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Variations in SME Characteristics and the Use of Service Intermediaries for R&D

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Abstract

Large companies are increasingly looking externally for opportunities to enhance innovation which has resulted in closer study of innovation systems. We examined the role of service intermediaries (universities, technology centers and consultants) within these systems using a sample of predominately small and medium sized enterprises located in Valencia Spain. As with studies of large companies, absorptive capacity (e.g., research and development expenditures) was positively related to the likelihood that a firm would engage in service collaborations. However, the rate of collaboration was higher relative to studies dominated by larger companies. Also, there were differences in the pattern of firm characteristics associated with the use of specific services. For example, the level of SME export activity related positively to the use of technology centers, but negatively with university collaborations.

Keywords: innovation systems; firm collaboration; intermediary organizations; technology centers

Innovation Systems and Firm Collaboration Among SMEs

Innovation, the process by which new products, processes and/or services are introduced into the marketplace (Edwards & Gordon, 1984) is essential to the survival of small and medium sized enterprises (SMEs). As noted by Howells (2006) among others, increased collaboration and outsourcing over time has resulted in innovation systems that are relatively more open and distributed (Chesbrough, 2003; Gassmann, Enkel & Chesbrough, 2010). This investigation concerns the role of service intermediaries (e.g., universities, technology centers and consultants) in these systems, who through their interaction with multiple parties can facilitate the innovation process, especially in environments where firms and services are geographically clustered (Davenport, 2005; Howells, 2006; Zhang and Li, 2010).

In changing contexts and when competition between firms increases, the generation of competitive advantage is going from material factors to intangible resources such as knowledge and innovation. However, the generation and diffusion of innovation requires access to suitable conditions. One of these conditions is the ability of the environment in which enterprises operate, and especially SMEs, to create "resources for innovation" (in the form of technical advisory services, R&D services, etc). These resources for innovation are channeled through intermediary organizations that perform actions of connection between users and providers (Bellini, 2002).

In considering the possibility that a firm will benefit from open innovation, the institutional infrastructure in its immediate environment is an important consideration (Molina-Morales, 2005). The territorial environment of firms varies in terms the presence of universities, technology centers, engineering, and consultancy services (Benneworth & Dawley, 2004) which can influence the potential for synergistic interaction (Edquist, 1997; Lundvall, 1992). For example, Zhang and Li, (2010) recently studied SMEs within a technology cluster in China and

demonstrated that company ties to service intermediaries (e.g., in the technology, accounting, financial, and legal services realms) were related positively to product innovation. Zhang and Li, (2010) argued that the service intermediaries contributed to innovation at SMEs by broadening the scope and reducing the cost of their external innovation search.

Although a variety of reasons have been offered to account for why firms may or may not elect to collaborate with outside entities (e.g., Belderbos, Carreeb, Diederen, Lokshin & Veugelers, 2004; Howells, 2006; Tether, 2002) almost all this research has involved large established firms. Thus, Zhang and Li (2010) noted that little is known about why new ventures such as the ones they studied elected to establish ties with service intermediaries. Similarly, with the exception of Muscio (2007), little is known about whether there are attributes of SMEs that are systematically associated with the choice to engage in R&D collaboration with different types of service intermediaries (e.g., consultants, universities, technology centers).

Our research focuses on studying the role of intermediary organizations in their relationship with SMEs. Although a growing body of research (Chadwick and Glasson, 2008; Doloreux et al., 2010) is devoted to the analysis of the role of intermediary organizations and, particularly, to knowledge-intensive services, previous research has focused on individually studying the role of some of these institutions and especially universities (including Coenen, 2007) mainly in relation to large companies. However, the various intermediary organizations have a high heterogeneity in terms of expertise and technological capabilities, which requires a joint analysis but distinguishing by type of organization. And, secondly, the characteristics of SMEs (Liao et al. 2003) determine that the collaboration of these firms with external organizations have their own specificities. In fact, there is little empirical research on outsourcing in general (Antonietti and Cainelli, 2008) and, especially, little is known about what

determines the collaboration of SMEs with different types of organizations. This research aims to fill these gaps through an empirical analysis based on a sample of firms in a region (Community of Valencia) in Spain.

The paper is structured as follows. We first explore the conceptual frame of the study. It is based on the context of innovation, that is, innovation systems and the role played by intermediary organizations. Then we then present three propositions about the determinants of R&D collaborations by SMEs. The next section describes the sample and outlines the method for the study. After that, the results are reported. In the final section, we discuss the results and draw conclusions about their implications for scholarship and policy.

Theoretical Background

The Context of Innovation: Innovation Systems

When innovation is examined from a systems perspective, the interactions among various local and/or global as well as public and/or private entities are studied (Filippetti & Archibugi, 2011) for the organizational, technological, and/or human capital they contribute to generate economic dynamism (Edquist & Hommen, 2008; Ernst, 2007). The systems perspective encourages companies to look outside themselves to help generate new ideas and build new capabilities and/or competencies to foster sustained growth. This relatively open approach to innovation has recently received considerable attention in the literature (Chesbrough 2003; Dahlander & Gann, 2010; Dodgson, Gann & Salter 2005). The usefulness of the systems-based view is well illustrated in the study of high-tech regions (Fleming & Frenken, 2006; Keeble & Wilkinson, 2000) known for innovation such as Munich, Greater Boston, and Silicon Valley (Bathelt, 2001; Garnsey & Heffernan, 2005; Lee, Miller, Hancock & Rowen, 2000) where interactions between business enterprises and high quality research organizations, universities

and technology centers are thought to be essential to their success. Indeed, cooperation with intermediaries is positively associated with innovation (e.g., Baum & Oliver, 1992; Greunz, 2004; McEvily & Zaheer, 1999). Certain research (Markusen and Bloch, 1985) has highlighted the role played by military procurement programs related to the high-tech research. According to this approach, the presence of universities and research centers has been a necessary but not sufficient condition for the emergence of agglomerations such as Silicon Valley. In the same vein, authors such as Saxenian (1988) and Leslie (1993, 2000) emphasize the catalytic nature of federal defense spending for the birth of high-tech firms in such environments.

