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Net present value approach: method for economic assessment of innovation projects

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Abstract

This paper is dedicated to the issue of innovative performance measurement. It focuses on techniques that can be employed for evaluation of single innovation project. The framework is based on detailed literature review and net present value (NPV) approach analysis. Furthermore, the paper investigates its pros and cons and discusses methods able to deal with NPV weaknesses. Used with care, these techniques can guide the management of innovation project by providing indications of its potential financial value.

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Keywords: Net present value; innovation projec; desk research.

1. Introduction

The scientific aim of the paper is to gain knowledge and analyse the present status of innovation projects and their performance measurement by net present value (NPV) approach as it pertains to the Czech and especially foreign professional literature. In addition, it is also important in terms of innovation management, which is a field of science, and also of related disciplines, specifically strategic management.

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If we want to assess the success of innovations, we need to choose a type of criteria to be used for the assessment. There are several ways to innovation project performance assessment, from identifying barriers that might threaten the process, pre-setting criteria for individual stages of the innovation project to economic evaluation (Muska et al., 2009). Hauschildt (2007) recommends the following three types of criteria to measure innovation success:

- technical,
- economical,
- others.

This paper is intended to assess the economic performance of the innovation projects of the company. Methods for economic analysis are currently the most diffused methods for evaluation of innovation projects (e.g. Ryan and Ryan, 2002). Although the existing methods largely differ in their implementation, they all share a common principle, that is, the capital budgeting approach for calculating the economic return of a project as a sequence of discounted cash flows (Chiesa and Frattini, 2009).

Probably the most popular and most sophisticated economic valuation technique is the NPV approach. It consists in discounting all future cash flows (both in- and out-flow) resulting from the innovation project with a given discount rate and then summing them together (see Equation 1). The merit of innovation is measured considering its contribution to the creation of economic value out of the investment needed. This technique offers many variations (see Copeland et al., 2010) but it basic principles and limitation will be discussed in this paper.

Equation 1. Net present value (Khan, 1999)

$$NPV = \sum_{t=0}^{n} \frac{NCF_t}{(1+r)^t}$$

Where NPV = net present value; NCFt = net cash flow generated by innovation project in year t;
r = discount rate.

The first principle of NPV approach is that a risky Euro tomorrow is less valuable then a certain Euro today. Hence future cash flows are discounted each year. The discount rate reflects the opportunity cost of the capital mobilized, which increases with the estimated riskiness of the innovation opportunity. Indeed, riskier projects are expected to provide higher returns. This means that such an approach is risk-adjusted, while other metrics such as ROI or IRR are not (Gaily, 2011).

In its basic application the discount rate is calculated looking at the "real" cost of capital employed in the innovation, that is, by calculating the weighted average cost of equity and debt used to finance the project. For small projects, where it is rather difficult to identify the quotas of equity and debt used for financing a single project, the cost of capital – also named WACC (Weighted Average Cost of Capital) – is usually assumed to equal the cost of capital of the whole company, that is, it is calculated using annual report data that take into account the firm's overall equity and liabilities (Chiesa and Frattini, 2009).

Typical discount rates used for corporate projects range from 10 percent to 15 percent, while investors in high-tech start-ups can use rates of up to 25 percent to 30 percent, as a result of the inherently risky nature of such ventures.

The second principle of the NPV approach is to take into account all the future net cash flows linked to the innovation opportunity. By contrast, metrics such as the pay-back period or upfront investments consider only the initial cash flow.

The NPV approach requires on the one hand the discounting and summing-up of all the future net cash flows for which reasonable assumptions can be made, and on the other hand to estimate and discount the final value of the remaining cash flows (the "final" value). The value of the innovation projects is then equal to the sum of the discounted cash flows considered plus the final value.

The final value can then be estimated either as zero (in the case of an innovation facing complete obsolescence), negative (in the case of an innovation involving rehabilitation or recycling costs, as, for example, in the energy sector) or as a proxy of future cash flow based on resale value, balance-sheet metrics or "perpetual" value.

