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Related diversification and R&D intensity dynamics

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ABSTRACT

Using longitudinal data of Spanish manufacturing companies, we study the dynamic, bidirectional relationship between firm research and development (R&D) intensity and corporate diversification in an organic growth setting. Our empirical approach accounts for the different sources of endogeneity. Although we find a positive linear effect of R&D intensity on related diversification, the effect of related diversification on R&D intensity assumes the form of an inverted U. Thus, the effect of related diversification on R&D intensity is positive, but marginally decreases for moderate levels of related diversification. Such an effect can become negative, however, for high levels of related diversification. Additionally, as a consequence of dynamics, the effects after one year are substantially lower than the overall effects that occur over several years.

1. Introduction

The relationship between R&D intensity and corporate diversification has attracted considerable attention in empirical research on strategic management over the last couple of decades (e.g., Chatterjee and Wernerfelt, 1991; Chen, 1996; Miller, 2006; Silverman, 1999). Although there is pervasive evidence for a linear and positive effect of related diversification on R&D intensity, empirical evidence for the effect of R&D intensity on diversification is mixed. Additionally, most empirical work has concentrated on unidirectional relationships, and evidence off the potential feedback between related diversification and R&D intensity is lacking.

We attempt to reconcile contradictory findings concerning the link between corporate diversification and R&D. We posit a dynamic bi-directional hypothesis between related diversification and R&D intensity, and we evaluate this relationship at the empirical level. The dynamic nature of such a relationship is sustained by the concepts of synergies and economies of scope. This bi-directional link emphasises the endogenous character of the relationship between corporate diversification and technological resources (Baldwin and Scott, 1987; Miller, 2004).

Most empirical studies of corporate diversification have focused on the experience of U.S.-based companies (Wan and Hoskisson, 2003). However, the institutional environment in which firms operate influences their dominant growth mode. Studies, in which both organic growth and external growth are considered, do not distinguish between the effects of these alternative growth modes. Thus, isolating the effect of organic growth by analysing a sample of companies that makes use of only this growth mode is worthwhile.

We evaluated the theoretical hypothesis using information supplied by the Survey of Business Strategies, a representative sample of Spanish manufacturing companies, between 1990 and 2001. The availability of longitudinal firm-level panel data permits us to consider the dynamic features of R&D intensity and diversification decisions as well as allows for the lagged effects distributed over time. This permits us to distinguish between the direct effect after one year and the full effect, which requires several years. To operationalise the simultaneous decisions regarding R&D intensity and diversification as well as the potential feedback between them, we estimate a bivariate vector auto-regression (VAR) for R&D intensity and related diversification, augmented by additional covariates. To increase the robustness of our results, we also controlled for two potential sources of endogeneity: censoring and unobserved firm heterogeneity. The failure to account for either of these two sources of endogeneity can lead to misleading conclusions.

Our empirical results provide evidence in favour of a bi-directional relationship between corporate diversification and R&D intensity at two levels. First, an increase in R&D intensity positively affects related diversification; innovation increases firm incentives to establish businesses in related activities. Second, related

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diversification has a positive effect on R&D intensity, at least for moderate levels of related diversification. In this situation, firms undertaking related diversification may be more likely to innovate to consolidate their position in new activities and make them more efficient in implementing R&D expenditures. However, we find that the positive effect of related diversification on R&D intensity is marginally decreasing and may be offset when related diversification reaches a certain level. Our results suggest the effect of related diversification on R&D intensity exhibits an inverted-U shaped form.

2. Theory and hypothesis

The link between diversification strategy and R&D intensity has been empirically analysed in several studies, which are summarised in Table 1. Empirical studies have adopted a unidirectional approach, and therefore, provide conflicting evidence. The common finding is that diversification has a positive effect on R&D intensity. Among the few exceptions to this finding are the results reported by Hill and Hansen (1991), who concentrated on very particular industries, and those reported by Miller (2004), who focused on an external growth framework. Evidence is contradictory with regard to the effect of R&D intensity on diversification. Some authors find a positive effect (Davis and Thomas, 1993; Hoskisson and Johnson, 1992), while other authors find a negative effect (Hitt et al., 1996; Stimpert and Duhaime, 1997).