Not surprisingly, innovation systems can vary considerably in terms of their specific characteristics. For example, Lambooy (2005) differentiates between self-organizing and governance systems. In the former, the firms engaged in innovation search take the lead role and have direct links to the public and/or private entities in the system. In the later, public entities such as universities and technology institutes lead in the regulation and coordination of the system on behalf of the regional government. Cooke (2003) distinguished between institutional and entrepreneurial regional innovation systems which differ in terms of their elements (public versus private) and primary leadership (quasi governmental versus entrepreneurs and venture capitalists). Finally, systems vary in the degree to which members have experience with, and confidence in each other (Doloreux & Parto, 2005; Todtling & Trippl, 2005) such that a good relationship between intermediaries and the SMEs looking to benefit from the transfer of knowledge is seen as crucial (Klofsten & Jones-Evans, 2000).

The Role of Intermediary Organizations within Innovations Systems

The role that service intermediary organizations play in connecting various elements within an innovation system has received attention (Asheim et al., 2003; Howells, 2006; Inkinen

& Suorsa, 2010; Sapsed et al., 2007). As noted by Howells (2006), the intermediary role has been examined in fields ranging from innovation management to technology transfer and has been referred to in various terms including third parties (Mantel & Rosegger, 1987), bridgers (Bessant & Rush, 1995), intermediary firms (Stankiewicz, 1995), brokers (Provan & Human, 1999) or bridging institutions (Sapsed et al., 2007).

Among other contributions (cf. Hargadon, 1998; Howells 2006; Miles, 2007; Muller & Zenker, 2001; Stankiewicz, 1995), the role of intermediary organizations can involve: (1) identifying knowledge and technology that is potentially nurturing to the system, (2) testing, evaluating, and validating technologies, (3) adapting and transforming knowledge to form new applications, and (4) transferring applications to the agents in the system while protecting the originators. As such, intermediaries foster dialogue, connection and collaboration in the system including in the areas where it is most in need of strengthening (Sapsed et al. 2007).

Given the broad nature of the role it is no surprise that different types of organizations can potentially function as intermediaries. Large research universities are an example especially when regional governments are supportive of them to moving beyond their primary missions of research and teaching (Gertler, 2010; Gunasekara, 2006; Huggins, Jones & Upton, 2008). Technology centers are another institutional form (Spithoven, Clarysse & Knockaert, 2010) wherein part of the mission is to serve an intermediary role. Nonetheless, the mere existence of a technology center does not ensure a surge in innovation (Asheim et al., 2003; Landabaso & Mouton, 2005). A critical mass of interested firms is required in the region as are trust-based interactions among them (García-Quevedo & Mas-Verdú, 2008). Finally, private firms offering a wide range of business services (e.g., accounting, finance, law, technology, and talent search)

can act as intermediaries to enhance the innovation of firms in a cluster (Kuusisto, 2005; Zhang & Li, 2010).

Development of Hypotheses

As noted by Muscio (2007) among others, most of the research concerning the use service intermediaries has involved samples dominated by large firms. This is somewhat surprising since SMEs (i.e., companies with less than 250 employees) are typically characterized as being resource poor relative to large firms such that they might be expected to especially benefit from such collaborations (de Jonga & Freel, 2010). As described below, there is good reason to examine whether some of the findings derived mainly from the study of large firms apply also to SMEs.

Absorptive capacity (AC) refers to the ability of an enterprise to "identify, assimilate, and exploit knowledge from the environment" (Cohen & Levintal, 1989, p. 589) and holds that firms cannot benefit from external knowledge flows by merely being exposed to them. Rather, the internal knowledge base of the organization influences its capability to recognize, assimilate and profitably use external knowledge (Cohen & Levintal, 1989; 1990). Among large enterprises, AC has been widely associated with both the level of external collaboration and innovation per se. The proportion of revenue dedicated to R&D expenditures has been often used as a proxy for AC in studies dominated by large companies (Volberda, Fos & Lyles, 2010) where it positively relates to both innovation and external collaboration (e.g., Escribano, Fosfuri & Tribó, 2009, Fabrizio, 2009; Negassi, 2004; Un, Cuervo-Cazurra & Kazuhiro, 2010). Nonetheless, owing to differences in the manner in which R&D is typically conducted, Muscio (2007) argued that the relevance of AC among SMEs might not be evident unless it was assessed using measures of

human capital (e.g., the education levels of R&D staff). Ultimately, he found both types of measures to positively relate to external collaborations, even among SMEs. Hence:

H1a: AC as reflected in measures of both R&D expenditures and human capital will be positively associated with the tendency to use service intermediaries among SMEs.

A number of research studies also found firm size, at least among large firms, to be positively related to various forms of R&D collaboration, in line with the AC notion (e.g., Belderbos et al., 2004; Colombo & Paola, 1996; Fritsch & Lukas, 2001; Negassi, 2004; Tether, 2002; Un et al., 2010). In this way, and following part of our rationale for H1a, Tether (2002) argued that large enterprises were simply more likely to be aware of the capabilities offered by outside research organizations due in part to their increased resources. However, it is still an open question whether this logic extends to samples dominated by SMEs, where resources and capabilities are assumed to be relatively constrained. For example, when Muscio (2007) examined SME size for its relationship to the use of different types of services, it had a small but significant positive relationship with university collaboration only. Further, consistent with studies involving large firms, an analysis conducted across all types of service collaboration revealed a small but significant relationship. Hence:

H1b: The size of the SME will be positively associated with the tendency to use service intermediaries in general.

In terms of specific types of service intermediaries, collaboration with universities has been the most frequently studied (e.g., Belderbos et al., 2004; Leiponen, 2001; Tether, 2002; Un et al., 2010; Veugelers & Cassiman, 2005) albeit again, mostly among large established companies. For example, Tether (2002) found that 16% of firms who engaged in innovation reported collaborations with these institutions. The comparable figure in Un et al. (2010) was

25%. At the same time, the demand for R&D personnel in the private sector is determined, in part, by the collaboration between firms and universities (Beltramo et al., 2001; Slaughter et al., 2002; Cruz-Castro and Sanz-Menéndez, 2005; Wallgren and Dahlgren, 2005). Specifically, firms that subcontract R&D to universities demand R&D personnel with at least a university degree (García Quevedo et al., 2011). It is also arguable the greater agility of SMEs (Liao et al., 2003) in terms of simpler and less bureaucratic organizational structures, which facilitates their ability to access external resources provided by universities.

