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# Risk Assessment for Development Projects: An Integrated Approach

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**Abstract:** Aim of the study is showing, with particular reference to the assessment of an infrastructural investment to be implemented in a developing country, one possible evaluative pattern that, using different but integrated analytic tools, allows to face the problem of estimating induced impacts, whose attainment and amount depends on the behaviour of the community, not directly controllable by the Decision Maker and so, uncertain.

**Key words:** Risk, uncertainty, evaluation methods

## INTRODUCTION

The evaluation of public development projects is a very complex procedure. Such a complexity is due to not only the difficulty to estimate the benefits flow generated by the investment, but mainly because of the uncertainty of the starting hypotheses of the estimation it self.

Development investments main justification, in fact, is not to be found just in the benefits directly yielded, but in its capacity of inducing people to realize new investments (from now on induced investments) so as to start up a territorial virtuous development circuit (Baker, 2000).

In such cases, by using the usual economic tools, public agent cannot control the critical variables dynamics strongly influencing the investment final outcome, because they mainly depend on choices and behaviors of other operators.

In these cases, a correct assessment of investment induced benefits amount is crucial (Bamberger, 2000).

The most widespread traditional approach, used for development project evaluation (from now on classical approach) (Brent, 1990; Snell, 1997; EU Commission, 2008) is that one of defining a "reference" scenario (from now on $S_{ref}$) and treat it as if it were certain, even though it is only the most probable scenario, the modal scenario.

The achieved results are, then, normally subjected to sensitivity analysis in order to verify their robustness and reliability referring to the behaviour of parameters for which an absolute variation of 1% around the best estimate gives rise to a corresponding variation of not less than 1% in the NPV (i.e., elasticity is unity or greater) (Iman and Helton, 1988; Mohr, 1995).

This most widespread approach suffers the limit of considering as "certain" the attainment of $S_{ref}$, even though decision maker has no control on people who are the ultimate agent of development activation, as they are responsible for "induced" investment implementation and, so, for "induced" benefits attainment (Aven and Heide, 2009; Aven and Nokland, 2010). For such reasons we believe that classical approach is misleading.

Estimation of induced impacts, therefore, must be tackled using different paradigms.

The following paragraph is going to describe a possible integrated approach for development project assessment. The proposed evaluative pattern begins with the results generated by the classical approach and is enriched by further steps, based on different techniques and sequentially articulated, so that each step generates new useful information for developing the following one. Such a scheme allows both to deepen the information produced by the evaluative process and to guarantee more decisional transparency.

## AN INTEGRATED EVALUATIVE APPROACH

The proposed evaluative pattern (Monacciani, 2008) is composed of three different consecutive phases, following the classical analysis.

The first step (phase 1) consists in building up a reversal scenario[1] (from now on $S_{rev}$), starting from a coherent set of underlying hypotheses that should happen in order to obtain a sufficient amount of induced benefits (from now on $B_{ind}$) to justify the monetary expenses for project implementation and management.

The $S_{rev}$ underlying hypotheses represent a benchmark easily comparable with economic-statistic values of analyzed territory, in order to help the decision maker in evaluating if those forecasts are easily achievable or not.

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[1]The reversal scenario implies a NPV equal to zero and an IRR equal to opportunity cost of capital

According to us, the results of this kind of analysis are very useful as they give a first, rough information about the size of benefits that should take place in order to economically justify the development project implementation.

Once verified the reversal hypothesis plausibility, the second step (phase 2) consists in implementing some scenario analysis, starting from the results obtained in the reference scenario, elaborated within the "classical" analysis approach.

In fact, as reference scenario underlying hypotheses are not "certain" in terms of their fulfilment, verifying the investment feasibility in case of different amount of induced investment is a necessary procedure.

For example, one can build two different contrasting scenarios, optimistic ($S_o$) and pessimistic ($S_p$), based on different coherent induced investment hypotheses.

New scenarios could be obtained, for example, by increasing or, respectively, decreasing the amount of reference scenario estimated induced benefits, of a certain measure that is probably the highest (lowest) achievable.

