

INNOVATIVE MODELS FOR THE ECONOMIC ANALYSIS OF INVESTMENT RISK AND FOR ESTIMATING THE EXTRA-FINANCIAL EFFECTS OF INTERGENERATIONAL PROJECTS

Abstract

Premise and research topic. The *ex-ante* assessment of the investment risk for civil works is an essential part of the decision-making process. In fact, when it is not possible to express with certainty forecasts on the critical variables of a project, both practical requirements and regulatory guidelines make it necessary to consider the risk by evaluating economic performance indicators in stochastic terms. In this regard, it is worth emphasising from the outset that EU and non-EU regulatory references explicitly require the investment risk rates to be included, in relation to the size of the project and the availability of necessary data.

It is necessary to distinguish the issues related to the estimation of investment risk in the two cases of: (i) *financial evaluations*, i.e. made from the point of view of the private investor; (ii) *economic evaluations*, i.e. carried out from the point of view of the public operator, who aims at maximising the welfare of the community.

With reference to case (i), the main limitation of investment risk analysis is the lack of acceptability thresholds in the legislative framework. This makes it difficult to make economic judgements based on shared criteria and objective data.

In the case of economic evaluations (ii), in addition to the problems mentioned above, there is the need to give due “weight” to the environmental, social and cultural externalities of the project. In this regard, the result of the Cost-Benefit Analysis (CBA) is significantly influenced by the choice of the Social Discount Rate (SDR), a parameter that allows to make the Cash Flows economically comparable when they occur at different times from the moment of the evaluation. However, the use of traditional discount procedures - based on constant rates - ends up underestimating costs and benefits progressively further away in time, not guaranteeing in the long run a balance between environmental integrity, intergenerational equality and economic efficiency.

Research purposes and novelties. With reference to *financial evaluation* (i), the aim is to characterise an innovative risk management model able to support the investor in the decision-making process by overcoming the limitations and criticalities identified. This can be done firstly by defining the minimum levels of acceptance of the investment risk; then by characterising a methodology for the estimation of the threshold values. With regard to the definition of threshold values, the novelty is the use of the As Low As Reasonably Practicable (ALARP) logic, which has never before been used for the economic assessment of investment risk. According to the ALARP principle, which is used whenever the risk of loss of human life has to be estimated, the risk assessment is related to two thresholds: the threshold of acceptability and the threshold of tolerability. Specifically, a risk is defined as ALARP if it falls between these two thresholds, i.e. if the costs of mitigating the risk appear disproportionate to the benefits to be gained. Once the risk acceptance criterion has been established, it is necessary to define a methodology for estimating the limit values of acceptability and tolerability of the project risk. The idea is to use both the Capital Asset Pricing Model (CAPM) and statistical survey tools, thus making it possible to estimate risk thresholds according to both the investment sector and the territorial context in which the project is located.

In the case of economic evaluation (ii), the aim is to define an evaluation protocol that considers both the investment risk, which tends to increase over time, and the need to give due weight to the environmental and social impacts of the project: while it is true that these terms are not known with certainty, the joint “risk-discounting” effect would lead to underestimating significant environmental and social effects.

If the reference for the evaluation of the investment risk is again the ALARP logic, the main novelty concerns the characterisation of an innovative model of economic-environmental discounting that allows to estimate a discount rate of the strictly economic components different from the one to be used for the evaluation of the environmental externalities. There are two main innovative elements of the model: the first concerns the definition of environmental quality as a function of the Environmental Performance Index (EPI), which makes

it possible to establish how close countries are to achieving the UN's 2015 Sustainable Development Goals; the second novelty concerns the growth rate of consumption, modelled as a risky variable.

Findings. The estimation of risk acceptability and tolerability thresholds to be used in financial evaluations is conducted for both the European and Chinese economic context in the following sectors: Engineering-Construction; Environmental & Waste Services; Green & Renewable Energy. The calculations show that the risk thresholds differ significantly depending on the country and the investment sector. Specifically, these thresholds have much higher values in China than in Europe, due to the different systematic risk.

The estimate of the discount rates to be used for Italy and China shows how the higher uncertainty related to environmental quality compared to the uncertainty on the evolution of the macroeconomic framework, leads to a lower environmental discount rate than the economic one. In addition, the faster decreasing functions of the economic discount rate and the environmental discount rate for the Chinese economy show that China has a more pressing need to invest in green projects than Italy.

Finally, the application of the proposed model to an investment programme for urban development in China, along the route of the Belt and Road Initiative (BRI), allows to effectively guide the analyst in the selection of risk mitigation and residual risk of the investment.

Practical and social implications. The two models that the research outlines for investment risk management allow for a consistent triangular balancing of risks, costs and benefits, making the entire decision-making process more transparent and rational.

In addition, the study demonstrates the weight of the Social Discount Rate on the outcomes of economic evaluation. The use of dual and declining discounting allows to give a fair value to environmental damages and benefits that are more distant in time: the use of conventional discounting procedures would lead to unsustainable choices, as the decision-maker would be oriented towards investments with high initial returns, but with long-term environmental repercussions. Remarkable are the policy implications that research results can bring about in terms of a more sustainable allocation of resources.

Structure of the work. It is divided into seven chapters. The first chapter analyses the critical issues of Cost-Benefit Analysis with respect to: the assessment of the investment risk, the choice of the analysis time horizon, the estimation of the discount rate. Chapter 2 deals with a critical review of the relevant literature. The third and fourth sections are devoted to the characterisation of the protocol for project risk management, respectively in the case of financial and economic evaluation. A relevant part of section 4 is the definition of an innovative econometric model of economic-environmental discounting.

The last part of the paper deals with the application case, an investment programme in support of the Belt and Road Initiative (BRI). The case study was selected during the research semester at the School of Economics at Shanghai University. Section 5 describes the initiative under analysis, section 6 reports the implementation of the proposed model and returns the results, section 7 renders concluding remarks and relevant economic policy implications.

Keywords: Economic evaluation of the projects; Cost-Benefit Analysis; Investment risk; ALARP logic; Social discounting; Environmental externalities.