Dynamic Portfolio Selection of NPD Programs Using Marginal Returns

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Selecting program portfolios within a budget constraint is an important challenge in the management of new product development (NPD). Optimal portfolios are difficult to define because of the combinatorial complexity of project combinations. However, at the aggregate level of the strategic allocation of resources across product lines, investment in a program is not an all-or-nothing decision, but can be *adjusted*, resulting in a higher or lower program benefit (e.g., higher or lower quality). In some cases, resources can be adjusted even for individual projects.

With this insight, one can use *marginal analysis* to optimally allocate the scarce budget. This article develops a dynamic model of resource allocation, taking into account multiple interacting factors, such as independent or correlated, uncertain market payoffs that change over time, increasing or decreasing returns from the NPD investment, carry-over of the investment benefit over multiple periods, and interactions across market segments. We characterize optimal policies in closed form and derive qualitative decision rules for managers.
(*New Product Development; Resource Allocation; Portfolio Selection; Portfolio Investment; Dynamic Programming; Marginal Benefits*)

1. Introduction

All companies that engage in new product development (NPD) face the important problem of selecting a project portfolio. Choosing the NPD portfolio practically determines the firm's strategy for the medium-term future and is senior management responsibility (Roussel et al. 1991, Cooper et al. 1998). However, portfolio decisions are difficult, because of the combinatorial complexity of allocating a scarce budget over multiple periods, because decisions have multiperiod consequences, and because the product lines have different return functions while competing for a common pool of resources and are uncertain and often interdependent (e.g., complementarity or substitution effects).

Because of this complexity, decision-theoretic models have not found widespread use in practice (e.g., Souder 1973, Schmidt and Freeland 1992, Loch et al. 2001). Managers tend to complement financial project evaluations with ad-hoc portfolio balancing tools, such as combinations of risk-return matrices and portfolio balances over "strategic" market segments and over multiple period cash flows (e.g., Wheelwright and Clark 1992, Cooper et al. 1998). While such tools do help management "think through" a problem, they lack a theoretical or empirical basis for the resulting recommendations.

The complexity of the problem is partially driven by the assumption (common to all methods used, and a common mindset among R&D managers) that a project is "in" or "out." However, at the level of a strategic business unit, top management typically does not discuss every single technical project, but allocates funds to different product lines. Thus, the allocation to a product line can be increased or reduced (almost) continuously, increasing or reduc-

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