Also with regard to university collaboration per se, we expect the educational level of the R&D staff at the SME to be positively related to such partnerships. This is in keeping with the notion of AC, where SME awareness for the potential contribution of universities should be enhanced by the extent to which academically degreed R&D people are on staff. This would be especially true if the SME recruited R&D talent locally. In line with this thinking, Muscio (2007) found R&D education levels at SMEs to be positively associated with university, but not with technology center collaboration. Thus,

H2: The education level of R&D staff at SMEs will be will be positively associated with the use of universities as service intermediaries.

One the many strategic choices SMEs must make is whether or not to pursue export opportunities. Not surprisingly, given the pressures and complexities of facing international competition (Buckley & Ghauri, 2004; Pearce & Robbins, 2008), exporting firms tend to be more productive than non-exporters (cf. Helpman, 2006; Salomon & Shaver, 2005). Among SMEs per se, Yunus (2010) reported a knowledge gap between exporters and non-exporters in that managers at the later were aware of the internal challenges (e.g., the time and capital needed

to build an export business) but not as cognizant of the external barriers (e.g., the need for international market intelligence and a competent distributors).

Since competition in international markets requires higher levels of efficiency (Helpman, 2006), SMEs that export tend to be more innovation intensive than non-exporters (Bernard et al., 2005). Simultaneously, the internationalization strategies have become more complex (Buckley and Ghauri, 2004). Thus, the definition of the SME export strategy needs to have not only its internal resources, but also collaboration with other organizations (Pearce and Robbins, 2008). In other words, the export potential of SMEs is related to their ability to access a wide range of intermediary organizations that act as bridge to connect them with external sources of knowledge and innovation. Hence:

H3a: The export intensity of the SME will be positively associated with the use of service intermediaries.

It is possible to identify heterogeneous roles when the different organizations act as intermediaries (Belussi and Sedita, 2009). In the case of universities, it should be kept in mind two aspects that affect their role. First, the role played by universities is conditioned by the context in which they operate. On the one hand, universities usually act as a leader in the innovation process when there is a predominance of high-tech activities (Gertler, 2010). On the other hand, when universities are integrated in an economic structure dominated by SMEs operating in traditional activities, as is the case with this research, the role of universities faces various constraints (Belussi and Sedita, 2009). These limitations are manifested particularly when addressing issues related to the end of the value chain, i.e., the commercialization.

Secondly, there are restrictions arising from the fact that the primary mission of the universities is to research and teach (Gunnasekara, 2006, Huggins et al, 2008). Thus, the

relationship between universities and export activities is not obvious. In fact, in the specific case of Valencia, available studies show that the largest growth in relations between the university and SMEs occurs mainly in the field of R&D (Capó et al., 2011). By contrast, university-industry relations have less dynamism in other more general activities (for instance, testing), better suited to business related to the commercialization stage, such as export. Hence:

> H3b: The export intensity of the SME will be negatively associated with their use of universities as service intermediaries.

Method

Sample

The Community of Valencia, with five public universities and a strong network of Technology Centers, is an interesting case for the study of service intermediaries-industry links. This European region has some economical and industrial features that are of interest for this study, including: (i) low-tech economic structure and high proportion of SMEs in services and traditional manufacturing; (ii) innovation mostly incremental in the form of machinery and equipment acquisition; (iii) lack of qualified personnel. The innovation policy actions have focused on increasing the technology transfer to the level of high-tech regions or countries, but aligned to the Valencian industry, by establishing a strong network of technology centers in the early 1980s (Fernández de Lucio et al., 2010). These centers act as bridges between firms and public research institutions (universities, etc.) and were founded mostly as industry-based firm associations.

In order to examine the role of intermediaries (universities, technology centres and consultants), we use data from a survey conducted in 2007 to firms based in the Community of Valencia, Spain. During that year, the High Consultative Council on Research and Development

of the Presidency of the Community of Valencia and the IMPIVA (a public entity of the Valencian Regional Government created to promote innovation in SMEs), embarked on the construction of a survey containing innovator firms. Our cooperation in this project provided us with an opportunity to gain enhanced access to collect the firm-level data required to test the hypotheses proposed above.

The questionnaire was sent by mail to the CEOs of the 988 firms in the Community that received public support for R&D activities over the previous three years. As detailed below, the overall structure of the questionnaire is consistent with the Spanish version of the Community Innovation Survey, and also includes some complementary questions on the performance of innovation activities, human resources, acquisition of R&D services and participation in public R&D support programs. There were 280 responses but 62 were dropped due to inconsistent or missing data, resulting in a final sample size of 218. The variety of sectors present in the region was also found in the sample. The most well-represented sectors are: chemical products, industrial machinery, food industry, textile and wholesale trade. The average firm size was 186 employees.

Measurement

Collaboration with external organizations**.** Information concerning four dichotomous variables was collected to characterize whether a firm subcontracted R&D services, and if so, with whom. Specifically, COLLAB (1 = subcontracting of R&D to any external organization 0 = when it did not), Technology Centers, TC_COLLAB (1=subcontracting R&D services with a TC, 0 = when it did not), University, UNIV_COLLAB (1=subcontracting R&D services with a UNIV, 0 = when it did not), and finally, external consultant, CONSUL_COLLAB (1=when a

firm subcontracted R&D services with a TC, 0 when it did not). The former includes, for example, consultancy when applying for public programs to support R&D activities**.**

Absorptive capacity. Given the broad nature of the concept, we assessed the AC from a number of perspectives. First, innovation intensity was reflected by the internal R&D expenditure of the firm (INT_RD_EXPEND) and the percentage of R&D expenditure relative to annual sales (RD_INTENS). Second, a dichotomous variable RD_DEPT, reflected whether a firm had a permanent R&D unit (1=yes, 0 = no). Third, EDUCATION reflected the highest level of education among the R&D staff (1= Ph.D. or M.Sc. Degree; 0= if not).

Exports. A continuous variable EXP_INTENS, the ratio of exports to total sales was used to measure export intensity.

Size. As mentioned earlier, the region we sampled is dominated by SMEs. Firm size was coded using 1 = firms with less than 50 employees; 2 = firms with between 51 and 250 and 3= those with 250 or more employees. Firm size tends to be positively related to external R&D collaboration especially in the manufacturing sector (Audretsch & Thurik 1999; Bennett & Robson, 1999; Johnson, Smallbone & Froud, 1998; Tether 2003).

