Collaboration with whom? SMEs at a Crossroad between R&D partnership exploration and exploitation

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Alfredo D'Angelo - Alessandro Baroncelli

Abstract

Purpose of the paper: *Collaboration with external partners is essential for small- and medium-sized enterprises (SMEs) that want to innovate. The purpose of this paper is to examine the impact of three different types of R&D collaborations, namely with universities, research centres and other companies, on SMEs' product innovation and innovation performance.*

Methodology*: Hypotheses are tested using a Probit/Tobit regression on an Italian sample of manufacturing SMEs.*

Findings*: Our analysis shows that collaborating with universities has a positive impact on product innovation, but not on innovation performance. Whereas, collaboration with research centres and other companies has a positive impact on both product innovation and innovation performance.*

Research limits: *Our results refer to a specific area, Italy, and to a specific period, so that the usual problem of generalisability across time and space arises. Moreover, we focussed on R&D partners considering only three groups, universities, research centres and other companies. For the latter, data at our disposal allowed us to differentiate neither between rival/not rival companies nor on the basis of their industry, size or geographic location.*

Practical implications: *Our findings provide implications for SMEs managers and entrepreneurs who have to decide between R&D partners for their explorative vs exploitative outside-in innovation strategy. Our findings reveal the need to align different R&D partners with different expectations and final outcomes.*

Originality of the paper: *Previous studies shed minimal light on open innovation practices in the SMEs context. Just a few looked at the effect of different R&D partners on product or process innovation and innovation performance (this latter often measured with product or patent number) but separately. We looked at the effects of different R&D collaborations on both product innovation as well as the monetization side of the SMEs innovation process.*

Key words: inbound open innovation; product innovation; innovation performance; R&D collaboration; manufacturing SMEs.

1. Introduction

The size-innovation relationship has often been ambiguous in academic research. Indeed, it has long been assumed that large firms were the only

businesses able to carry out innovative activities (Damanpour and Evan, 1984). Nevertheless, several studies revealed that bigger firms can often be locked in their organizational routines and bureaucratic constraints producing inertia towards innovation (Acs and Audretsch, 1990; Link and Bozeman, 1991; Rothwell and Dodgson, 1994). In the last three decades, many scholars (e.g. Bougrain and Haudeville, 2002; Freel, 2005, Freel and Robson, 2004; Hanna and Walsh, 2008; Nieto and Santamaria, 2010; Rothwell and Dodgson, 1991) have shown that also small and medium-sized enterprises (SMEs) - thanks to their flexibility and ability to efficiently leverage resources or missing knowledge from external partners - were able to more than compensate their size limits (Edwards *et al.*, 2005; Hewitt-Dundas, 2006) and to consequently develop novel and disruptive innovations (Tether, 1998; Vossen, 1998). Lee *et al.* (2010) noted that the external focus could put SMEs at the forefront of the innovation process.

The external focus of including ideas, knowledge and technologies originated in external sources is one of the key points behind the Open Innovation (OI) framework (Chesbrough, 2003; Gassmann, 2006; Huizingh, 2011). The OI paradigm assumes that valuable ideas, knowledge and technologies can come from both inside and outside the firm and can equally reach the market from inside or outside the company (Chesbrough, 2003; Chesbrough *et al.*, 2006). It thus comprises both inbound and outbound movements of ideas, knowledge and technologies (Lichtenthaler, 2008). Lee *et al.* (2010) observed that inbound open innovation practices are more common in larger companies, whereas smaller companies were more involved in outbound open innovation. Other researchers, instead, showed that SMEs do operate open inbound R&D management practices (Huizingh, 2011; Inauen and Schenker-Wicki, 2011; van de Vrande *et al.*, 2009) as "these firms are in a position to use external generated knowledge rather than create it" (West *et al.*, 2014, p. 806).