There are several possible reasons for these striking differences. First, the measures of these two strategic variables, diversification and R&D intensity, differ across studies. In particular, many studies do not distinguish between related and unrelated diversification, whose consequences can differ remarkably. Second, most studies do not distinguish between growth modes, yet the dominant growth mode can influence corporate decisions on both diversification and R&D intensity. Third, assumptions about the time schedule of when the effects occur may affect the results. Fourth, differences in the methodological approaches can affect the conclusions. The different approaches used in earlier studies, as shown in Table 1, had a high probability of affecting the empirical findings. Nonetheless, and more importantly, none of the previous studies analysed the bidirectional relationship of these two variables. Therefore, they ignored the potential feedback between these two strategic decisions. To further the research, we propose and test a new hypothesis that posits a dynamic bi-directional relationship between related diversification and R&D.

Economies of scope and synergies play a key role in diversifying firms, in general, and also in the particular case of the mutual relationship between related diversification and R&D. The analysis of economies of scope and synergies can be considered from the viewpoint of outputs and costs (see Tanriverdi and Venkatraman, 2005). From the production perspective, input complementarities may increase the value of a multiproduct firm in comparison to a single-product firm through super-additive value synergies among the firm's different businesses (Davis and Thomas, 1993). From the cost perspective, economies of scope may reduce the unit costs of a multiproduct firm in comparison to single-product firms by sharing resources between the firm's businesses (Teece, 1982) in the joint production process. Synergies and economies of scope are suitable for a firm that diversifies among related activities but are not relevant in cases of unrelated diversification.

From a dynamic resource-based view, a firm involved in several related businesses should efficiently use its current resources, particularly its technological resources, and generate sufficient resources to make future strategies viable. This implies a long-term dynamic interaction between related diversification and technological resources.[2] When a firm increases its degree of related diversification by entering in a new business, the firm takes advantage of its excess resources and acquires complementary resources needed to operate (Chatterjee, 1990). Research indicates the closer the relation with the previous business of the firm, the lower the costs of entering in a new business (Yip, 1982).

If the firm grows through related diversification, the new activities can take advantage of the existing technological resources, which will be exploited to a greater extent. This effect arises as a result of synergies and economies of scope (Teece, 1982) derived from the use of the firm R&D in their different businesses. An increase in R&D investment may boost related diversification, as long as it improves the capacity to exploit the available technological resources. Further, the firm technology affects the firm's diversification strategy (Silverman, 1999) because the greater the R&D investment, the greater the related diversification (Burguelman, 1983).

In addition, the specificity of R&D can influence the firm strategy on related diversification. Such specificity, which can be due to (path-dependent) learning inside the firm and firm-specific capabilities, may generate appropriability, both through protection from imitation and through the use of complementary resources (Helfat, 1994; Teece, 1986). Therefore, highly specific R&D resources can provide the firm further incentives to related diversification, to improve appropriability.

Related diversification, as part of a long-term corporate strategy, tends to increase the expected return from R&D in two instances: the greater the diversification, the better the capacity to use research outputs (Teece, 1980). Consequently, a higher degree of related diversification can favour R&D investment and technology adoption (Hill and Snell, 1988; Chen, 1996). However, a firm entering or strengthening a given business area might undertake technology investments to improve its competitive position in that business (Itami and Numagami, 1992; Lunn and Martin, 1986; Scherer, 1984). Therefore, a firm introducing a certain degree of related diversification may have incentives to increase its R&D.

There are some forces that may induce an opposite effect of related diversification on R&D effort. These forces have to do with the efficiency gains in R&D exploitation associated with (related) diversification strategies (Baysinger & Hoskisson, 1989). From the resource-based view, the optimal amount of additional resources (particularly, technological resources) tends to decrease with the number of related businesses. Technological knowledge is not limited to a particular business but extended to related businesses (Helfat and Raubitschek, 2000). Thus, the complementarity of technological resources in related activities (Helfat, 1997) can eventually reduce the optimal R&D intensity. In other words, the same R&D investment has a greater impact the higher the diversification, due to synergies and economies of scope (Baysinger and Hoskisson, 1989; Miller, 2004), so the necessity to increase R&D is reduced.

As a consequence, related diversification may produce counteracting effects on R&D. We have argued that related diversification boosts innovation, thus increasing R&D investment. However, if related diversification increases the efficiency in the use of technological resources, the need of further R&D effort may be moderated.[3] These two conflicting forces suggest that the effect of related diversification on R&D behaves as an inverted U-shaped

[2] One explanation of Penrose (1995) for the process of related diversification over time refers to efficiency gains from learning that result in excess resources, which can be used to diversify.

[3] Although R&D expenditure keeps increasing, it could be the case that R&D intensity, defined as the ratio of firm R&D expenditure to total sales, falls. This phenomenon is due to the relative increase in sales, associated with the firm additional related businesses, which is larger than the increase in R&D expenditure because of the aforementioned economies of scope.