Abstract
We have studied the determinants of science-based cooperation in small and micro firms. Here, we propose an analytical framework designed around a resource-based approach of the firm. We identify a set of organisational features, which we classify as internal, external and structural factors. Each of these factors can be linked to at least one reason – from the company’s point of view – for cooperating with universities and public research centres. Each reason can, in turn, serve as an indicator of a company’s organisational needs or capacities. To validate our theoretical model, we estimate a logistic regression that models propensity to participate in science-based cooperation activities within a sample of 285 small and micro firms.

Keywords: science-based cooperation, determinants, absorptive capacity, small and micro firms.

* The authors would like to acknowledge Barcelona Activa for its support.
INTRODUCTION

The aim of this paper is to study the reasons leading small and micro firms to engage in science-based cooperation. Hence, we identify a set of determinants of cooperation based on the needs and abilities of firms to network with scientific agents. Our theoretical approach is grounded in the resource-based view – RBV – of the company (Barney, 1986a, 1986b, 1991) and is also related to the absorptive capacity construct proposed by Cohen and Levinthal (1989, 1990). We focus on science-based cooperation, defined as agreements signed by firms with universities and public research centres. This cooperation is geared towards innovation.

The RBV theory states that the essence of a company's strategy is defined – or rather, should be defined – by the particular and unique set of resources and capacities of individual firms (Rumelt, 1984). Thus, it is assumed that company strategies are shaped by two main elements: the opportunities offered by the environment, i.e. market opportunities, and the constraints of organizational strengths and weaknesses, i.e. internal assets and capacities. Innovative agents take part in multiple and complex network relationships with the aim of sharing and acquiring knowledge. In this sense, innovation can be described as a collective process (Malecki, 1991) that is increasingly interdependent and interactive. One specific form of networking is cooperation (Vázquez Barquero, 1999). In particular, cooperation with universities and research centres plays an important role in improving business performance, since university research has important and pervasive effects on industry R&D and innovation. ¹ Cooperation, however, is not a universal practice: only 25% of innovative EU firms engage in cooperation activities (CIS, 2006). As a result, strengthening cooperation between science and economy is one of the goals of EU innovation policies (Eurostat, 2009).

The structure of this paper is as follows: the next section looks at the development of our analytical framework, which is based on the relationship between organizational resources, cooperation and innovation. This is followed by an empirical application to validate the determinants of science-based cooperation we have identified in a sample of small and micro firms. A discussion and a series of conclusions round off the paper.

¹ For a summary, see Zucker et al., 2001, and Kim et al., 2005.
ANALYTICAL FRAMEWORK

Absorptive capacity

Absorptive capacity is one of the most important conceptual constructs to have emerged in research on organizations in recent decades (Lane et al., 2002 and 2006). Its emergence coincided with the development of the RBV theory and its derivative, the knowledge-based view of the firm. The most common definition of absorptive capacity is that given by Cohen and Levinthal in 1990:

Absorptive capacity is the ability of a firm to recognize the value of new external information, assimilate it, and apply it for commercial ends.

The authors argue that it is a critical element in shaping the innovative capacity of the firm, since the concept of absorptive capacity is based on the fact that an organization needs some previous related knowledge in order to assimilate and utilize new acquired external knowledge. Learning is a cumulative process, so learning productivity increases when the object of the learning process is known previously. For this reason, diversity of knowledge within a company plays a very important role in absorptive capacity. Hence, absorptive capacity is firm-specific and path-dependent. It is also shaped by the capacity for absorption of the individual members of the organization. To summarise, then, absorptive capacity is not an end but a means – an instrument – to determine and modulate the results that a company can achieve. It is a multidimensional, multilevel and trans-disciplinary construct (Bosch et al., 2003).