Age. The age of a firm has often been unrelated to external collaboration (Díaz-Díaz, Aguiar-Díaz & De Saá-Pérez, 2006; Shane & Katila, 2003) since the possibility that learning processes might improve with age is countered by the risk that older firms gradually become less adaptive. Still some suggest that external consultancy is especially useful to newer firms (Smallbone, North & Leigh, 1993). The relationship of firm age to AC and to innovation has also been inconsistent (Huergo & Jaumandreu, 2004; Jung, Chow & Wu, 2003; Sorensen & Stuart 2000). In any case, AGE of the enterprise measured in the years, was included in our analysis.

Analysis. Logistic regression analysis was used to test the hypotheses since each of the dependent variables were dichotomies reflecting the presence or absence of a given form of collaboration with an external organization.

Results

Descriptive statistics associated with all the variables in the study are shown in Table 1.

Insert Table 1 about here

As expected, small firms comprised the majority of the sample (59%) followed by medium-sized (29%) and large (11%) enterprises. The majority of firms in the study (65%) subcontracted R&D services to external organizations, with TCs being used the most frequently (39%) followed by consultants (26%) and universities (24%). The proportion of firms involved in some type of collaboration was much higher than in some other studies involving mostly large companies (e.g., Belderbos et al., 2004; Tether, 2002; Un et al., 2010) where overall collaboration rates were lower by at least 20%.

Four logistic regressions are shown in Table 2, one for each of the dichotomous collaboration variables. Likelihood ratio tests revealed that the variance explained by each of the models was statistically significant ($p < .01$ or better).

Insert Table 2 about here

Hypothesis Tests

In line with studies dominated by large companies (e.g., Escribano, Fosfuri, & Tribó, 2009, Fabrizio, 2009; Negassi, 2004; Un et al., 2010) and consistent with H1a, Model 1 shows

that R&D INTENS positively related to the tendency of a firm to engage in R&D collaborations across the types of service intermediaries. On the other hand, contrary to Muscio (2007), the human capital oriented measure of AC (EDUCATION) was not related to collaboration overall. TC_COLLAB (see Model 2) was the only form of collaboration that was not positively associated with any of the measures of AC.

Also with regard to Model 1, both AGE and EXP_INTENS were positively associated with the likelihood of service collaborations but contrary to H1b, SIZE was not related to collaboration overall. This is contrary to many large company studies (e.g., Belderbos et al., 2004; Colombo & Paola, 1996; Fritsch & Lukas, 2001; Negassi, 2004; Tether, 2002; Un et al., 2010) and to the Muscio (2007) SME investigation. On the other hand, as Muscio (2007) noted, the size effect he observed was small in magnitude.

As a group, the AC variables were most strongly related to collaboration with universities (Model 3) where RD_INTENS and INT_RD_EXPEND were both positive predictors. Also with regard to this model, Hypothesis 2, that the education level of the R&D staff (EDUCATION) would be positively associated with UNIV_COLLAB was not supported. Though it was not hypothesized, CONSUL_COLLAB was also positively associated to UNIV_COLLAB (see Model 3). UNIV_COLLAB was the only significant predictor in Model 4, where CONSUL_COLLAB is the dependent variable. Thus university and consultancy R&D services might be complementary (Belderbos et al. 2004; Veugelers & Cassiman, 2005).

Consistent with H3a, EXP_INTENS was positively associated with collaboration in general (see Models 1). Nonetheless, differences were observed across the types of collaboration. In line with H3b, EXP_INTENS was negatively associated with UNIV-COLLAB but positively associated with TC_COLLAB (see Model 2) (cf. Garcia-Quevedo & Mas-Verdú, 2008).

Discussion

Summary

This is the first study to compare university, technology center and consultant service collaborations using a sample dominated by SMEs and is one of the few investigations of any kind concerning service intermediaries and SMEs. As hypothesized, various measures of AC were positively associated with the overall likelihood of collaboration- a finding that is well established among large companies. On the other hand, unlike many large company studies, firm size was not associated with service collaborations overall. Moreover, the proportion of firms engaged in R&D service collaborations (65%) was substantially higher than in some of the studies dominated by large firms. Finally, some of the hypothesized patterns concerning differences in the use of various services were found. For example, export intensity related negatively to collaboration with universities, but positively related to collaboration with technology centers. Firms that worked with universities tended to collaborate with consultants as well.

Contribution to scholarship

This work contributes to the literature by examining the specific determinants that lead SMEs to engage in R&D collaboration with universities, technology centers and consultants. The lack of empirical research concerning this is illustrated by the few direct comparisons that can be made to the existing literature. For example, the proportion of firms that used intermediaries here was twice as high as some other large company studies where a broader range of collaborators were included (e.g., Belderbos et al., 2004; Tether, 2002; Un et al., 2010). This difference could be considered simply as evidence that as theorized, SMEs are more likely than larger firms to engage in collaborations because of a greater need to overcome a relative lack of resources (cf.

de Jonga & Freel, 2010; Muscio, 2007). As noted earlier, the Community of Valencia is seen as one in which firms are in need of external resources (Mas-Verdú, 2007). Moreover, the firms in our sample were receiving public funding, which has been associated with an increased propensity to engage in R&D collaboration (Busom & Fernandez-Ribas, 2008; Un, Romero-Martínez & Montoro-Sánchez, 2009). On the other hand, the data from predominately large company studies were often collected nearly a decade ago (e.g., Belderbos et al., 2004; Tether, 2002; Un et al., 2009) leaving open the possibility that interest in collaboration has simply grown over time. Nonetheless, higher collaboration rates among SMEs per se cannot be ruled out since the Muscio (2007) data were obtained between 1999 and 2001, but still revealed high rates of collaboration (e.g., 52% with technology centers per se) relative to studies dominated by large companies.

Firm conclusions concerning intermediaries in innovation systems are also difficult to come by because the studies differ in their categorization of the types of collaboration involved (e.g., services, versus suppliers, competitors and customers), the degree to which the sample is restricted to active innovators, and variations in the size of the network being examined (e.g., local, regional, versus national). One exception to the inability to make fairly broad generalizations involves the positive association between AC and the likelihood of external collaboration.