How SMEs organize and manage inbound open innovation practices and whether the adoption of those practices increases different dimensions of SMEs' performance (Gassmann *et al.*, 2010; van de Vrande *et al.*, 2010; Wynarczyk *et al.*, 2013) remains still controversial. According to a recent study conducted by the Digital Transformation Academy in collaboration with PoliMI (2020), only 28% of SMEs in Italy have embraced OI. However, 20% of SMEs have R&D collaborations with partners like universities and research centers and only 4% with other horizontal companies. The purpose of this paper is to examine the influence that R&D collaborations with partners like universities and research centers (Fontana *et al.*, 2006; Spencer, 2001) as well as with other horizontal companies (e.g. Shin *et al.*, 2016) have on SMEs' product innovation and innovation performance. However, different from previous studies that looked at their effects on product or process innovation and innovation performance (this latter often measured with product or patent number) separately[1], we looked at the effects of different R&D collaborations on both product innovation as well as the monetization side of the SMEs' innovation process (Freel, 2005; Stone *et al.*, 2008).

[1] See Kang and Kang (2010, p. 948 Table 1), Medda (2018, p. 8 Table 1) and Pippel and Seefeld (2016, p. 458 Table 1) for a review.

2. Theoretical framework and hypothesis development

2.1 Open innovation paradigm

'The use of purposive inflows and outflows of knowledge to accelerate innovation..' is the most used definition of OI (Chesbrough *et al.*, 2006, p. 1). As Lichtenthaler (2008) noted, it comprises both outside-in and inside-out movements of ideas, knowledge and technologies. According to Gassmann (2006), OI encompasses three core processes namely inbound, outbound and coupled activities.

Inbound open innovation, also called outside-in process, refers to the internal use of external generated knowledge and includes all activities for external technology sourcing such as customer involvement, external networking, external participation, outsourcing R&D and IP in-licensing (van de Vrande *et al.*, 2009). As previously mentioned, this inbound open innovation process focuses on technology exploration which enables enterprises to acquire new knowledge and technologies from sourcing and networking with external knowledge providers and innovative upstream companies (Chesbrough *et al.*, 2006).

Outbound open innovation, also known as inside-out process, refers to the external use of internal generated knowledge and it includes all activities related to technology commercialisation such as sales of projects, spinoffs, provision of services and IP out-licensing (van de Vrande *et al.*, 2009). This outbound open innovation process relates to technology exploitation which enables enterprises to transfer new knowledge and technologies to external downstream companies in order to exploit the commercial value of innovation (Enkel *et al.*, 2009; Litchtenthaler, 2005).

Coupled open innovation combines outside-in and inside-out processes resulting in alliances and joint ventures, where the focus lies on network usage and/or the participation of other firms (Chesbrough, 2003; Gassmann, 2006).

At the beginning, the realm of OI studies was mainly focused on large multinational enterprises (e.g., Chesbrough and Crowther, 2006; West and Gallagher, 2006). Subsequently, many studies on OI in SMEs have followed (e.g. Brunswicker and Vanhaverbeke, 2014; Parida *et al.*, 2012; Spithoven *et al.*, 2013; Usman and Vanhaverbeke, 2017; van de Vrande *et al.*, 2009; Vanhaverbeke, 2012). Podmetina *et al.* (2011) presented evidence on how companies of different size, rather than having different degrees of openness, adopt different open business models and remarked inbound OI practices which are being prevalently used in SMEs. Albors-Garrigós *et al.* (2011) highlighted the inbound OI practices in SMEs as an alternative method for outsourcing R&D services following a more strategically focused approach.

In the next paragraph, while revising the OI literature in the context of small firms, we report the main empirical studies examining the effect of some key horizontal R&D collaborations on the SMEs' innovation outcomes in order to develop working hypotheses.

2.2 Inbound open innovation in SMEs

The potential advantages from innovation partnerships are well documented in literature (e.g., Ahuja, 2000a; Bayona *et al.*, 2000; Faems *et al.*, 2005). They include benefits such as flexibility, reducing or sharing risk and access to complementary assets and resources (e.g., Ahuja, 2000b; Ireland *et al.*, 2002; Lorenzoni and Lipparini, 1999). Chesbrough and Schwartz (2007, p. 55) defined collaboration as "a mutual working relationship between two or more parties aimed at creating and delivering a new product, technology, or service". Through collaborative development projects with external partners SMEs can acquire necessary complementary assets, useful to facilitate the commercialization of their innovation outputs (Spithoven *et al.*, 2013). Collaboration activities facilitating the transfer of codified and tacit knowledge may also support the SMEs' development of new and valuable resources (Ahuja, 2000b; Laursen and Salter, 2006; Massa and Testa, 2008). Finally, SMEs' R&D risks and costs can be spread through inter-organizational collaboration projects with external partners (Bougrain and Haudeville, 2002; Freel, 2005; Nieto and Santamaría, 2010). SMEs tend to collaborate horizontally with external partners such as universities, research institutes, other companies, and vertically with customers and suppliers (e.g., Aquilani *et al.*, 2016; Dowling and Helm, 1996;Hanna and Walsh 2008; Massa and Testa, 2008; Nieto and Santamaria, 2010; Shin *et al.*, 2016; Veugelers and Cassiman 2005).