Among other aspects, organizational strategy is related to the adoption and spread of innovation, participation in R&D cooperation agreements, and to the performance of basic research. Absorptive capacity affects all of these activities (Cohen and Levinthal, 1990). Specifically, it shapes cooperation for innovation with universities and research centres: firms have different absorptive capacities which, in turn, determine “the will” of the organization to enter into cooperation agreements (Hernán et al., 2003). Absorptive capacity even plays a relevant role in the relationship between weak links with other economic agents and the achievement of results in innovation because it contributes to taking better advantage of existing weak links with external agents (Julien et al., 2004).
Indeed, a number of empirical studies reveal how absorptive capacity shapes cooperation activities. In particular, the formal training of company staff has a positive effect on cooperation activities (Belderbos et al., 2004).

Sufficient capacity is required to engage in cooperation activities (Foss, 1999) because “firms need resources to get resources” (Eisenhardt and Schoonhoven, 1996, p.137). A case in point is science-based cooperation, in which company-university relationships can be extraordinarily difficult to manage (Pavitt, 2005, p. 94). Transaction costs can be high when the interlocutor is a university or a research centre due to their differences with respect to firms in terms of commercial and general organizational goals and aims.

Nonetheless, internal factors are necessary but by no means sufficient in defining the absorptive capacity of the firm (Camisón and Forés, 2007). Therefore, there is a clear need for an appropriate combination of internal and external assets to ensure that absorptive capacity leads to optimum results and company performance. Selected internal and external elements can also be identified with reasons for science-based cooperation.

**Reasons for science-based cooperation in small and micro firms**

The available statistical evidence on innovation shows that cooperation is greater among larger companies (CIS, 2006). However, small and micro firms may be more dependent on external links and external resources, meaning that cooperation would act as a mechanism to compensate for size-inherent competitive disadvantages (Audretsch and Feldman, 2003). Hence, size is one of the dimensions to take into account when analysing the determinants of cooperation. Other organisational factors also affect propensity to cooperate. Our taxonomy identifies three categories: structural factors, such as company size or activity sector; external factors, such as access to and use of institutional support for innovation and the existence of market turbulence, and internal factors, such as the embedded knowledge of a firm’s staff (referred to as human capital) and ongoing engagement in R&D activities.

We can identify these factors as indicators of some of the main reasons for engaging in science-based cooperation (see Figure 1). From the point of view of small companies, there

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are three main reasons for cooperation (Hanna and Walsh, 2002; Tether, 2002; Jong and Vermeulen, 2004): (1) lack of internal resources; (2) spreading of risk, and (3) to exploit complementarities. These three reasons can, in turn, be understood in terms of the firm’s need or capacity to cooperate. The first two reasons concern need, since their rationale is the need to access external resources in order to compensate for organizational weaknesses. By contrast, the third reason relates to the firm’s capacity for cooperation, since any company seeking to create and take advantage of potential complementarities must be able to share its (own) assets and/or knowledge.

\[ C = \text{Capacity for cooperation; } N = \text{Need to cooperate.} \]

Source: Authors' own work.

Figure 1: Reasons for science-based cooperation in small and micro firms.

In this theoretical approach, these factors can be regarded as indicators of the determinants of science-based cooperation among small and micro firms. We will now attempt to validate the theoretical framework through empirical application.

**EMPIRICAL APPLICATION**

In order to validate the proposed analytical framework by means of empirical application, we will use a logistic regression to model the propensity of small and micro firms to engage in science-based cooperation. We look at self-declared cooperation activities, without making a distinction between formal and informal agreements. This broad definition affords a closer and more realistic picture of these types of company. A set of indicators is used to proxy the factors (structural, external and internal) that shape science-based cooperation activities.
The above information can only be gathered through a survey. The data collected for our specific application came from a cross-sectional sample of 285 mainly young, small and micro firms. These companies are located in Barcelona and are either closely or loosely linked to the local development agency, an institution created by the City Council (for more details, see Fernández-Ardèvol, 2009, and Castells and Vilaseca, dirs. 2007).