Our findings support the idea that AC is positively related to external collaboration even among SMEs. Thus ultimately, AC is positively related to successful innovation (de Jonga & Freel, 2010; Muscio, 2007; Zhang & Li, 2010). Our results are likely to keep open the debate concerning the conceptualization and measurement of AC (e.g., Muscio, 2007; Lichtenthaler, 2009; Volberda, et al., 2010). For example, even the most commonly used proxies for AC (R&D

spending and R&D intensity) did not exhibit the same relationships as measures more directly reflective of human capital (e.g. level of education among R&D staff).

As some would expect (e.g., de Jonga & Freel, 2010), there was a positive relationship between service collaborations in general and the likelihood that the SME was an exporter. Still, as Zhang and Li (2010) implied it may be that not all services are of equal use to SME exporters. As hypothesized, among the services we studied, universities were the least less likely to be used by SME exporters. Interestingly, our model of the choice to collaborate with universities was more predictive than Muscio (2007) (24% versus 19%) mainly because ours included the export variable. On the other hand, Muscio (2007) placed greater emphasis on a wide range of AC indicators, which mattered in accounting for the use of technology center intermediaries. With that service category, Muscio (2007) accounted for 25% of the variance compared to 15% in our study. This difference was largely attributable to an AC-related predictor concerning whether the respondent was aware of the fact that their firm was part of an innovation system. Interestingly, of the services studied by Muscio (2007), awareness was associated with technology centers collaborations only.

Some apparently common sense relationships did not materialize. For example, we expected that cost considerations would result in a tendency for SMEs to collaborate more with universities than with consultants. As this was not the case, perhaps the perceived strengths of consultants were substantial enough to override the cost differences. For example, as noted earlier, relative to consultants, university services are sometimes seen as slow and unresponsive to specific customer needs (Tether, 2002). Interestingly, even though Zhang and Li, (2010) speculated that universities might be reluctant to partner with new ventures, Tether (2002) reported the proportion of large companies collaborating with universities to be only 16%, but

the 25% rate reported in another predominately large company study (Un et al., 2010) was more comparable to the 30% found among SMEs by Muscio (2007) and the 24% found here. Various investigations (Aleck et al., 2006; Cantwell and Piscitello, 2005) emphasize that the interaction between actors (companies, universities…) is linked with the geographical proximity which favours the transmission of knowledge, and with the acceptance of certain cultural norms (Hassink, 2005) that are unique to each specific context. Muscio (2007) noted there were twelve universities in the Lombardy Italy region he studied, which is a reminder of the potential relevance of variations across studies in the institutional infrastructure available to SMEs.

Applied implications

To the extent that AC related variables are associated with enhanced collaboration and ultimately with successful innovation even among SMEs (Muscio, 2007; Zhang & Li, 2010), the challenge for management is to ensure that AC-related investments, such as R&D infrastructure and personnel capabilities, are not abandoned or ignored in the face of other resource constraints. Our results also imply that the specific choice of collaborator matters. The export intensity of the firm provides the clearest example in this regard, since it was positively associated with technology center and consultant collaboration, but negatively related to involvement with universities. This finding might be especially critical for managers at SMEs who are relatively uninformed about the challenges of exporting (Yunus, 2010), and therefore will attempt to achieve competitive advantages in terms of differentiation by using, for instance, Technology Centers (Garcia-Quevedo & Mas-Verdu, 2008). In addition, the possibility that some services might be more helpful than others to SMEs is relatively unexplored. Among the private sector

services examined (technology, accounting and finance, legal, and talent search) by Zhang and Li (2010), only talent search was generally unrelated to product innovation.

As noted by Muscio (2007), to the extent that the findings concerning AC, collaboration and innovation can be extended to SMEs, there are important policy implications. Efforts by regions and national governments to encourage networking and clustering among SMEs seem appropriate, though the types of collaboration encouraged may need to be tailored to the needs and aspirations of the SME. Finally, tax breaks and other incentive to encourage the hiring of academically trained R&D people also appear to be well founded.

Limitations and Future Research

A major limitation of this study is that we did not measure the degree to which firms were engaged in innovation. Given the positive association between AC, service collaborations and innovation (Muscio, 2007; Zhang & Li, 2010) it is likely that at least some of the SMEs examined here were successful innovators. Nonetheless, it would have been informative to examine the links of each type of service to innovation per se. We also lacked data on the degree to which the collaborations involved were relatively local. Recently, de Jonga & Freel (2010) found that even among SMEs, 21% of the R&D collaborations were not local.

Given the small number of studies available concerning service collaborations among SMEs, there are many opportunities for future research. For example, as noted earlier, it has been argued that successful collaboration is especially important to SMEs because they need to compensate for their relative lack of resources. While this is likely to be true, enterprises with less resources can also compensate by competing in narrow markets where extensive manufacturing resources are not required (Katila & Shane, 2005). Thus, it is of interest to study SME collaboration patterns while accounting for variations in the nature of their competitive

environments. We concur with Volberda et al. (2010) that the field would benefit from the development and use of more sophisticated multifaceted measures of AC, since the positive association between AC and collaboration appears to hold for both large and small companies. Finally, more research is needed on the complementarities between different R&D partners to characterize firm's simultaneous access to them.

References

Alecke, B., Alsleben, F., Scharr, F. & Untiedt, G. (2006). Are there really high-tech clusters? The geographic concentration of German manufacturing industries and its determinants. *Annals of Regional Science*, vol. 40 (1), pp. 19-42.

Asheim B.T., Isaksen A, Nauwelaers C., & Tödtling F. (eds) (2003). *Regional Innovation Policy for Small-Medium Enterprises*, Edward Elgar: Cheltenham, UK. Northampton, MA. USA.

Audretsch, D., & Thurik, R. (1999). Do services differ from manufacturing? The post-entry performance of firms in Dutch services. In D. Audretsch and R. Thurik (Eds.), *Innovation, industry, evolution, and employment* (pp. 230–252). Cambridge: Cambridge University Press.

Bathelt, H. (2001). Regional competence and economic recovery: divergent growth paths in Boston's high technology economy, *Entrepreneurship and Regional Development* 13, pp. 287-314.

Baum, J.A.C. & Oliver, C. (1992) Institutional embeddedness and dynamics of organizational populations, *American Sociological Review*, 57, pp.540–559.

Belderbos, R., Carreeb, M., Diederen, B., Lokshin, B., & Veugelers, R. (2004). Heterogeneity in R&D cooperation strategies. *International Journal of Industrial Organization* 22, 1237–1263.