With reference to these horizontal inbound practices, we referred to the theoretical concepts of exploration and exploitation (March, 1991) in order to derive working hypotheses on their influence on the SMEs' product innovation and innovation performance.

Lee *et al.* (2010) found that SMEs tend to prefer universities and research centers for technology sourcing to other R&D strategic alliances. Roper and Hewitt-Dundas (2013) also reported similar results, but with universities and research centers having a bias towards larger firms (medium-sized, 51-250 employees). Brunswicker and Vanhaverbeke (2014), drawing on a large sample of SMEs labeled those recurring to external knowledge sourcing from universities and research centers as technology-oriented searchers. Acknowledging that there are barriers to external knowledge sourcing from universities and research centers because of cultural differences, differences in the strategic orientation and different contractual rules and rewards systems (Harryson *et al.*, 2008), Brunswicker and Vanhaverbeke (2014) underlined their trustworthy role being important not only for the access to complementary resources (Veugelers and Cassiman 2005), but also to anticipate inventive trends.

Many studies reported that explorative R&D collaboration with universities has a positive effect on product innovation (Aschhoff and Schmidt, 2008; Belderbos *et al.*, 2015; Kang and Kang, 2010; Medda, 2018; Un *et al.*, 2010), enhancing the SME's innovation performance (Belderbos *et al.*, 2004; Laursen and Salther, 2006; Parida *et al.*, 2012; Zeng *et al.* 2010). Therefore, following these positive outcomes, we hypothesize that:

HP1 - R&D collaborations with universities and research institutes positively influence the SMEs' product innovation as well as their innovation performance.

OI inbound practices by SMEs also include other horizontal technology collaborations with other companies (Parida *et al.*, 2012). Santoro *et al.* (2016) in a recent survey on smaller firms engaged in OI reported that 31% comes from other companies. R&D collaborations with other companies allow the focal firm to share the risk and combine resources and skills inherent to the innovation process (Veugelers andCassiman , 2005). However, appropriability issues may emerge around the benefits of the research investment (Hewitt-Dundas, 2006) given the exploitative nature of the collaboration and the opportunistic nature of firms, particularly when they are rivals. Hakanson and Lorange (1991), however, asserted that whether the R&D partner is a rival or not, they improve a firm's knowledge base enhancing innovation. The impact on the innovation performance of the collaborations with other firms remains quite controversial in literature (Medda, 2018). Belderbos *et al.*, (2004) show that an R&D collaboration with competitors has a positive effect on product innovation, whereas Aschhoff and Schmidt (2008) find no positive effect. Un *et al.* (2010) reported a negative effect on product innovation when external R&D was carried out by competitors. Belderbos *et al.* (2015) found again a positive correlations with product innovation when cooperation with competitors is carried out for two consecutive years. Kang and Kang (2010) reported an inverted u-shape effect on product innovation when external R&D is carried out by competitors.

Given this contested terrain made of confusing and chaotic results, we prefer to remain neutral and wait for empirical validation. Therefore, we hypothesize that:

HP2 - There is a relationship between external R&D carried out with other companies and the SMEs' product innovation as well as their innovation performance.

3. Data and methodology

3.1 The dataset

To test the hypotheses we used data from the IX wave of the "Survey on Manufacturing Firms" conducted by the research department of Capitalia (now Unicredit, a large Italian bank). We relied on a secondary data source based on both questionnaire data and balance sheet information on a representative sample of manufacturing firms operating in Italy. The joint use of both sources of information (i.e. balance sheets and surveys) makes this dataset a very reliable source of information allowing us to overcome the methodological limitations occurring when using only one source of information (Canibano *et al.*, 2000). Moving from the original dataset accounting 3,452 observations, we defined SMEs according to

the EU Commission definition (2003) which considers two thresholds, the number of employees (>10 and <250) and the total turnover (<50 million euro). The decision to concentrate on SMEs resides in the fact that they represent almost 99% of all enterprises in the EU, providing around 100 million jobs or 67% of the total employment in Europe (European Commission, 2003). Italy is the European country with the greatest number of SMEs per inhabitants (65 SMEs per 1,000 inhabitants). Thus, the relative importance of SMEs for the Italian economy exceeds by far the EU average (Eurostat, 2008). Having defined our unit of analysis, the standard data cleansing operations lead us to a reduced working sample of 2,591 Italian manufacturing SMEs on which to test the relationship between our predictors and innovation measures.

