Determinants of technological innovation success and failure: Does marketing innovation matter?

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1. Introduction and motivations

The purpose of this paper is to explore the role of marketing innovation on innovation performance, namely, the failure of technological innovation projects (i.e. the abandoning of innovation activities) and success of enterprises' technological innovations. Our research stems from considering that the adoption of a technological innovation per se might not be sufficient to acquire competitiveness (Edwards et al., 2004; Bloom and Van Reenen, 2007) and that the practice of launching not only technological but also promotion, placement, price or packaging (i.e. marketing) innovation at the same time can lead to take advantage of potential synergies and benefits from the joint adoption of multiple innovations (Battisti and Stoneman, 2010).

Innovation is a topic worthy of deep exploration. In complex and dynamic markets, innovation has been regarded as a valuable option to increase the competitiveness of enterprises (Hall and Rosenberg, 2010; Boehlje et al., 2011; Gunday et al., 2011) and a major driver of economic growth (Cainelli et al., 2006). In most European countries, innovation has attained increasing importance in public authorities and organisations (Medrano and Olarte-Pascual, 2016). Improving competitiveness through innovation is the second of the five objectives proposed by the European Union for Horizon 2020 (European Commission, 2012).

It has been noted that practitioners tend to overestimate the role of product innovation as a source of competitive advantage and neglect other sources of innovation such as marketing (Ren et al., 2010). Academics, however, have attracted attention to the role of marketing innovation as a driver of the sustainable competitive advantage of an enterprise (Bhaskaran, 2006; O'Dweyer et al., 2009; Medrano and Olarte-Pascual, 2016) and of its profitability (Bhaskaran, 2006). Marketing innovation, that is, changes in product design, packaging, promotion, or pricing (OECD-Eurostat 2005), should be regarded as critical as technological innovations for enhancing companies' competitiveness (Medrano and Olarte-Pascual, 2016). Hence, it is relevant to identify to what extent marketing innovation can contribute to foster innovation success and explain innovation failure. Innovation success and failure could be considered the two sides of innovation performance (D'Este et al., 2016). Innovation success is generally defined as the turnover directly originated from introducing technological innovations (Mothe and Nguyen, 2010). Innovation failure occurs when companies abandon their innovations before introducing them to the market (Tranekjer, 2017).

This paper responds to two relevant research gaps. First, the literature has devoted increasing attention to technological innovations (process and product innovations) rather than to the role of

nontechnological innovations (i.e. marketing and organisational innovations) as drivers of innovative performance in organisations (Mothe and Nguyen, 2010; Geldes et al., 2017).
Second, the literature on abandoned projects is scarce (Leoncini, 2016; García-Quevedo et al., 2017; Tranekjer, 2017) and largely neglects the role of marketing innovation. This study aims to address this gap by investigating how marketing innovation is related to the likelihood of abandoning a technological innovation.
To fill such gaps, we posit the following research questions:

RQ1: What is the contribution of marketing innovation beyond technological innovation to innovation success?
RQ2: How likely is a technological innovation project to be abandoned if marketing innovation is jointly introduced?

To answer these two research questions, this study focuses on innovative enterprises: the performance of the innovation (i.e. success or failure) is conditional on being an innovative enterprise. This study then adopts a definition of innovative enterprise that is broad and consistent with the CIS (Community Innovation Survey) framework: an enterprise is considered innovative if - within the time period of reference - it introduces at least one product or process innovation or implements any innovation activity that still does not result in any product or process innovation because it is incomplete or ongoing.
The contributions from this work are twofold. First, according to our review of the literature, this study is one of the few that investigates the effect of the conjoint adoption of technological and marketing innovation types on innovation failure and success. Marketing innovation is considered both at the aggregate and innovation-type levels, such as innovation in design and packaging, promotion, placement, and pricing.
Second, this work specifically considers both innovation success and failure by taking into account the potential sample selection issue not considered in most of the literature on marketing innovation (e.g. Geldes et al., 2017): it employs a probit model with sample selection (Van de Ven and Van Praag, 1981) for the binary outcome (i.e. innovation failure) and a Cragg's double hurdle model (Cragg, 1971; Blundell and Meghir, 1987) for the continuous outcome (i.e. innovation success).
To provide such contributions, this paper examines the link between technological and marketing innovation based on a sample of German CIS enterprises related to the period 2010–2012.