The results of such analyses allow to widen the information available for the Decision Maker because, starting from results of $S_{ref}$, $S_o$ e $S_p$ and from their underlying hypotheses, it is easy to understand the leeways of uncertainty between which investment decision must be taken.

The last step (phase 3) of proposed evaluative pattern aims at understanding the investment risk rate, that is the probability of achieving one result or another (Helton and Davis, 2002; Kaplan, 1997). According to our model, this information can be obtained through a three sub-steps pattern (phases 3a, *3b and 3c*), based on various methods differing from each other for what concerns the depth of knowledge the decision maker has to have about the aleatory variables behaviour.

Each step aims at producing new information, useful both for implementing the following one and for deepening analyst global knowledge about investment risk and about the main variables causing it.

In particular, the first sub-step (phase 3a) consists in deriving inductively, directly from the evaluative model already presented, the set of probabilities associated to the two contrast scenarios ($S_o$ and $S_p$). Such an information can be derived from a backward calculation of the contrast scenarios ($S_o$ and $S_p$) probability, so that the two scenarios outcome weighted sum equals the reference scenario outcome.

One must simply solve the following two equations system:

$$(P_o * V_o)+(V_p * P_p) = V_{ref}$$
$$P_p = 1 - P_o$$

where, $P_o$ and $P_p$ are So e $S_p$ probabilities; $V_o$ and $V_p$ are $S_o$ and $S_p$ NPV (calculated in phase 2) and $V_{ref}$ is $S_{ref}$ NPV (calculated in "classical" analysis).

The solution of this system let us find the value of $P_p$ and $P_o$, implicitly associated by the model to $S_o$ and $S_p$[2], so that the NPV expected value is exactly equal to modal scenario NPV.

Such an analysis lets the analyst quantify the hypotheses allowing to interpret the reference scenario as the expected scenario.

Considering the simplicity in generating such information, the described procedure can be usefully repeated with reference to reversal scenario.

Next step (phase 3b) consists in refining the obtained results through a direct explicitation of probabilities by the analysts, basing on information produced during former evaluative steps (Clemen and Winkler, 1999).

The availability of such probabilities, even if based on analysts subjective perceptions, allows to calculate investment expected value as the weighted sum of all the implemented scenarios.

So, investment expected value $V_a$ can be obtained as following:

$$V_a = \Sigma_j V_j * P_j$$

with j = 1…J and $\Sigma_j P_j = 1$ where, $V_j$ is the value attained to further j evaluation scenario; $P_j$ is the probability associated by analysts to further j evaluation scenario[3].

The so obtained mean scenario can be considered as the "reference" scenario, now correctly estimated; on the contrary, the latter is usually built on analyst's aprioristic perceptions of future and uncertain events.

Last step (phase 3) of evaluative pattern consists in calculating the probability distribution of investment economic index (NPV and IRR), using Monte Carlo method (Hertz, 1964; Hertz and Thomas, 1983).

With regard to the latter, Monte Carlo method very often suffers the limit deriving from the aleatory variables probabilistic behaviour lack of knowledge (Bedford and Cooke, 2003; Savvides, 1994).

According to us, such a problem could be bridged if Monte Carlo method is used as last step of the proposed evaluative pattern. In fact, optimistic, pessimistic and reference scenarios underlying hypothesis can be used

[2]$P_p$ and $P_o$ are not explicitly set by the analyst, but they are implicitly assumed by him while defining the two contrast scenarios underlying hypotheses. In other words, $P_p$ and $P_o$ implicitly depend on the values of variables mix chosen for building $S_o$ and $S_p$. As $P_p$ and $P_o$ are not directly and exactly quantifiable by the analyst, the described equations system can help him calculating them, thus verifying if the $S_o$ and $S_p$ underlying hypotheses are well balanced or not.
[3]Modal scenario $S_{ref}$ should be, of course, the one with the highest probability.

as inputs for constructing probability distribution of critical variables.