3.2 The variables and measures

Innovation has been measured in different ways due to its multidimentional nature (Cefis and Marsili, 2006). We measured the firms' innovativeness using product innovation as a proxy of the capacity of firms to produce tangible innovative results (De Jong and Vermeulen, 2006; Kang and Kang, 2010). The variable assigns the value of 1 to the firms that introduced a new product innovation, and the value of 0 to the firms that did not introduce product innovation (*Inn Prod*). However, product innovation, as tangible result of the firm's innovation activity, represents only a pre-market result of such activity (Barlet *et al.*, 2000). In other words, firms that generate product innovations are not guaranteed to have their products welcomed by the marketplace. The higher level of sales which derived from introducing a new innovation into the marketplace, represents the ex-post result of this process (Brouwer and Kleinknecht, 1996; Freel, 2005; Hewitt-Dundas, 2006). This is in line with the definition of innovation provided by the entrepreneurs themselves: "innovation is anything that makes money" (Massa and Testa, 2008, p. 396). Following Brouwer and Kleinknecht (1996) and Aschhoff and Schmidt (2008), we used the percentage of turnover derived from introducing innovation into the marketplace to measure the firm's innovation performance (*Turn Inn*). This variable gauges the monetization side of the firm's innovation process (Freel, 2005; Stone *et al.*, 2008).

Our independent variables consist in a series of measures evaluating the innovation process that is undertaken in collaboration with outside R&D partners, diversifying a set of external R&D collaborations as percentage of sales. Following previous studies (Inauen and Schenker-Wicki, 2011) we defined OI as a model for innovation based on cooperation with different stakeholders during the R&D process. Here, we used measures that consider three groups of R&D partners, Ext R&D done by universities; *Ext R&D done by research centres; Ext R&D done by other companies.*

Innovation outputs can also strongly depend on other endogenous and exogenous factors such as R&D investments, firm size, business age, economic sectors and home location industrial environment. Therefore, we considered the R&D employees to total employees (*R&D EMP*) as a control variable for a small firm's R&D investments. As previous studies

(Santoro *et al.*, 2019) showed, internal R&D helps firms in improving the effects of a higher level of openness. We also controlled for firm size measured as number of employees (*Size*) so as to see whether they can be held constant as they can affect both product innovation and innovation performance (Lin and Chen, 2007). We also controlled the effect of the firm's maturity, i.e. years in business (*Age*). Furthermore, we controlled the home country location effect by introducing four dummy variables (*North-East, Centre, South and Islands*). Finally, we considered the industry effect including control variables for the 4 economic industry sectors defined by Pavitt's (1984), *Traditional, Scale, Specialised and High-tech sectors*.

3.3 The method

We applied different statistical techniques according to the different nature of our dependent variables. Two models are developed to examine the influence of an open outside-in R&D model on (i) the probability of producing product innovation and (ii) innovation performance. We relied on the hierarchical Probit and Tobit regression models. The reason for the Tobit regression rather than the OLS estimates is that the dependent variable is a doubly truncated random variable and its values vary between 0 and 100 by definition. The Tobit model is a generally used approach for dealing with the problem of censored samples (Greene, 2000). The same method was applied by previous scholars in similar cases (Aschhoff and Schmidt, 2008; Brouwer and Kleinknecht, 1996; Hewitt-Dundas, 2006). Due to the possible mutual causation relationship between the dependent and the independent variables, a lag structure approach was adopted. The data collected through the Capitalia Survey allowed us to measure the independent variables with a lag time period of three years compared to our target variables. This is in line with the OECD (2005) recommendation of taking into account a three-year period when measuring innovation since it is a path dependent process which may take some time to manifest its effects. In order to deal with the problems of causality due to the possible endogenous nature of the variables, the use of lagged rather than contemporaneous variables represent a strategy that allows alleviating the possibility that independent variables and the dependent variable are jointly determined (Spanos *et al.*, 2004).