There are three main sources of attractiveness of the NPV approach:

it associates a cash value with an opportunity, rather than a time period or a relative rate, it allows the consideration of projects with different risk profiles; riskier projects being discounted more heavily,

it does not involve setting an explicit arbitrary threshold such as a minimum rate of return or a maximum pay-back time (Gaily, 2011).

On the other hand, the NPV approach also has strong limitations when is used to assess innovation opportunities, which are often ignored or underestimated. The criticism of many scholars (e.g. Kester, 1984; Hodder and Riggs, 1985; Chapman and Cooper, 1987; Brealey and Myers, 1996). Their criticism has focused on:

The calculation of the discounted rate – the discount rate in the evaluation of innovation projects should be made of two elements (Doctor et al., 2001):

a risk-free rate accounting for general risk and usually considered to be the interest rate offered by short-term government bonds,

a risk-premium rate to take into account the perceived risks (financial, technical and commercial) associated with the specific project. The use of WACC, on the contrary, allows the evaluator to account only for the financial risk and does not differentiate among projects.

The definition of cash flows in the long term horizon – the use of NPV requires definition of the exact value of the cash flows to be discounted for each time period considered in the evaluation. This value could be rather difficult, if not impossible, to determine for those innovation projects having great potential in the long term, but for which managers are unable to make a proper evaluation. Again, NPV appears to discriminate unreasonably against longer term and more risky projects.

2. Method

The purpose of this paper is to provide systematic and updated overview of the innovation project evaluation with the help of net present value (NPV) approach as well as to address some important gaps in the existing research on innovation evaluation and performance measurement.

The paper is based on literature analysis of NPV approach. The system approach and analysis and comparison are applied in this paper. Analysis is used as a method of acquiring new knowledge and for its interpretation. When processing secondary data, the secondary analysis method was used. The professional literature, and particularly foreign resources, provided a source of secondary data. Comparison is used when various NPV approaches are compared in discussion section.

The first part reviews the literature and presents a brief description of NPV approach as well as benefits and strong limitations of NPV. The next section discusses potential methods able to deal with NPV weaknesses. Finally, the last section summarizes the findings and gives a proposal for future research.

3. Results

In order to address NPV weaknesses and to develop methods for economic analysis able to deal also with longer term and higher risk projects, a number of adjustments have been proposed to traditional NPV. Among them three methods will be discussed below:

- risk-adjusted NPV,
- certain equivalent NPV,
- stochastic NPV.

3.1. Risk-adjusted NPV

Risk-adjusted NPV based on the approach of Stewart et al. (2001) takes into account the costs, risks and time to obtain a realistic value of innovation project. In their model, the development that entails a risk is considered by multiplying the payoff with a probability which reflects conclusion of the development process and the generation of sales. The associated costs multiplied by the probability of successful conclusion of the development process are subtracted from this (Stewart et al., 2001).

Equation 2. risk-adjusted value (Steward et al., 2001, p. 815)

$$rV = PR_0 - \sum_{i=0}^{n} C_i R_0 / R_i$$

Where rV = risk-adjusted value; P = payoff; R0 = current risk; Ci = associated costs; R0/Ri = the likelihood of having to pay each cost.
The risk-adjusted NPV is accordingly calculated as follows.

Equation 3. risk-adjusted NPV (Steward et al., 2001, p. 816)