Beltramo, J., Paul, J., & Perret, C. (2001). The recruitment of researchers and the organization of scientific activity in industry. *International Journal of Technology Management*, 22, 811–834.

Belussi, F y Sedita, S.R. (2009). Life Cycles vs. Multiple Path Dependency in Industrial Districts", *European Planning Studies*, 17(4), pp.505-527.

Bennett, R. & Robson, P. (1999). The use of external business advice by SMEs in Britain. *Entrepreneurship and Regional Development*, 11, 155–180.

Benneworth, R. & Dawley, S. (2004). The territorial development of innovation support assets through university-business interactions. In R. Wink (Ed.), *Academia-business links. European policy strategies and lessons learnt* (pp. 197–223). Basingstoke, UK: Palgrave Macmillan.

Bernard, A. B., J. Bradford and K. P. Schott (2005). «Firms in International Trade», *Journal of Economic Perspectives*, vol. 21, n. º 3, pp. 105-130.

Bessant, J. & Rush, H. (1995). The globalization of technology: a new taxonomy. *Cambridge Journal of Economics.* Vol 19, pp 121-140.

Buckley, P.J & Ghauri, P.N (2004). Globalisation, Economic Geography and the Strategy of Multinational Enterprises. *Journal of International Business Studies*, 35(2) , 81-98.

Buckley, P.J, and Ghauri, P.N (2004). Globalisation, Economic Geography and the Strategy of Multinational Enterprises. *Journal of International Business Studies*, 35, 2, 81-98.

Busom, I. & Fernandez-Ribas, A. (2008). The impact of firm participation in R&D programmes on R&D partnerships, *Research Policy*, 37, (2), 240-257.

Cantwell, H. & Piscitello, L. (2005). Recent location of foreign-owned research and development activities by large multinational corporations in the European regions: the role of spillovers and externalities. *Regional Studies*, 39, pp. 1-16.

Capó-Vicedo, J., Expósito-Langa, M., Molina-Morales, F X (2011). La universidad en los distritos industriales ante el cambio en el contexto competitivo. *Investigaciones Regionales*. 19, pp. 137 - 145

Chesbrough, H. (2003). The era of open innovation. *MIT Sloan Management Review*, 44(3), 35–41.

Cohen, W. & Levinthal, D. (1989). Innovation and Learning: the Two Faces of R&D. *The Economic Journal*, 99, 569–596.

Cohen, W. M. & Levinthal, D.A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*. 35(1) Special Issue: technology, Organizations and Innovation (Mar. 1990), 128-152.

Colombo, M, & Paola, G. (1996). Technological cooperative agreements and firm's R&D intensity: a note on causality relations. *Research Policy* 25, 923– 932.

Cooke, P. (2003). The regional innovation system in Wales: evolution or eclipse?' in Cooke, P., Heidenreich, M. and Braczyk, H. (eds) *Regional Innovation Systems*. London: Routledge

Dahlander, L. & Gann, D. M. (2010). How open is innovation? *Research Policy* 39 (6) 699-709.

Davenport, S. (2005). Exploring the role of proximity in SME knowledge-acquisition. *Research Policy*, 34(5), 683–702.

de Jonga,, J, & Freel, M (2010). Absorptive capacity and the reach of collaboration in high technology small firms *Research Policy*, 39(1), 47-54.

Díaz-Díaz, N.L.; Aguiar-Díaz, I. & De Saá-Pérez, P. (2006). Technological knowledge assets in industrial firms. *R&D Management*, 32(2), 189–203.

Dodgson, M, Gann, D. & Salter, A. (2005). *Think, Play Do: Technology, Innovation, and Organisation*. London: Oxford University Press.

Doloreux, D. & Parto, S. (2005). Regional innovation systems: Current discourse and unresolved issues, *Technology in Society*, 27(2), 133 – 153.

Edquist, C., Ed. (1997). *Systems of Innovation: Technologies, Institutions and Organizations*. London, Pinter.

Edquist, C.; Hommen, L. (2008). *Small Country Innovation Systems*, Cheltenham: Edward Elgar.

Edwards, K. & Gordon, T. (1984). Characteristics of innovations introduced on the U.S. market in 1982. Washington, DC: The Futures Group and U.S. Small Business Administration.

Ernst, D. (2007). Beyond the 'Global Factory' model: innovative capabilities for upgrading China's IT industry, International *Journal of Technology and Globalisation*, 3(4), 437 – 459

Escribano, A., Fosfuri, A., & Tribó, J (2009). Managing external knowledge flows: The moderating role of absorptive capacity *Research Policy*, 38(1), 96-105.

Fabrizio, K.R. (2009) Absorptive capacity and the search for innovation. *Research Policy* 38(2), 255-267.

Fernández de Lucio, I., Mas-Verdu, F. and Tortosa, E. (2010). Regional innovation policies: the persistence of the linear model in Spain, *The Service Industries Journal*, 30: 5, 749-762.

Filippetti, A & Archibugi D. (2011). Innovation in Times of Crisis: National Systems of Innovation, Structure, and Demand *Research Policy* (forthcoming).

Fleming, L. & Frenken, K. (2006). The Evolution of Inventor Networks in Silicon Valley and Boston Region. Papers in Evolutionary Economic Geography 06,09, Utrecht University.

Fritsch, M. & Lukas, R., (2001). Who co-operates on R&D? *Research Policy* 30, 297–312.

García Quevedo, J; .Mas Verdú, F. Polo-Otero, J (2011) R&D human resources in firms: What determines the educational level required? *Applied Economics Letters* DOI: 10.1080/13504851.2010.548774

García-Quevedo, J. & Mas-Verdú, F (2008). Does only size matter in the use of knowledge intensive services? Small Business Economics, 31(2), 137-146.

Garnsey, E. & Heffernan, P.(2005). High-technology Clustering through Spin-out and Attraction: The Cambridge Case. *Regional Studies* 39, 1127-1144.

Gassmann O., Enkel, E. & Chesbrough H. (2010). The future of open innovation *R&DManagement* 40(3), 213–221.

Gertler, M.S. (2010). Rules of the game: the place of Institutions in Regional Economic Change, *Regional Studies*, 44(1), 1-15.

Gertler, M.S. (2010). Rules of the game: the place of Institutions in Regional Economic Change, *Regional Studies*, 44(1), 1-15.

Greunz, L. (2004). Industrial structure and innovation-evidence from european regions. Journal of evolutionary economics, 14(5), 563-592.