Selection of variables

The selection of variables for the empirical application was based on a review of the literature. Given the available data gathered through the survey, the variables implemented were those that follow. For structural factors, or basic organizational characteristics, size was measured as the total number of employees (expressed as full-time equivalent). Size would be insufficient for predicting propensity to cooperate, so it is considered here as a control variable and we do not put forward any hypotheses as to its influence on the endogenous variable. Activity sector is implemented by considering whether or not the company is in the ICT sector. Given the sector distribution and characteristics of the survey, we selected the ICT sector as the indicator of the need to spread risk within a sector. The ICT sector reveals higher levels of innovation, so we would expect firms from this sector to be more likely to cooperate with science agents.

The first external factor is institutional support. This is a discrete, quantitative variable that indicates the intensity of institutional support. It is bounded between 1 and 7. The lower value corresponds to firms that are only supported by Barcelona Activa, while the higher value corresponds to those supported by all seven types of institution considered in the survey. The second internal factor reflects the competitive pressure perceived by the person in charge of the firm, i.e. that the market(s) in which the company does business put(s) relevant pressure on the business. This is a dichotomous variable that equals one when competitive pressure is stated as “high” or “very high” and zero in all other cases.

<table>
<thead>
<tr>
<th>Qualitative variables (dichotomous)</th>
<th>Model</th>
<th>Yes</th>
<th>Role in the model</th>
</tr>
</thead>
</table>

3 The survey gathered information on the following business sectors: ICTs, service companies, industrial production, commercial distribution, personal services and social activities, and other services.

4 These institutions range from public ones to universities, business schools and the chamber of commerce.
There are another two variables, internal factors, that can be regarded as indicators of a firm’s absorptive capacity: human capital with a strong educational background (majority of employees) and the existence of a permanent R&D and innovation department in the company. Again, both are dichotomous variables.

Models: specification and estimation

Two models were specified. Model 1, the baseline model, has three explanatory variables: the two internal factors usually identified as indicators of absorptive capacity, and company size, the control variable. Model 2, on the other hand, is an enlarged model that includes the external factor variables listed in Table 1. Both models include a constant term.

The goodness-of-fit G statistic shows that both models are significantly different to a model in which the only predictor was the constant term. Complementary statistics confirm that Model 2 is preferable to Model 1: predictive capacity is similar (76.1% vis-à-vis 76.5%) but there is a greater balance of correct predictions for each category of the endogenous variable in Model 2. However, the Akaike and Bayes information criteria (AIC and BIC) are lower in Model 2 and the deviance statistics show that the contribution of the variables added to Model 1 in
order to build Model 2 play a significant role. In the following paragraphs, therefore, we will focus on the results of Model 2.

Company size can be seen to exert a positive influence on likelihood of engaging in science-based cooperation. In light of this, we can consider that number of employees is an indicator of absorptive capacity in the context of the sample under study here, since the firms have less than five employees on average. To be able to assume the transaction cost inherent to cooperation – and more specifically, science-based cooperation – the company needs sufficient internal resources. Increased size, in our context, could mean the availability of knowledge and capacities that are more complex and tacit in nature (Lee et al., 2001; Kogut and Zander, 1996). Having a larger knowledge base would increase the firm's capacity to engage in cooperation with scientific institutions because the firm's perception of risk with regard to these relationships would be lower.

Secondly, the two internal factors (human capital and own R&D and innovation department) have a positive effect on the endogenous variable. Higher education appears to be a key determinant, as can be seen from the magnitude of the estimated parameter (2.132). Given that 76.1% of the companies in the sample have a majority of employees with university degrees, this result is particularly revealing as it signals the importance of internal capabilities for engaging in science-based cooperation.
Table 2. Determinants of science-based cooperation for innovation. Logistic models.

<table>
<thead>
<tr>
<th>Endogenous:</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science-based cooperation for innovation</td>
<td>Yes = 16.11%</td>
<td></td>
</tr>
</tbody>
</table>

**Explanatory variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of employees (full-time equivalent)</td>
<td>0.079</td>
<td>0.073</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Majority of employees with university degree</td>
<td>2.365</td>
<td>2.132</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Own R&amp;D and innovation department</td>
<td>1.146</td>
<td>0.834</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Intensity of institutional support (1-7)</td>
<td>-</td>
<td>0.765</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>Heavy competitive pressure (perceived)</td>
<td>-</td>
<td>0.562</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.331)</td>
</tr>
<tr>
<td>ICT sector</td>
<td>-</td>
<td>0.398</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.331)</td>
</tr>
<tr>
<td>Constant term</td>
<td>-9.575</td>
<td>-6.482</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