2. Theoretical background and conceptual development

Innovation has been conceptualised as the adoption of an idea, behaviour, system, policy, programme, device, process, product, or service new to an organisation (Damanpour, 1992). Innovation is often divided into technological and nontechnological innovation. Technological innovation includes process and product innovations. Nontechnological innovation entails marketing and organisational innovations. Despite the substantial amount of literature focused on innovation, little attention has been devoted to the role of marketing innovation in economics and business (Medrano and Olarte-Pascual, 2016).

2.1 *Marketing innovation*

Marketing innovation is defined as the implementation of a new marketing method entailing significant changes in product design or packaging, placement, promotion, or pricing (OECD, 2005). A broad stream of the literature (e.g. Ren et al., 2010; O'Dwyer et al., 2009; Schmidt and Rammer, 2007) points to the role of marketing innovation as a driver of the competitive advantage for enterprises: marketing innovation has been found to be relevant to developing and maintaining a competitive advantage, leading to an increased business performance (Bhaskaran, 2006; Naidoo, 2010). Through marketing innovation, enterprises can diversify into new products and services (Medrano-Sáez and Olarte-Pascual, 2013) and increase the willingness-to-pay for product innovations (Schubert, 2010).

Complementarities have emerged among marketing and technological innovations in fostering propensity to innovate and innovation performance (e.g. Bartoloni and Baussola, 2015; Geldes et al. 2017); therefore, an emphasis on technological innovation alone would be misleading (Battisti and Stoneman, 2010; Bartoloni and Baussola, 2017). For instance, new technologies that significantly improve the characteristics of a product might also require new marketing strategies to drive sales of the product itself (Schmidt and Rammer, 2007). Specifically, the literature has investigated the direct and synergistic role of marketing innovation with other innovations in predicting innovation performance. Conflicting results have emerged. Mothe and Nguyen (2010) found no relationship between marketing innovation and the share of turnover from new products. This result has been further confirmed by Pino et al. (2016) and Geldes et al. (2017), who analysed the role of marketing innovation in emerging economies such as Colombia, Peru, and Chile. Schmidt and Rammer (2007) found that marketing innovation affects the share of turnover from market novelties only when complemented by organisational and product innovations. Moreover, marketing innovation did not influence the share of turnover from products new to the firm as a stand-alone innovation nor when accompanied by processes, products, or organisational innovations. Schubert (2010) found that marketing innovation positively influences the share of turnover from new products among

enterprises that have introduced a technological innovation. Adams et al. (2019) found that introducing a marketing innovation has a positive effect on the relationship between customer orientation and innovation performance. This effect is greater for enterprises with a higher technology orientation and for those enterprises that manage to implement more than one marketing innovation activity at the same time. Along the same line, Lee et al. (2019) reported a moderating effect of marketing innovation in the relationship between product innovation and firm performance: the moderation appears also to be stronger as far as high-tech (versus low-tech) industries are concerned. Finally, Nieves and Diaz-Meneses (2016) and Nicolau and Santa-María (2013) found that marketing innovation positively affects, respectively, the financial performance and market value of hotels in the hospitality industry.

Regarding firm's growth (expressed in terms of firm employment growth), marketing innovations have been found to exert a positive greater effect when they complement product innovations than when implemented alone (Szczygielski et al., 2016).

The literature on marketing innovation has not devoted sufficient attention to the type of marketing innovation, considering only whether companies have introduced at least one marketing innovation, regardless of its nature. Specifically, previous studies have focused on the general concept of marketing innovation by measuring it with a dummy variable taking the value of one if the company has undertaken at least one marketing innovation and zero otherwise (e.g. Szczygielski et al., 2017). Alternatively, researchers have employed the count of all the marketing innovations that have been deployed (e.g. Geldes et al., 2017).

The present study posits that each marketing innovation type has a specific role and it might display a positive or a negative relationship with innovation performance. Hence, a general measure of marketing innovation could obscure conflicting relationships. Therefore, as far as the general concept of marketing innovation is concerned, the present study hypothesizes what follows:

H1a) The introduction of a marketing innovation, regardless the type, is not related to innovation success

H1b) The introduction of a marketing innovation, regardless the type, is not related to innovation failure

In the following part we will focus on the relationship between each marketing innovation type and innovation performance.

