

Strategic resource commitment of high-technology firms An international comparison

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Abstract

This study investigates the dynamics of three strategic variables across three countries in the high-technology sector. The variables under investigation are research and development (R&D) expenditure, capital expenditure (CPX), and sales and administrative (S&A) expenditure and the three countries are the US, Japan, and the UK. We estimate the contemporaneous responsiveness of each of the three strategic variables in response to changes in revenues across the three countries. We also test the statistical causality among the three variables as it impacts revenues. Based on our analysis, we observe that the highest R&D intensity is among the US firms in comparison to firms from Japan and UK. American firms maintain R&D intensity at a stable level with an elasticity of one. We find that Japanese firms have the highest R&D elasticity. Japanese firms show the highest intensity in the area of CPX, whereas American firms have the highest elasticity. Our results show a less globally integrated high-tech sector in each country.

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1. Introduction

With the increasing rate of technological change in most competitive industries, research and development (R&D) has assumed a key functional role in many firms. In the technology intensive (or high-tech) industries, its role is even more significant. Just from a pure expenditure point of view, the firms in this sector spend on average 5% of their annual sales on R&D, whereas the low-technology sector spends approximately only 1% of their annual sales on R&D (Anon., 1994). The business dictionary and the US government define high-tech industries as those involved in biotechnology, computers, audio–video equipment, electronic components, aircraft parts, spacecraft, scientific instruments, medical instruments, and photographic instruments.

However, R&D is only but one among many key variables that are strategically important to a high-tech firm. The three variables that we chose are labeled as “strategic inputs” and they are R&D expenditures, capital expenditures

(CPX), and marketing and selling (S&A) expenditures. Collectively, these three expenditures account for a major portion of a firm’s funds commitment. Funds committed by high-tech firms for these activities have greater emphasis on long-term results. For the high-tech sector, it is easier to make the case for the effects of R&D and CPX on a firm’s performance from a long-term point of view (Lach and Schankerman, 1989; Echevarria, 1997). But, the incorporation of S&A expenditures as a strategic commitment by firms needs an explanation. Marketing is an integral part of a firm’s overall corporate strategy. In the case of high-tech firms, innovations have to be successfully introduced for the long-term success of the product and viability of the high-tech companies. From a strategic perspective, corporate and brand image has to be cultivated and bolstered via direct and indirect resource commitment. Sales force efforts, advertising expenditures, and other promotional activities are necessary to successfully launch innovations and extend the lifecycle of old products. In addition, other expenditures such as after-sales service, warranties, etc. are an integral part of corporate strategy with long-term outlook. Marketing efforts in conjunction with R&D expenditures have been identified as critical drivers for new product introductions among high-tech firms (Song et al., 1997).

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However, within a firm, at the corporate level, these three variables often compete amongst themselves. Top management carries the responsibility of allocating funds for these areas in some optimal manner. The focus of this study is not on the optimality or effectiveness of a firm's expenditures but on the interaction of these three strategic variables across countries. Specifically, the objective of the paper is to (1) compare the high-tech sector firms in the three countries in terms of contemporaneous responsiveness of each of the three strategic variables to changes in sales revenues and (2) measure the statistical causality among the three variables and sales revenues.

The sample used in this study consists of high-technology sector firms from Japan, UK, and US for the years 1986–1996. These three countries collectively account for roughly 70% of the world's total R&D expenditure (Cookson, 1998). Of the three countries, Japan and the US spend far more on R&D about 5% of annual sales than UK whose companies spend about 2% (Gow, 1998).

In recent years, business leaders and policymakers have questioned the R&D efforts of businesses, especially firms in the high-technology sector. They are concerned that firms in Japan, UK, and the US underinvest in R&D. It is noted that the expenditures in the R&D area have remained stagnant in Japan and declined in the UK and the US (Gow, 1998; IDG News Service, 1998; Yoshida, 1998). These claims raise interesting questions such as: Is there underinvestment in R&D in the developed countries? What are the interactive effects of R&D and other strategic expenditures such as plant and equipment and selling and administration?

In this context, the empirical investigation of elasticities and intensities of R&D as well as other strategic inputs will help us understand the high-technology sector of each country better. Elasticity or the contemporaneous response is closely related to the changes in the intensity level of the corresponding input. For example, when the R&D elasticity is greater than 1.0, we expect the R&D growth rate to exceed the growth rate of sales. This results in a higher R&D intensity, especially in the long-term.

The second area of inquiry covers the statistical causality or precedent/antecedent relationship among changes in R&D expenditure, CPX, S&A expenditure, and sales revenue. These tests assess the adaptive and dynamic nature of the high-technology sector in the three countries. Variables are deflated by sales to control for heteroskedasticity. We also use year-to-year change in the variable rather than the level measurement of the variables, which minimizes problems due to autocorrelation and spurious regression.

2. Literature review

There has been extensive coverage of the virtues of R&D spending of firms in the US and other major industrialized countries for high-technology firms. R&D efforts result in both product innovation and process innovation. Whereas

the US predominantly focused on product innovation, the Japanese and European firms concentrated on process innovation to catch up with the advances made by the Americans. The result of these efforts by the Japanese and European firms was an efficient production system that enabled these companies to produce higher quality products at a much lower cost. However, there is no clear evidence that R&D holds the key to competitive superiority in markets (Balachandra and Friar, 1997). R&D expenditures do not yield immediate results, they offer the least certain outcome and face the toughest competitive environment (Lee et al., 1986). There is abundant evidence that industries with higher R&D intensity also show higher levels of international capital investment (Anand and Kogut, 1975).

In fact, existing studies on the relationship between strategic investments and performance of the firm have been conducted without consideration of its relationship to sales and marketing activities. R&D efforts are always viewed as a necessary activity within most high-technology companies. Meanwhile, it is generally agreed that R&D has pervasive influence on the new product innovation process and that the future success of high-technology firms, in particular, rests on their ability to create new products and market them successfully (Schmitt, 1985). As firms operate in a highly competitive and dynamic global environment, product innovation and process innovation become critical components of successful strategies for high-technology firms (Stern, 1992). Porter (1980, 1985), in his formulation of business strategy topologies, suggests that there is a linkage between strategy and technology. He also stresses the interconnection between technological leadership and competitive advantage.

While the relationship between R&D spending and sales growth is intuitively appealing, empirical evidence of a direct link is not available. There is no indication of simple clear-cut cause-and-effect relationships to be found in the existing literature. Obviously, sales, profits, and other performance measures are dependent upon a host of factors in addition to research; any relationship that might exist tends to become obscured. In a study using data from 1960 to 1986, Franko (1989) directly associates market share growth to R&D intensity. He attributes the decline of the US industry during this period to lower levels of R&D intensity compared with Japan.

Recognizing that relationship between R&D expenditures and profitability does not imply direction or causality, Branch (1974) employs a distributed lag technique with pooled time-series and cross-section data to discriminate among alternative types of time relations. The findings strongly suggest that R&D activity tends to increase both profits and sales growth. For six of the seven industries investigated, the peak impact of R&D activity on sales growth is either preceded by or simultaneous with the peak on profits. Lunn and Martin (1986) suggest that profitability and market power play a less critical role in the high-technology sector. Technological environment, advertising, and R&D can be complementary depending on the product

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