4. Empirical analysis and results

Table 1 shows the results of the Probit and Tobit analysis. After the inclusion of the control variables, we tested our hypotheses predicting a positive effect of an inbound outside-in R&D model on the firms' product innovation and innovation performance. Our results show that all the three groups of R&D partners considered, universities, research centres, and other companies, have a positive influence on product innovation, but only the R&D collaboration with research centres and other companies has a positive influence on generating higher level of innovation performance. In the next section, we discuss these main results in the light of the theory to highlight our contribution, limitation and avenues for future research.

Tab. 1: Estimated Probit and Tobit models
(Dependent variables: product innovation; % of turnover derived from innovations)

	Model 1	
	Inn Prod	Turn Inn
Ext. R&D done by universities	+*	+
Ext. R&D done by research centres	+**	+**
Ext. R&D done by other companies	+***	+***

NOTE 1: *** p < 0.01; ** p < 0.05; * p < 0.10.
NOTE 2: Positive coefficients denote a greater probability of product innovation or percentage of turnover

Source: Authors' elaboration

5. Discussion and conclusions

SMEs represent the backbone of most economies in the world (95% of all firms in OECD countries are SMEs providing around two-thirds of the total employment). The increasing competition and the critical current economic scenario force them to engage in innovation in order to survive (OECD, 2017). Despite their flexibility and little routines, the liability of smallness and resource constraints put SMEs in a relatively weak position when tackling the complexity of any innovative process (Narula, 2004). One viable solution for SMEs to successfully engage in innovation is to collaborate embracing OI practices (Spithoven *et al.*, 2013; van de Vrande *et al.*, 2009).

By building on the OI framework as an integrated part of the companies' innovation strategies (Enkel *et al.*, 2009), this paper has focused on the inbound R&D model, also called outside-in process, which refers to the internal use of knowledge from external horizontal R&D partners such as universities, research institutes, and other companies. Despite the factors hindering the adoption of OI in SMEs (Bigliardi and Galati 2016), these firms do not lag behind large firms (Capone *et al.*, 2018). The inbound R&D model is the OI practice mostly used by SMEs and the main aim of this paper has been to understand what type of R&D partners have an impact on the SMEs' product innovation as well as innovation performance.

Despite the increased interest of practitioners and researchers in collaborative innovation, we know surprisingly little about the micro-foundations of collaborative innovation (Bogers *et al.*, 2017). Our research setting made of SMEs is ideal for micro-foundations studies given the tight connection between the entrepreneur and the OI strategy of the company (van de Vrande *et al.*, 2009; Vanhaverbeke, 2012).

The main findings revealed that the innovation process of SMEs, characterised by inbound R&D collaborations (Inauen and Schenker-Wicki, 2011; Lee *et al.* 2010) with universities, research centres and other companies, has a positive influence on the firm's product innovation (Dowling and Helm, 2006; Pippel and Seefeld, 2016; Un *et al.*, 2010). However, our results show a weak role played by universities as R&D partners for not generating a higher level of turnover from innovation. Our findings

are in contrast to Balderbos *et al.* (2004) who find a significant positive effect of university cooperation on the growth of new-to-the-market sales. Although universities are increasingly becoming commercially-oriented institutions, they play their role as the enabler of novelties (i.e. product innovation), but not for generating innovation performance. The possible spill-over effects related to the R&D collaboration with universities are therefore limited to the production of new product innovations (Medda, 2018). Generally, public research institutions such as universities have a scientific incentive towards research results. On the contrary, private firms have an economic incentive towards monetary results. This pecuniary incentive aligning interests of both sides (focal and partner companies) may counterbalance potential opportunistic behavior justifying the second main finding that shows that R&D collaborations with research centres and other companies has a positive influence not only on the SMEs' product innovation but also on their innovation performance (Freel and Robson 2004; Hewitt-Dundas, 2006; Lee *et al.* 2010; Lichtenthaler 2005; Zeng *et al.*, 2010).