Gunasekara, C. (2006). Universities and associative regional governance: Australian evidence in non-core metropolitan regions', *Regional Studies*, vol. 40, no. 7, pp. 727 – 741.

Gunasekara, C. (2006).Universities and associative regional governance: Australian evidence in non-core metropolitan regions, *Regional Studies*, 40(7), 727 – 741.

Hargadon, A. (1998). Firms as knowledge brokers: lessons in pursuing continuous innovation. *California Management Review* 40, 209-227.

Hassink, R. (2005). How to unlock regional economies from path dependencies? From learning region to learning cluster. *European Planning Studies*, 13, pp. 521-535.

Helpman, E. (2006). Trade, FDI, and the Organizations of Firms, *Journal of Economic Literature*, (XLIV), 589-630.

Howells, J. (2006). Intermediation and the role of intermediaries in innovation, *Research Policy*. 35, 715-728.

Huergo, E. & Jaumandreu, J. (2004). How does probability of innovation change with firm age? *Small Business Economics*, 22, 193–207.

Huggins, R., Jones, M. & Upton, S. (2008) Universities as drivers of knowledge-based regional development: a triple-helix analysis of Wales, *International Journal of Innovation and Regional Development*, (1), 1, 24 – 47.

Inkinen,T. & Suorsa, K. (2010) Intermediaries in Regional Innovation Systems: High-Technology Enterprise Survey from Northern Finland *European Planning Studies*, 18(2), 169 – 187.

Johnson, S., Smallbone D. & Froud, M. (1998). Support for new and micro enterprises: The case for selectivity. Paper presented at the *Institute of Small Business Affairs Annual Conference*. Durham.

Jung, D.I., Chow, C. & Wu, A. (2003). The Role of Transformational Leadership in Enhancing Organizational Innovation: Hypotheses and Some Preliminary Findings. Leadership Quarterly 14, 525–544.

Katila R & Shane S. 2005. When does lack of resources make new firms innovative? Academy of Management Journal 48, 814–829.

Keeble, D. & Wilkinson, F. (Eds.) (2000) *High-Technology Clusters, Networking and Collective Learning in Europe*, Aldershot: Ashgate.

Klofsten M. & Jones-Evans D.(2000). Comparing Academic Entrepreneurship in Europe –The Case of Sweden and Irely, *Small Business Economics*, 14(4), 299-309.

Kuusisto, J. (Ed.) (2005). Knowledge-intensive service activities in the Finnish forest and related engineering and electronics industries (Forenel) cluster. A research report for the OECD KISA focus group by ETLA, SC-Research and VTT. Paris: OECD.

Lambooy, J.G. (2005). Innovation and knowledge: theory and regional policy. *European Planning Studies*, 13(8),, 1137 – 1152.

Landabaso M. & Mouton, B. (2005). Towards a Different Regional Innovation Policy: Eight Years of European Experience through the European Regional Development Fund Innovative Actions in van Geenhuizen, M., Gibson, D. V., and Heitor, M. V., (eds), *Regional Development and Conditions for Innovation in the Network Society*, Layfayette, IN: Purdue University Press.

Lee, C. M., Miller, W. F., Hancock, M.G. & Rowen, H.S. (Eds.) (2000). Th*e Silicon Valley Edge: A Habitat for Innovation and Entrepreneurschip.* Stanford: Stanford University Press.

Leiponen, A., (2001). Why do firms not collaborate? The role of competencies and technological regimes. In: Kleinknecht, A., Mohnen, P. (Eds.), Innovation and Firm Performance: Econometric Exploration of Survey Data. Palgrave, pp. 253– 277.

Leslie, S. (1993). The Cold War and American science: the military-industrial- academic complex at MIT and Stanford. New York: Columbia University Press.

Leslie, S. (2000). The Biggest Angel of Them All: The Military and the Making of Silicon Valley. In *Understanding Silicon Valley: the anatomy of an entrepreneurial region*, edited by Martin Kenney. Stanford, Calif.: Stanford University Press.

Liao, J.; Welsch, H., and Stoica, M. (2003). Organizational Absorptive Capacity and Responsiveness: An Empirical Investigation of Growth-Oriented SMEs. *Entrepreneurship: Theory & Practice*, 28, 1, 63-86

Lichtenthaler, U. (2009). Absorptive Capacity, Environmental Turbulence, and the Complementarity of Organizational Learning Processes *The Academy of Management Journal* 52(4), 822 – 846.

Lundvall, B.A., Ed. (1992). *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*. Londres, Pinter.

Mantel, S.J. & Rosegger, G. (1987). The role of third-parties in the diffusion of innovations: a survey. In: Rothwell, R.; Bessant, J. (eds.): *Innovation: Adaptation and Growth*. Elsevier, Amsterdam, pp. 123-134.

Markusen A. & Bloch R. (1985). Defensive cities: military spending, high technology and human settlements. In: Castells, M., Editor. *High Technology, Space & Society*, Sage, Beverly Hills.

Mas-Verdú, F. (2007). Services and innovation systems: European models of Technological Centres. *Service Business. An International Journal*, 1, 7–23.

McEvily, B. & Zaheer, A. (1999). Bridging ties: a source of firm heterogeneity in competitive capabilities, *Strategic Management Journal*, 20, 1133–1156.

Miles, I. (2007). Business Services and their Users: a literature review, in: L.Rubalcaba and H.Kox, eds., Business services in European economic growth, Palgrave MacMillan.

Molina-Morales, F.X. (2005). The territorial agglomerations of firms: A social capital perspective from the Spanish tile industry. *Growth and Change*, 36(1), 74–99.

Muller, E. & Zenker, A. (2001). Business services as actors of knowledge transformation: The role of KIBS in regional and national innovation systems. Research Policy, 30(9), 1501–1516.

Muscio, A. (2007). The impact of absorptive capacity on SME's collaboration. *Economics of Innovation and New Technology* 16, 653–668.

Negassi, S. (2004). R&D co-operation and innovation: A microeconometric study on French firms. *Research Policy* 33, 365–384.

Pearce, J. & Robbins, K. (2008). Strategic transformation as the essential last step in the process of business turnaround. *Business Horizons*, 51, 121-130.

