before answering to these questions, we have to recall the logic of investment for both the private operator and the public sector in order to explore the financial logic of a PPP. From the classical point of view of microeconomics, it is assumed that a private operator implements a project if the expected IRR covers:

- the market interest rate,…
- plus a risk premium which takes account of the uncertainties that necessarily affect assessments of, for example, costs and future traffic and revenue,[1]…

…

A fundamental relationship

In order to formalize this relationship we shall consider a standard project for which an investment C will be made for a duration d, which is the number of years over which it has been assumed that expenditure will be evenly spread. The net profit made by the operation of the project once it has come into service is denoted by a, and it has been assumed that this will increase by an annual amount b.

This corresponds to the stylized, but nevertheless quite familiar, account of costs and benefits …

Concavity and tyranny of the financial profitability

What is of prime importance to us in this function is clearly the relationship between τ and δ. However, Eq. (5) also shows that this relationship obviously depends on the values of the parameters c, d, a, b and, of course, α_0, which characterize the economics of the project and which are moreover linked together by Eq. (4) which established the IRR of the project α_0. If we wish to represent Eq. (5) we, therefore, need to keep some of these five parameters constant and vary just those whose…

How to find the optimal order for a set of PPP projects?

To confirm this point, we will take the set of 17 toll highway projects for which homogeneous economical data can be obtained.[4] Subsidizing rates have been calculated from Eqs. (4), (5), taking 8% as the target IRR. We assume that there exists a budget constraint …

Simulation approach to optimization

Let us present briefly the three most widely used methods. First, the ‘simulated annealing’ (Kirkpatrick et al., 1983, van Laarhoven and Aarts, 1992) method mimics the way physical systems approach thermal equilibrium. The system is taken to a high ‘temperature’ (introducing disorder, which allows to explore a

large number of configurations), then 'cooled' slowly, hoping that the internal dynamics of the system will steer it towards the optimum configuration, as happens with crystallization of…

Conclusion

Let us summarize here our three main results, which may seem paradoxical but are a direct consequence of the present financial constraints.

1. When financial constraints are tight, the social return of a program of investments is higher when projects are ranked according to their pure financial characteristics (such as financial IRR), instead of their pure socioeconomic characteristics.…
2. We have also confirmed the *hybrid* optimum ranking criterion: the 'output', defined as the ratio of the…

…

References (6)

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From Natural to Artificial Swarm Intelligence
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2022, Socio-Economic Planning Sciences

> *Citation Excerpt :*
> …While implementing ICT projects through the PPP, economic valuation is considered beforehand to effectively address the value for money for both partnering parties [25]. The most commonly used valuation method is the internal rate of return (IRR) of the project, which is an alternative way of using the net present value (NPV) of the project [26]. The IRR is more suitable because of its ability to account for the value for money when discounting factors are included.…

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>
> …These are consistent with a cost–benefit analysis framework, but are difficult to apply to tourism development. However road infrastructure is sometimes evaluated in terms of changes in regional economic activity, in part because those impacts may be relatively easy to predict (Bonnafous and Jensen, 2005; Maudos et al., 2005). Often investment in tourism infrastructure requires evaluation in terms of potential expansion of the tourism base, tourism expenditure and contribution to economic growth (Dwyer et al., 2004; Banerjee et al., 2015, in press), which is difficult to reconcile with evaluation frameworks such as cost–benefit analysis.…

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>
> …Simulation techniques are widely applied. For example, by applying discrete optimisation and standard techniques such as Monte Carlo simulation, Bonnafous and Jensen (2005) created a model for identifying the most efficient program for investments, taking into account the partial incomes of individual projects. The paper presented a theoretical approach and an explanation of the method, but no application to specific problems was covered.…

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>
> …The IRR technique has been used in the literature to evaluate project viability. Examples include decision economic models for parking facility planning in urban locations (Merino, 1989), ranking of the transportation projects by their financial rate of return (Bonnafous & Jensen, 2005), sensitivity analysis of various transportation investment projects (Borgonovo & Peccati, 2005), and testing the feasibility of multiple agency development projects (Khasnabis, Dhingra, Mishra, & Safi, 2010; Khasnabis, Opiela, & Arbogast, 1982). For joint public private projects, questions are often raised

about the inclusion of externalities, or social costs/benefits such as: environment damages, pollution, savings in travel time, and in travel cost, etc., that are not reflected in the markets (Johnson & Kasarda, 2007)....

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☆ An earlier version of this paper was presented to the 10th World Conference on Transport Research in Istanbul, Turkey (4–8 July 2004) and was awarded the prize of the best communication of the Conference.

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