Research Policy 41 (2012) 36–53

Contents lists available at SciVerse ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Is there a linear relationship between R&D intensity and growth? Empirical evidence of non-high-tech vs. high-tech SMEs

Paulo Maçãs Nunes[a,b], Zélia Serrasqueiro[a,b,*], João Leitão[c]

[a] Management and Economics Department, Beira Interior University, Portugal
[b] CEFAGE Research Center, Évora University, Portugal
[c] Polytechnic Institute of Portalegre and IN+ Research Center, Technical Superior Institute of Lisbon, Portugal

ARTICLE INFO

Article history:
Received 27 March 2009
Received in revised form 14 July 2011
Accepted 23 August 2011
Available online 17 September 2011

JEL classification:
L25
L26
O32

Keywords:
High-tech SMEs
Non-high-tech SMEs
R&D intensity
Two-step estimation

ABSTRACT

To investigate whether there is a similar relationship between R&D intensity and growth in high-tech and non-high-tech small and medium-sized enterprises (SMEs), we examine two samples of SMEs in manufacturing industries, applying the two-step estimation method. Our findings are that R&D intensity restricts the growth of high-tech SMEs at lower levels of R&D intensity and stimulates their growth at higher levels. However, R&D intensity restricts the growth of non-high-tech SMEs regardless of the level of R&D. The relationships obtained between other determinants considered in the literature and the growth of high-tech and non-high-tech SMEs allow us to conclude that (i) smaller, younger, non-high-tech SMEs grow more quickly than larger, older, non-high-tech SMEs, which does not occur in the case of high-tech SMEs; and (ii) financing restrictions are especially important in financing the growth of high-tech SMEs, compared with non-high-tech SMEs.

1. Introduction

High-tech small and medium-sized enterprises (SMEs) are considered to be principal drivers of economic and employment growth in developed countries. In European countries, high-tech SME activity is considered to be crucial to achieving the desired structural transformation of economies (European Commission, 2008). Henrekson and Johansson (2010) conclude that government policies on entrepreneurship (incentives for entry, survival, and growth of high-tech SMEs) are fundamental for stimulating economic and employment growth in European economies.

Among the activities of high-tech SMEs, R&D investment is particularly important (Stam and Wennberg, 2009; Lee, 2010). This is the case because, aside from the ability to create new products and develop more efficient productive processes, R&D investment encourages strategic cooperation among firms (Gilsing et al., 2008; De Jong and Freel, 2010). Together, these factors promote a greater spread of knowledge spillovers (Coad and Rao, 2008) and help to increase absorptive capacity (Cohen and Levinthal, 1989).

While admitting that R&D investment is fundamental to the success of high-tech SME activities and, consequently, to increased gains in countries' macroeconomic and microeconomic productivity (Ortega-Argilés et al., 2010), European countries still trail far behind the United States (for example) with respect to investment in high-tech sectors (European Commission, 2008). Ortega-Argilés et al. (2010) conclude that the low productivity of high-tech sectors in Europe compared to the United States is not explained by lower levels of R&D investment but is instead a consequence of the inability to transform R&D investment into productivity gains, which would thereby make firms more competitive. One possible explanation for that inability resides in firms' failure to use assets efficiently. Teece (1986) argues that taking advantage of asset complementarity may be particularly important for improving firm performance. Nevertheless, that same author concludes that SMEs have difficulty benefiting from innovation insofar as their complementary assets are more limited compared to large firms.

The growth of SMEs is crucial to ensure survival and subsequent consolidation in their operating markets (Lotti et al., 2009). In addition, SMEs are considered to be the main driving force behind economic and employment growth in European countries and, therefore, should be given a special status in major government policies, especially those related to high-tech SMEs (European Commission, 2008).

* Corresponding author at: Management and Economics Department, Beira Interior University, Portugal. Tel.: +351 275319600; fax: +351 275319601.
E-mail address: zelia@ubi.pt (Z. Serrasqueiro).

0048-7333/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.respol.2011.08.011

Considering the importance of high-tech SMEs for economic and employment growth in developed countries in general, and in European countries in particular, studying the relationship between R&D intensity and high-tech SME growth is especially important. Thus, we seek to ascertain if the relationship between R&D intensity and growth is different between high-tech SMEs and non-high-tech SMEs. On the basis of our findings, we also hope to formulate helpful advice for managers/owners of high-tech SMEs and non-high-tech SMEs as well as for policy-makers.

To do so, we consider two samples of Portuguese SMEs in manufacturing industries: (i) 330 non-high-tech SMEs and (ii) 133 high-tech SMEs. We believe Portugal (a small open economy within the single European market (IAPMEI, 2008)) to be a good setting for this investigation because 99.6% of all firms are SMEs. It is clear, therefore, that such firms play a leading role in the performance of the country's economy and employment.

We use the two-step estimation method proposed by Heckman (1979). This method is considered suitable for efficiently solving the problem of result bias associated with the matter of survival. In the first stage, we estimate probit regressions of survival, considering all non-high-tech and high-tech SMEs. In the second stage, after calculating the inverse Mill's ratio and including it in the regressions, we estimate relationships between determinant factors and the growth of non-high-tech vs. high-tech SMEs, considering only surviving non-high-tech and high-tech SMEs.