**Goodness of fit**

<table>
<thead>
<tr>
<th>Classification table</th>
<th>% correct predictions (cut: 16%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>63.0%</td>
</tr>
<tr>
<td>No</td>
<td>79.1%</td>
</tr>
<tr>
<td>Total</td>
<td>76.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>285</td>
<td>285</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Chi-squared test of global significance: G</td>
<td>41.755</td>
<td>64.363</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Deviance of variables added to the model</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>-2 ln likelihood</td>
<td>210.179</td>
<td>187.571</td>
</tr>
<tr>
<td>Akaike Information Criterion (AIC)</td>
<td>216.179</td>
<td>199.571</td>
</tr>
<tr>
<td>Bayes Information Criterion (BIC)</td>
<td>227.137</td>
<td>221.486</td>
</tr>
<tr>
<td>Nagelkerke Pseudo R²</td>
<td>0.232</td>
<td>0.344</td>
</tr>
<tr>
<td></td>
<td>5.364</td>
<td>6.746</td>
</tr>
<tr>
<td>Hosmer-Lemeshow test</td>
<td>(0.616)</td>
<td>(0.564)</td>
</tr>
</tbody>
</table>
In the light of the results, we can consider that the first three exogenous variables (number of workers, human capital, and own R&D and innovation department) act as indicators of the absorptive capacity of the firms sampled. This set of minimal internal capacities appears to favour the capacity of firms to consider scientific agents for cooperation, a strategy that would make the portfolio of external alliances more complex (Duysters and Lokshin, 2007).

The third group of variables corresponds to external factors. We confirm that institutional support has a significant positive influence on propensity towards science-based cooperation. Perceived competitive pressure also has a positive influence but its parameter is not statistically significant. The perception of business managers in this regard is extremely high (with 82.8% declaring that their business is under heavy pressure from competition), so we could say that this is perhaps not the best instrument for measuring competition in the markets in which the surveyed companies do business. As stated in previous works (for example, Fritsch and Lukas, 2001), the predictive capacity of the model could be improved if information were available on the internalization of spillovers generated by innovative activity or on effective cost savings as a result of cooperation.

Lastly, forming part of the ICT sector, which can be regarded as an indicator of market dynamism, as argued above, has a positive parameter but is not statistically significant. In the surveyed firms, the multivariate model shows that activity sector is not significant when considering absorptive capacity indicators.

DISCUSSION AND CONCLUSIONS

The results reveal the key role of absorptive capacity as a determinant in setting up science-based cooperation with small and micro firms. More specifically, we were able to identify two different sources of absorptive capacity: a set of internal factors and a set of external factors. Both enhance propensity to engage in science-based cooperation.

The most important internal factor is the qualification of employees, although the existence of an R&D and innovation department is also significant. These two factors are key aspects that

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6 A model considering all sectors of activity was estimated. The results obtained were similar to those described here; therefore, the most parsimonious model is the one discussed here.
help organizations to deal better with universities and research centres for cooperation purposes. Moreover, company size is also relevant in the sample studied, since the average number of staff is less than five full-time employees. In this particular case, firms are clearly shaped by the number of their employees since the addition of one more employee would have greater significance here than in a medium-sized or large company.

Of the external factors, institutional support would appear to be crucial in improving the absorptive capacity of the firms sampled, since it can help these small-scale young companies to enhance their organizational knowledge and access (more) networks with (more) diverse members. Thus, we consider that support institutions act as an effective interface between small and micro firms and universities and research centres.

To sum up, absorptive capacity increases propensity to set up cooperation with universities and research centres, even among the firms studied from non-university innovative milieus managed by the local development agency of the City Council. In turn, absorptive capacity can be improved – and is effectively improved – both from within and outside the company, an important point to consider in the case of small and micro firms.

REFERENCES