$$rNPV = NPVPR_0 - \sum_{i=0}^{n} NPVC_i R_0 / R_i$$

Where rNPV = NPV of the risk adjusted payoff minus the sum of the NPV of the risk-adjusted costs; NPVPR0 = NPV of the risk-adjusted payoff; R0 = current risk; NPVCiR0/Ri = sum of the risk-adjusted costs.
To measure the future financial surpluses with decision alternatives, the cash flows are discounted by a suitable interest rate to a key date, in a fashion similar to the DCF approach. The period-specific cash flows are weighted with the associated probabilities of success and probabilities of occurrence, with the innovation risks also considered. Locke (1990) states that the discount rate should be adjusted to consider explicitly the aforementioned two basic elements: the risk-free rate and the project specific risk premium. The cash flows for all the other periods, which grow at a constant rate of growth g, are included in the remaining part of the rNPV calculation (Steward et al., 2001 or Kaufmann and Ridder, 2003).
The use of rNPV can lead to a reasonable value for an innovation project. This clear approach to valuation can support the company in its search for an investor financing even at the early stages of research (Kaufmann and Ridder, 2003).
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Equation 4. risk-adjusted NPV (Kaufmann and Ridder, 2003, p. 448)

$$rNPV = \sum_{t=0}^{n} \frac{CF_t R_0}{(1+r)^t R_t} + \frac{R_0 CF_{n+1}}{(r-g)(1+r)^n}$$

Where rNPV = risk-adjusted NPV; CF_t = cash flow in period t; R_0 = the present probability of successfully concluding the development process and as a result of making sales; R_t = the probability as considered in period t of successfully taking the product to market maturity ($p_{t,8}$ with t>1); R_0/R_t = the probability as considered today generating the cash flows arising in period t, i.e. of reaching period t or attaining this stage of development (corresponds to $p_{1,k}$); r = discount factor; n = the last period for which costs and revenues are accurately planned; g = growth rate.

Literature documents the use of risk-adjusted NPV applications for innovation project evaluation in different industries (Chiesa and Frattini, 2009). On the other hand, several criticism have been levied at risk-adjusted NPV (Schmeisser, 2010). In order to take into account the specifics of some industries, a stochastic NPV has been developed based on expected NPV approach by Kellogg and Charnes (2000).

3.2. Stochastic NPV

Stochastic NPV goes further in considering each component of cash flow as a stochastic variable, with a given distribution of probability (usually a normal distribution), a mean value and a variance. For example, the revenues of a project aimed at substituting an existing product in a consolidated market might be characterized by a relative low variance and a mean value that is closely linked to current revenues. However, if the same project requires a technology the company has never managed before, development costs might be characterized by a huge variance and have as mean value the result of a reverse engineering effort made by the company on existing

applications of this technology. NPV is therefore, in turn, a stochastic variable with an associated probability distribution (Chapman and Cooper, 1987; Ho and Pike, 1992; Raftery, 1994).
The expected value of the NPV is obtained as:

Equation 5. Expected NPV (Chiesa and Frattini, 2009, p. 69)

$$E(NPV) = \sum_{t=0}^{n} \frac{E(NCF_t)}{\left(1 + r_f\right)^t}$$

Where E(NPV) = expected NPV; $E(NCF_t)$ = the expected value of the net cash flow in each year t; r_f = the risk-free rate.

Also in this case, indeed, risk is neutralized in the estimation of cash flows. The overall risk of the project can also be calculated by the dispersion of the values of NPV, that is, through its variance, standard deviation or dispersion coefficient (Chiesa and Frattini, 2009).

Expected NPV approach distinguishes between two different cash flows and discount factors. The R&D phase is distinguished from the actual market phase by using a "Discovery cash flow" as opposed to a "Commercialisation cash flow". The Discovery Cash Flow stands for the cash flows of the development process that are discounted by a discount factor. If the product is still under development, this expected value must also be weighted with the relevant probability of occurrence. The Commercialisation cash flow stands for the cash flows which occur after marketing of the product. This is discounted at a rate of interest that is greater than the discount rate for the Discovery cash flow. It is also weighted with a probability of occurrence and additionally with a quality factor (Schmeisser, 2010).