The empirical findings allow us to make the following contributions and implications regarding the literature on SMEs and R&D management. R&D intensity is a factor that restricts growth in non-high-tech SMEs, regardless of the level of R&D intensity. In the case of high-tech SMEs, R&D intensity is a factor that stimulates growth, but only for higher levels of R&D intensity. At lower levels of R&D intensity, it restricts growth. Smaller, younger, non-high-tech SMEs grow more quickly than larger, older, non-high-tech SMEs, which does not occur in the case of high-tech SMEs, where size and age have no influence on growth. Financial restrictions are more severe in the case of high-tech SME growth than in non-high-tech SME growth. Using the two-step estimation method allows us to make another contribution, which is to confirm that the factors determining survival in high-tech SMEs are different from those for non-high-tech SMEs.

The remainder of the paper is structured as follows: Section 2 presents the literature review and hypotheses for investigation; Section 3 presents the database, variables, and estimation method used; Section 4 presents the results; Section 5 discusses those results; and Section 6 presents conclusions and implications.

2. Literature review and research hypotheses

2.1. Relationship between growth and R&D intensity

The influence of R&D intensity on SME growth is an issue of great interest and complexity, especially with respect to the need for structural transformation in the economies of developed countries. Many studies have found that R&D intensity has a positive effect on SME growth. R&D expenditure contributes to increased diversification of activities, making SMEs more competitive (Deloof, 2003; Rogers, 2004; Baptista and Karaöz, 2011). R&D expenditure allows for increased export capacity, which may contribute decisively to reducing the level of risk associated with SME activities (Beise-Zee and Rammer, 2006).

The greater strategic and organisational flexibility of SMEs, associated with the possibility of diversifying activities as a consequence of R&D investment, may encourage SMEs to form strategic cooperation networks with other firms (Rogers, 2004; Rickne, 2006). Networks can help to implement strategies that include complementary activities with other firms or other centres of knowledge (e.g., higher education institutions and research laboratories), thereby increasing the marginal value of each individual firm's strategy (Arora and Gambardella, 1990).

R&D investment increases absorptive capacity, i.e., the capacity to absorb knowledge created from the relationships formed with agents outside the firm, as well as the capacity to use that knowledge to increase firm performance (Cohen and Levinthal, 1990; Gilsing et al., 2008; De Jong and Freel, 2010).

However, R&D intensity can also reduce growth in SMEs. R&D investment is associated with a high level of risk, added to which is its contribution to the creation of intangible assets in a firm, which in turn may make the level of risk faced by SMEs even higher. This may add to SMEs' difficulties in obtaining external finance, hampering efforts to grow and/or diversify (Yasuda, 2005; Müller and Zimmermann, 2009). Efficient use of R&D investment requires management expertise, and sporadic investment coupled with unsophisticated management may even contribute to decreased growth (Santarelli and Sterlacchini, 1990; Müller and Zimmermann, 2009). Management of projects involving high R&D intensity may be problematic in the short term, which may lead to R&D intensity being a restrictive factor of growth rather than a stimulant (Müller and Zimmermann, 2009).

Del Monte and Papagni (2003) and Lee (2009) conclude that the effect of R&D intensity on firm growth varies according to the sector: on the one hand, firms with limited technological intensity find that innovations resulting from R&D investment are relatively easily copied by competitors and are not a barrier to new firms entering the market; on the other hand, in sectors with high technological intensity, characterised by high investment in R&D and sizeable economies of scale, R&D investment can function as an effective barrier to new firms entering the market. Therefore, R&D investment can positively influence the growth of firms belonging to high-tech sectors, but the same positive effect is not found in firms in non-high-tech sectors.

Compared to large firms, SMEs face additional difficulties in managing R&D projects that require qualified human resources and efficient management of technology and information (Freel, 2003; Lee, 2009). This can further constrain efficient implementation of R&D projects. Therefore, it is especially important to highlight that most scientific positions in SMEs are found in high-tech sectors (Kuusisto, 2008).

Other factors have been advanced in the literature that may be important to boosting firm performance: (i) good internal organisation (Eisingerich et al., 2009); (ii) suitable strategies for diversifying activities (Kindström and Kowalkowski, 2009; Noone et al., 2009); and (iii) strategic cooperation between firms with respect to R&D projects (Lee, 2009). The greater organisational flexibility of SMEs (Rogers, 2004; Rickne, 2006), combined with their greater absorptive capacity (Cohen and Levinthal, 1990; Gilsing et al., 2008; De Jong and Freel, 2010), and the greater capacity to implement complementary strategies with other firms or R&D institutions (Arora and Gambardella, 1990), in the case of high-tech firms, may explain why high-tech SMEs have greater capacity for internal organisation, have greater strategic flexibility, and establish strategic cooperation networks with shared resources. Conjointly, these factors may contribute to higher growth rates in these firms than in non-high-tech SMEs.

Hölzl (2009) concludes that the effects of learning and experience in leading corporate processes of R&D project management are fundamental determinants of success. The author found greater relevance of R&D intensity in determining performance in firms in Northern and Central European countries than in Southern and Eastern Europe. Therefore, it is possible that in countries such as Portugal, with less experience in managing R&D projects than countries in Northern and Central Europe, R&D investment positively