2.2 *The role of each marketing innovation type*

The present paper draws from the resource-based theory of the firm (Barney, 1991) which has been previously adopted to study the role of marketing innovation (e.g. Pino et al. 2016; Adams et al. 2019). A central construct within the resource-based theory is that of capabilities (Kozlenkova et al. 2014). Capabilities are part of the firm's resources and can be defined as "an organizationally embedded non-transferable firm specific resource whose purpose is to improve the productivity of the other resources possessed by the firm" (Makadok, 2001, p. 389). Therefore, the purpose of capabilities is to allow enterprises to better deploy their other resources, by increasing related efficiency and productivity (Makadok, 2001). The capabilities that could be related to innovation performance as far as commercialization of new products is concerned are those pertaining to marketing management (Danneels, 2007) and to the development and execution of marketing mix decisions (Vorhies & Morgan, 2005; Adams et al. 2019). In this respect, marketing mix decisions are considered as the key elements of marketing capabilities (Barrales-Molina et al., 2014): they can leverage technological knowledge in order to achieve superior innovation performance. Marketing mix decisions are identified as the four elements of the marketing mix model (McCarthy, 1964): product, promotion, placement and price. The marketing mix model has represented and still represents a reliable framework for academics and practitioners to manage marketing activities and to classify marketing innovation activities (Romano and Ratnatunga, 1995; Coviello et al., 2000). Hence, in the present study marketing innovation types are identified in terms of four types, namely innovation in product, promotion, placement and price.

Only few researchers investigated the role of each type of marketing innovation activities. Among them, Mothe and Nguyen (2010; 2012) found that marketing innovations in product design, promotion, and placement have a significant positive relationship with propensity to innovate but no relationship with innovation performance. Quaye and Mensah (2019) identified a positive relationship, in small and medium enterprises in a developing country, between each of the four marketing innovation activities and sustainable competitive advantage.

The present work points to the role of each type of marketing innovations in their relationship with innovation performance. In this study, innovation performance is conceptualized by including two aspects: innovation success and failure. The literature has suggested that innovation failure and success are closely linked, and a closer investigation into both is required (e.g. D'Este et al., 2016). Innovative success is commonly defined as the percentage of total sales from new innovative products (e.g. Geldes et al., 2017; Schubert, 2010; Mothe and Nguyen, 2010). Failure in innovation occurs when enterprises cancel an innovation project before reaching the market (Tranekjer, 2017). Abandoning an innovation process is a difficult decision (Havila et al., 2013): the abandonment of an

innovation could represent a problem for the enterprise's economic activities and even a threat to its survival (Leoncini, 2016). Few works in the literature have investigated innovation failure (Leoncini, 2016; Gàrcía-Quevedo et al., 2017), and those studies have recognised several common determinants but fail to consider the role of specific marketing innovations.

Innovation in products is a type of marketing innovation involving changes in product design and packaging aimed to modify or improve the aesthetics of a product or target a new market segment or whole market (e.g. introduction of a new package, change in the product line design) (OECD, 2005). Changes to the design and packaging of products might influence consumer behaviour in the store and could be employed to improve the match between the presentation of the product, package design, and communication of the brand's image (Mothe and Nguyen, 2010; Orth and Malkewitz, 2008). Modifications of product packages could increase attention and create more favourable consumer evaluations of a product (Creusen and Schoormans, 2005). Hence, a new design has the potential to facilitate the differentiation of products (Veryzer and Borja de Mozota, 2005) and lead to higher sales from new products (Roper et al., 2016). Design-based innovation is key to competing without relying on price and creates value for enterprises and customers (i.e., a win–win situation): consumers have a better perception of the product and enterprises gain higher sales (Roos, 2016). Therefore, we hypothesize that innovation in product design and packaging is positively related to the performance of a new product innovation. Specifically:

H2a) The introduction of an innovation in product design and packaging is positively related to innovation success

H2b) The introduction of an innovation in product design and packaging is negatively related to innovation failure.