3.3. Certainty Equivalent NPV

Certainty Equivalent NPV The certainty equivalent, developed by Robichek and Myers (1965, 1966) and underlying a well-known model for evaluating financial options (Merton, 1973), is the certain cash flow that a risk-averse investor wou1d be willing to exchange for a risky cash flow. In other words, instead of adjusting the discount rate, certainty equivalent NPV adjusts future cash flows generated by the project taking into account their risk through introducing a coefficient α, ranging from 0 to 1 as in Equation 6. It is worth mentioning that, the risk of each cash flow being neutralized by the use of the coefficient α, the discount rate to be applied for calculating the NPV is the risk-free rate (Chiesa and Frattini, 2009).

Equation 6. Certainty equivalent NPV (Chiesa and Frattini, 2009, p. 68)

$$NPV_{CEQ} = \sum_{t=0}^{n} \frac{\alpha_t E(NCF_t)}{\left(1 + r_f\right)^t}$$

Where NPV_{CEQ} = certain equipment NPV; $E(NCF_t)$ = expected value of cash flows in the year t; r_f = risk free rate.

It follows immediately that the higher the risk associated with a given cash flow (either because it is expected in the long term or it is related to a high "volatile" input), the lower the va1ue of the coefficient α. Tables for this coefficient can be created for use as a reference framework in the evaluation of R&D projects in a given company (e.g. Chiesa, 2001).

Although certainty equivalent NPV has been claimed as one of the most appropriate methods for R&D project evaluation (Chiesa, 2001), its applications documented in the literature are rare (Chiesa and Frattini, 2009).

4. Conclusions and Future Research

To summarize, this paper draws upon the literature about the NPV approach to evaluation of innovation projects. Given the strategic assessment of innovation project, it is possible to analyse, learn and legitimate quantified measures related to the cash flows linked to the project.

The fundamental problem in applying the traditional NPV approach (as also the rNPV and eNPV) lies in the use of average probabilities of success and probabilities of occurrence. The probability of developing a product to the point where it can be launched on the market is much higher when one has a financially strong teaming partner, and this should therefore be considered. It is therefore essential that the probability of success in the development process is modified (Schmeisser, 2010).

This paper is limited by several factors that should be addressed in future research. First, this study is grounded in a theoretical secondary data analysis. Reviewing the empirical literature published on the topic of innovation performance measurement and NPV approach implementation, it has been found out both important evidence for positive effects of utilizing of NPV for innovative performance measurement and results that shed a more critical light on expected benefits stemming from its implementation in Czech SMEs practice. This has to be examined by surveying companies with the help of questionnaires or personal interviews.

Second, it should be noted that the measurement of innovative performance was, is and always will be encumbered by a certain inaccuracy associated with the creative nature of this process. What is detrimental is the fundamental resistance of creative workers to any form of measurement and standardization of their work. However, in view of the importance of the innovative process for the development of the enterprise and the amount of resources put into it, performance measurement in this area is necessary.

Future research on individual approaches to measuring and managing innovation process performance in Czech SMEs is the objective of post-doc research project of the Czech Science Foundation No. 13-20123P. It will last till end of 2015 and includes more in-depth research. The substance of this project is to design and verify measures and approach higher credibility of future benefits prediction from innovation processes. Future research is advised to collect, where possible, objective quantitative and also semi-qualitative data on the current state of the investigated issue.

The research focuses on Czech SMEs, since they are key drivers of the Czech economy. They provide around 2 million jobs, generate more than 36% of the Czech Gross Domestic Product and represent more than 99% of all Czech enterprises (MIT of the Czech Republic, 2012).

In-depth research can help understanding the complex interaction between innovation and performance of a company. This becomes even more important in the conditions of the current changing environment and economic situation of Czech SMEs. Well managed and successfully introduced innovation into the market represents a tool for the companies, by means of which they can achieve competitive advantages and enabling their prosperity. Therefore, the effectiveness must be assessed by financial and non-financial criteria in all stages of the innovation process, from the birth of the idea to the final commercialization stage. Research outcomes will help resolve the problem of empirical assessment of the importance of individual variables in the determination of future earnings, and will propose measures for the improvement in innovation performance assessment with the use of advanced mathematical methods and models. In this country, such an approach is missing and there is still a big gap in innovation performance measurement.

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