Provan, K.G. & Human, S.E. (1999). Organizational learning and the role of the network broker in small-firm manufacturing networks. In: Gryori, A. (ed.): *Interfirm Networks: Organization and Industrial Competitiveness*. Routledge, London, pp. 185-207.

Salomon, R.M. & Shaver, J.M. (2005). Learning by exporting: new insights from examining firm innovation. Journal of Economics and Management Strategy, 14(2), 431–460.

Sapsed, J., Grantham, A. & De Fillippi, R. (2007). A bridge over troubled waters: bridging organizations and entrepreneurial opportunities in emerging sectors in *Research Policy*, 36, 1314-1334.

Saxenian, A. (1988). The Cheshire Cat's Grin: Innovation and Regional Development in England. *Technology Review* 91.

Shane, S. & Katila, R. (2003). When are new firms more innovative than established firms? *Robert H. Smith School of Business Working Paper*, University of Maryland.

Slaughter, S., Campbell, T., Holleman, M., & Morgan, E. (2002). The ‘‘traffic’’ in graduate students: Graduate students as tokens of exchange between academe and industry. *Science, Technology, & Human Values*, 27, 282–312.

Smallbone, D., North, D. & Leigh, R. (1993). The use of external assistance by mature SMEs in the UK: Some policy implications. *Entrepreneurship and Regional Development*, 5, 279–295.

Sorensen, J. B. and Stuart, T. (2000). Aging, obsolescence, and organizational innovation. *Administrative Science. Quarterly*. 45(1) 81-112.

Spithoven, A. Clarysse, B. & Knockaert, M. (2010). Building absorptive capacity to organise inbound open innovation in traditional industries *Technovation*. 30(2), 130-141.

Stankiewicz, R. (1995). The role of the science and technology infrastructure in the development and diffusion of industrial automation in Sweden. In: Carlsson, B (ed.): *Technological Systems and Economic Performance: The case of Factory Automation*. Dordrecht, Kluwer, pp. 165-210.

Tether, B S. (2002). Who co-operates for innovation, and why: An empirical analysis. *Research Policy*, 31(6), 947-967.

Tether, B. (2003). The sources and aims of innovation in services: Variety between and within sectors. *Economics of Innovation and New Technology*, 16, 481–506.

Todtling, F. & Trippl, M. (2005). One size fits all? Towards a differentiated regional innovation policy approach’, *Research Policy*, 34(8), 1203-1219.

Un, C. A., Cuervo-Cazurra, A. & Asakawa, K., (2010) R&D Collaborations and Product Innovation. Journal of Product Innovation Management, 27, 673-689.

Un, C.A.; Romero-Martínez, A. M. & Montoro-Sánchez, A. (2009). Determinants of R&D collaboration of service firms. Service Business, 3, 373-394.

Veugelers, R. & Cassiman, B. (2005). R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing. *International Journal of Industrial Organization*, 23(5-6), 355-379.

Volberda, H.; Fos N. & Lyles, M.A. (2010). Absorbing the Concept of Absorptive Capacity: How to Realize Its Potential in the Organization Field *Organization Science*. 21(4), 931-951.

Wallgren, L., & Dahlgren, L. O. (2005). Doctoral education as social practice for knowledge development Conditions and demands encountered by industry PhD students. *Industry and Higher Education*, 19, 433–443.

Yumas, M. (2010). Barriers to export and export promotion programs: Insights from SME managers. Queensland University of Technology

Zhang, Y. & Li, H. (2010). Innovation search of new ventures in a technology cluster: the role of ties with service intermediaries *Strategic Management Journal*. 31(1), 88–109.

Table 1. Descriptive Statistics.

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1. COLLAB	.65	.48	1.000										
2. TC_COLLAB	.39	.49	.579	1.000									
3. CONSUL_COLLAB	.26	.44	.430	.117	1.000								
4. UNIV_COLLAB	.24	.43	.415	.079	.230	1.000							
5. AGE	22.52	16.05	.113	.097	-.087	-.053	1.000						
6. SIZE	1.52	.69	.038	.096	.026	.159	.347	1.000					
7. EDUCATION	.84	.37	.064	-.054	.035	.166	.121	.086	1.000				
8. RD_INTENS	.10	.18	.106	-.001	.091	.102	-.336	-.350	.096	1.000			
9. INT_RD_EXPEND	309	645	.121	.140	.106	.242	.032	.349	.159	.062	1.000		
10. RD_DEPT	.66	.48	-.084	-.002	-.038	.005	.105	.129	.120	.034	.114	1.000	
11. EXP_INTENS	.15	.23	.163	.283	.108	-.059	.247	.228	.084	-.169	.217	-.042	1.000

Table 2. Models of Service Collaborations Across Types and By Type

Model	(1) COLLAB	(2) TC_COLLAB	(3) UNIV_COLLAB	(4) CONSUL_COLLAB
Intercept	-0.223	-0.767	-3.565	-1.414 *
	(0.54)	(0.54)	(0.83)	(0.62)
AGE	0.024 *	0.009	-0.008 *	-0.018
	(0.01)	(0.01)	(0.01)	(0.01)
SIZE	-0.030	-0.025	0.641	0.073
	(0.26)	(0.26)	(0.30)	(0.30)
EDUCATION	0.100	-0.743	1.219	-0.062
	(0.40)	(0.41)	(0.66)	(0.47)
RD_INTENS	0.026 *	0.008	0.008 *	0.008
	(0.01)	(0.01)	(0.01)	(0.01)
INT_RD_EXPEND	0.001	0.000	0.001 *	0.000
	(0.00)	(0.00)	(0.00)	(0.00)
RD_DEPT	-0.534	0.021	-0.210	-0.138
	(0.33)	(0.32)	(0.38)	(0.35)
EXP_INTENS	1.571 *	2.529 **	-2.388 **	1.318
	(0.79)	(0.72)	(1.04)	(0.74)
TC_COLLAB			0.507	0.375
			(0.37)	(0.35)
CONSUL_COLLAB		0.476	1.169 **	
		(0.37)	(0.39)	
UNIV_COLLAB		0.311		1.082 **
		(0.35)		(0.38)
N	215	215	215	215
Chi-2 (df)	20.85 (7) **	24.77 (9) **	36.9 (9) **	18.36 (9) **
-2LL	258.47	262.93	198.68	226.16
Nagelkerke R^2	0.13	0.15	0.24	0.12

Standard errors in parentheses. * p < .05 ** p < .01.