In particular, when evaluating development investments, the critical variable to focus on is the amount of induced investments stimulated in each economic field. Regarding to that, analyst can assume a triangular probabilistic behaviour, whose maximum, minimum and mean values can be traced back to the contrast scenarios ($S_o$ and $S_p$) and by the correctly estimated reference scenario.

In this way, some software[4] allow both to easily calculate the NPV and IRR probability distribution associated to the "critical" variables statistic behaviour, and to determine which are the variables whose value mainly influences the investment outcome, thus giving the decision maker the chance to identify the most useful policy instruments to reduce their effect.

## A CASE STUDY: THE EVALUATION OF A HIGHWAY IN A DEVELOPING AREA

The proposed evaluative pattern has been experimentally tested within a Feasibility Study (PTI, Proger, ETEC, 2004) of a highway to connect the cities of Casa el Tyr and Al Maasna in southern Lebanon.

The aim of such an investment is both technical-political, and economic, as spill over effects in agriculture, industry, tourism and services are assumable.

In particular, considering that the new infrastructure will stimulate other induced investments[5], a high GDP growth, as shown in Table 1, is supposable.

Adding direct transport benefits flow to estimated incremental GDP flow, investment NPV and IRR have been calculated, thus showing the economic feasibility of the highway (Table 2).

After "classical" analysis, the proposed evaluative pattern has been implemented.

In particular, reversal analysis, whose main outcomes are shown in Table 3, allowed to determine the coherent hypothesis set, referring to the amount and growth rate of induced investments, necessary to obtain a NPV equal to zero and an IRR equal to 5%.

Implementation of reversal analysis brought to the conclusion that in order to justify investment and operational highway costs, during the first year after opening the infrastructure, community should make investments for about 305 million euros in agricultural, industrial, tourist and tertiary field. At this point, it is enough the above mentioned investments rise up at a rate quite limited (Table 3).

Such hypotheses and their related results have, then, been compared with real statistic data observed in

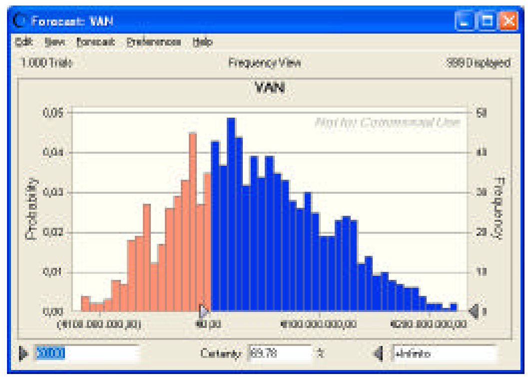
Table 1: Development hypotheses: reference scenario

| Factor | Turism | Agriculture | Industry | Services |
|---|---|---|---|---|
| Total investments* | 135.822.000 | 101.867.000 | 40.747.000 | 27.165.000 |
| Incremental GDP* | 9.507.540 | 6.112.020 | 4.074.700 | 2.716.500 |

*Values referring to first year after opening the highway

Table 2: Economic indexes: reference scenario

| | |
|---|---|
| NPV | € 6.161,75 |
| IRR | 5,3% |



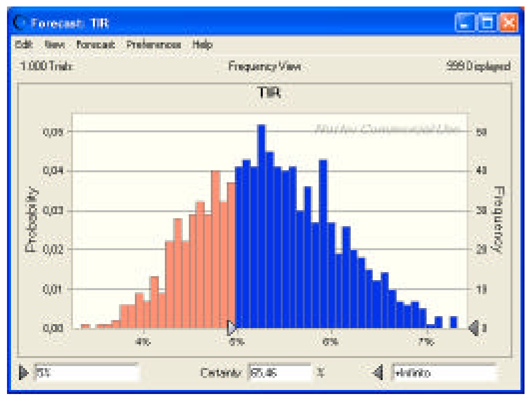




Fig. 1: (a) NPV and (b) IRR probability distribution

Lebanon, in order to verify that the model estimated values were not so different from reality.

In order to verify highway feasibility with different rate of economic growth, then, two alternative scenarios, based on different induced investment growth hypotheses (+30 and 15% than the reversal scenario), have been built.

