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Budgeting for research and development: a dynamic financial simulation approach

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Abstract

The research and development (R&D) budgeting decision is crucial for at least two reasons: if too much is spent, short-term financial stability is at risk, while, if the budget is too small, long-term competitiveness is threatened. Nevertheless, many enterprises simply extrapolate the past without further reflection.

This paper presents a computer-based dynamic stochastic simulation model that allows one to assess the impact of alternative R&D budgeting policies on corporate development. The core decisions to be evaluated concern timing and funding of investments in R&D. Our approach substantially expands earlier work by Brockhoff (R&D Manage. 19 (1989) 265). In particular, it distinguishes between product and process innovation, considers market dynamics related to technical progress via a modifiable S-curve, integrates marketing, and takes into account essential financial aspects. As a result, our model is closer to reality than previous ones. A sample application with real company data illustrates its potential usage.

Keywords: Research and development budgeting; Product and process innovation; Corporate finance; Dynamic simulation; Decision support system

1. Introduction

In 1999, the member countries of the Organization for Economic Co-operation and Development (OECD) spent 2.21% of their gross domestic product on research and development (R&D). Most of these resources are provided directly by companies; for the United States, these investments totaled $ 158 billion in 1999 [1]. Even at the corporate level, the numbers are quite impressive: In the same year, IBM, for example, invested $ 4.6 billion in activities covering basic and applied scientific research in the development of new and improved products [2].

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Clearly, then, within the field of R&D management, large amounts of resources are at stake. The task of R&D budgeting, i.e. striving for the best timing as well as optimum levels of investments, is thus key for many organizations. In this regard, it is critical to avoid financial waste while seeking to achieve long-term goals. Spending too little could mean reducing future profits, while spending too much could overtax company resources. For a recent review of R&D budgeting refer to [3].

In this paper, we present a computer-based, dynamic, stochastic simulation model that allows one to test the effects of R&D budgeting rules on a firm's further development. It is an improvement over its predecessor [4] mainly because it is more realistic, treats product and process R&D separately, explicitly integrates marketing expenses, considers an S-curve interaction between cumulative R&D budgets and market dynamics related to technological progress, and embeds the funding decisions into a financial framework. Furthermore, its decision support system (DSS) provides assistance for both risk and scenario analyses. Our focus is on the simulation model that can be used as an evaluation tool for various budgeting policies. The policies themselves, however, are not at the core of our reasoning here, and will thus be explored in future research.

The remainder of the paper is organized as follows: First, we present the model and discuss salient new features of our approach. This is followed by a sample application to a real company, demonstrating the potential usage of our DSS. Finally, key features are summarized and suggestions for further research are outlined.

2. The model

Our approach substantially extends the earlier work of Brockhoff [4]. The current model thus expresses profit as a function of past R&D and past marketing budgets. For each of several planning periods, sales revenues, variable costs, as well as investments other than R&D are determined. An overall financial framework summarizes the corporation's evolution under different budgeting rules. In the following, we develop the model in detail. For an overview of its "logic-flow", refer to Fig. 1.

Throughout the paper, it is assumed that the corporation in question consists of J independent divisions j ($j = 1, \ldots, J$). To keep notation simple, we omit index j in Sections 2.1–2.4. We keep in mind, however, that this index is part of every parameter used in those sections. Another core assumption concerns the products of a given division. They should be structurally similar in terms of their R&D process, market behaviour, and cost configuration. And, finally, we assume that both product innovations that influence sales, as well as process innovations that bear on production costs, are relevant for our firm. Hence, we divide the R&D budget by innovation category.

2.1. Sales revenues

Sales of a division depends both on the characteristics of the R&D process and the underlying product life cycle. Moreover, we assume that expenditures for marketing autonomously increase sales. Overall, potential sales revenues $\text{Sales}^{\text{pot}}_{T,k,l}$ can therefore be written as the sum of two