5.1 Managerial implications

In the last decades, collaborative innovation has been considered essential for SMEs. They collaborate with several partners but they may have a preference for universities because of the fear of giving away technology to potential competitors. This is because collaborations with universities, although characterised by high uncertainty, high information asymmetries between partners and high transaction costs, they are not seen as direct competitors of the focal firm. However, the SMEs' managers and business owners have to keep in mind that, while collaborations with universities may help them in exploring and developing new innovative products, it is by collaborating with research centers and other horizontal companies that they can reach the output markets exploiting their innovation efforts and generating economic returns.

For organizations which collaborate it is important to align their expectations. Indeed, many collaborations face unrealistic expectations, do not create satisfactory value and often collapse (Hyll and Pippel, 2016). Different characteristics apply to different R&D cooperation partners. For example, an R&D cooperation with universities has a different nature from an R&D cooperation with research institutes and other companies. Our results confirm that R&D collaborations with universities determine a higher propensity to generate product innovation given their broad knowledge base (Hall *et al.*, 2000). However, while the research activities of universities is long-term oriented and does not traditionally focus on the monetization needs of firms, R&D collaborations with research centers and other horizontal companies, which are more careful to market value than on scientific value (Harryson *et al.*, 2008), seem to favor a higher marginal return in terms of turnover derived from introducing innovation into the marketplace.

Our research is in line with the study conducted by the Digital Transformation Academy in collaboration with PoliMI (2020) that shows

that Italian SMEs are going to increase their use of OI practices in the next three years; specifically, through their collaboration with universities and research centers (+15%) and horizontal companies (+106%). This article provides valid indications not only to the SMEs' managers and business owners on the expected outcomes these R&D collaborations may bring, but also to policy makers who have been considered not particularly aware of the importance of various networks for SMEs (Hemert *et al.*, 2013). They should develop stronger measures to encourage the right participation in useful networks (McAdam *et al.*, 2014) in order to significantly accelerate open innovation in SMEs (Vega *et al.*, 2012). According to Roper and Hewitt-Dundas (2013), in many countries public funding is provided to universities and R&D centers to act as a catalyst for open innovation, whereas public funding should focus towards the needs of SMEs. Our research outcome may significantly help policy makers to design policies along with the SMEs' needs and guide them towards the right expectations of an R&D collaboration.

5.2 Limitations and avenues for future research

This study would not be completed without reference to its limitations. The first of these is that our results refer to a specific area, Italy, and to a specific period, so that the usual problem of generalisability across time and space arises. Secondly, our data do not allow us to distinguish between the different organisational modes characterising the inbound open innovation practices in SMEs (van de Vrande *et al.*, 2009). We only focussed on R&D partners considering three groups, *universities, research centres and other companies*. For the latter, data at our disposal allowed us to differentiate neither between rival/not rival companies nor on the basis of their industry, size or geographic location (Dowling and Helm, 2006; Freel, 2005; Hanna and Walsh, 2008; Nieto and Santamaria, 2010; Shin *et al.*, 2016; Un and Asakawa, 2015). Despite these limitations, we consider that our study, compared to existing empirical evidence, provides further strong empirical evidence with key differences in R&D collaborations (Rosenbusch *et al.*, 2011). Using a cross-sectional dataset of 2,591 Italian manufacturing SMEs, we highlight the importance of inbound R&D open innovation management (Inauen and Schenker-Wicki, 2011) for traditional manufacturing SMEs and not just for high-technology or multi-national corporations (e.g. Chesbrough and Crowther, 2006; Parida *et al.*, 2012; Spithoven *et al.*, 2013).

Moreover, our results have practical implications for the SMEs' managers and entrepreneurs who have to decide between *explorative vs exploitative* outside-in R&D partners.

Future investigations may extend the focus and scope of this study by investigating the impact of different in and outbound OI practices comparing different industries or sectors (Freel, 2005). Moreover, with the use of longitudinal data it would be interesting to assess the process of maintenance or persistence of collaboration (Belderbos *et al.*, 2015; Fayard and Metiu, 2014) and the (long-term) effect of collaborative outcomes.

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Academic or professional position and contacts

Alfredo D'Angelo
Associate Professor of Business Strategy
University Cattolica del Sacro Cuore Milano - Italy
e-mail: alfredo.dangelo@unicatt.it

Alessandro Baroncelli
Full Professor of Business Strategy
University Cattolica del Sacro Cuore Milano - Italy
e-mail: alessandro.baroncelli@unicatt.it

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