Table 4 shows profitability indexes for each implemented scenario, comprised between -50 and 100 millions euro.

Afterwards, optimistic and pessimistic scenarios probabilities implicitly set by the model have been calculated, in order to obtain a NPV expected value equal to that of reference scenario.

[4]Some useful software for performing risk analysis with Monte Carlo method are: "©RISK", produced by Palisade Corporation, Decker Road 31, Newfield, NY 14867, USA; "CRYSTAL BALL" produced by Decisioneering Inc.

[5]Read [Monacciani, 2008] for details.

Table 3: Reversal scenario: main hypotheses and results

| Factor | Turism | Agriculture | Industry | Services |
|---|---|---|---|---|
| Tot. induced investments * | 135.821.383 | 101.866.037 | 40.746.415 | 27.164.277 |
| Incremental GDP | 9.507.497 | 6.111.962 | 4.074.641 | 2.716.428 |
| Incremental GDP / Highway investment costs* | 1,37% | 0,88% | 0,59% | 0,39% |
| Incremental GDP due to highway construction* | 4.074.641 | 2.037.321 | 1.222.392 | 814.928 |
| Incremental GDP due to highway construction */ Highway investment costs | 0,59% | 0,29% | 0,18% | 0,12% |
| Sector mean growth rate | 4% | 5% | 21% | 6% |
| Highway generated benefits PV | 55.611.289 | 30.405.602 | 166.755.757 | 13.328.138 |
| Highway generated benefits PV/ Highway investment costs | 8% | 4% | 24% | 2% |
| Highway induced benefits PV | | | 266.100.787 | |
| Investment cost covering rate | | | 38% | |

* Values referring to first year after opening the highway

Table 4: Profitability index for each scenario

| Scenario | NPV | IRR |
|---|---|---|
| Reversal | € 0,00 | 5% |
| Optimistic | € 99.787.795,13 | 6% |
| Pessimistico | -€ 49.893.897,57 | 4% |

Table 5: Risk analysis with analysts perception based probabilities

| Resutes | NPV | IRR | Probabilities |
|---|---|---|---|
| Reference scenario | € 6.161 | 5% | 50% |
| Optimistic scenario | € 99.787.795 | 6% | 30% |
| Pessimistic scenario | -€ 49.893.897 | 4% | 20% |
| Expected value | € 19.960.639 | | |

Such analysis allowed to determine that model underlying hypothesis was that probabilities related to optimistic and pessimistic scenario were, respectively of 67 and 33%.

Being those probabilities too unbalanced, highway expected value has then been "corrected" by the analysts through a direct explicitation of personal, perception based probabilities associated to the implemented evaluation scenarios (Table 5).

In this way, investment expected value is about 20 millions €.

The so obtained investment mean value can be considered as the "reference" value, now correctly estimated.

Using Monte Carlo method, then, IRR and NPV probability distribution have been estimated. Figure 1a and 1b show the entire range of possible outcomes (derived by 1000 random trials) and the likelihood of achieving each of them; blue coloured bars represents the statistical likelihood of getting NPV>0 and IRR>5%,while brown coloured bars show the probability of getting worse results.

Such analyses show that even though investment might bring to a negative outcome, investment risk is not so high because there is a 69.8% chance that NPV>0 and a 65,46% chance that IRR>i.

In addition to this outcome, Monte Carlo method analysis has shown that investment risk derives mainly from investors' behaviour in industrial field.

Such an information, according to us, is very important as it gives the decision maker the chance to identify and propose the most useful policy instruments to stimulate private investment right in that field, so contributing to the activation of a development virtuous circle and, thus, reaching the final goal of public investment.

## CONCLUSIONS

The usefulness of this work goes beyond the specific case study outcomes and resides in showing how traditional approach for development project evaluation, that treats uncertain variables as certain, is completely unsatisfactory.

On the contrary, the proposed evaluative pattern, allows outcomes to converge within a reduced and defined range of solutions, by generating new information at each step: everything precise for logic and clear for methodology.

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