Innovation in promotion is related to the introduction of new promotional initiatives to increase the consumers' awareness of products or to deepen the relationships with the latter. This type of innovation, in the OECD approach, is broad as it includes the followings: use of a new media or new testimonial in advertising, introduction of a new brand symbol, or introduction of a loyalty programme (OECD, 2005). Innovations in promotion such as rebranding can trigger surprise among consumers (Collange and Bonache, 2015). According to the cognitive-evolutionary theory of surprise, when a rebranding occurs surprise stems from an expectancy disconfirmation (Stiensmeier-Pelster et al., 1995) or a schema discrepancy (Schützwohl, 1998) that are triggered because the new brand is perceived as an unexpected event (Vanhamme, 2000). Rebranding was found to be perceived as a "bad surprise" and to be associated with feelings of anger and fear among consumers (Collange and Bonache, 2015). Brand logos are the key visual representations of a brand and there have been

cases where even minor changes to a brand logo led to negative implications for the company concerned, including a fall in their sales (Tarnovskaya and Biedenbach, 2018; Peterson et al., 2015). Moreover, the introduction of new media has been found to negatively influence effectiveness of existing media and consumer exposure to them (Woo et al., 2014; Esteban-Bravo et al., 2015). Regarding the introduction of loyalty programmes, mixed evidence has been found regarding their effectiveness in terms of sales: positive effects (e.g. Cigliano et al., 2000) and no effects (e.g. Meyer-Waarden and Benavent, 2006). Moreover, enterprises with a smaller market share that introduce a loyalty programme to follow competitors or are too generous in rewarding customers are more likely to experience negative consequences (Danaher et al., 2016; Meyer-Waarden and Benavent, 2006).
To summarize, it can be expected that changes in the promotional activity might hamper innovation performance due to negative consequences of the new promotional elements on consumer response as far as the new product is concerned. Therefore, it is hypothesized that:
H3a) The introduction of an innovation in promotion is negatively related to innovation success.
H3b) The introduction of an innovation in promotion is positively related to innovation failure.

Innovation in placement concerns the types of sales channels selected for selling the product (e.g. franchising, direct sales, sales through internet or mobile) and change in the design of sales channels to market products (OECD, 2005). Innovations in sales channels, such as the development of electronic commerce or the introduction of an innovative retail concept, enable enterprises to widen their reach (Wyner, 2000), take advantage of synergies across channels (Huang et al., 2016) and acquire new customers (Hernant and Rosengen, 2017). Such benefits in terms of higher sales due to a higher number of customers or to channel synergies could favour innovation performance by increasing sales of new products and decreasing the likelihood of innovation failure. Hence, it is hypothesized that:
H4a) The introduction of an innovation in placement is positively related to innovation success.
H4b) The introduction of an innovation in placement is negatively related to innovation failure.

Innovation in price entails using new pricing methods to market goods or services (e.g. first time use of variable pricing by demand, new discount systems) (OECD, 2005). An example of pricing innovation is represented by dynamic pricing: several retailers have introduced dynamic pricing models that can employ data from e-commerce purchases or company enterprise resource planning systems in order to establish prices based on changing supply or demand characteristics (Nagle, Hogan, and Zale, 2016). Dynamic pricing has been found to be key for enterprises selling high volume of products or with high frequency (Grewal et al., 2011) and it allows for price discrimination even

at the customer level. However, dynamic pricing can also lead to consumer concerns related to price fairness and to the privacy of their purchase transactions (Grewal et al., 2004; Grewal et al., 2011). Zeng and Williamson (2007) showed how a low price innovation strategy increases the perceived value of a firm's new products, leading to a decrease in pressure from competitors.

Therefore, it is hypothesized that:

H5a) The introduction of an innovation in pricing is positively related to innovation success.

H5b) The introduction of an innovation in pricing is negatively related to innovation failure.

3. Data sources and variables

3.1 Data

The study employed the CIS 2010–2012 survey data[1] with reference to Germany. This harmonised survey is run every two years in each EU member state, some EFTA countries, and EU candidate countries and data are usually released two and half years after the end of the survey reference period. The survey is deployed by each national statistics institute under the coordination of EUROSTAT and designed to provide information on the degree of innovativeness of each sector. Specifically, questions are related to the different types of innovations (product goods and services—and process-organisational and marketing innovations) and to various elements related to the development of an innovation: e.g. objectives, source of information, public funding, and innovation expenditures. Enterprise-specific information is also retained: economic activity, geographic location, number of employees, turnover, expenditure on innovation, and research.

To the authors knowledge no other survey has combined and accumulated so much information at the enterprise level. Furthermore, this bi-annual largescale survey provides harmonized data that make possible to use it in a comparative approach. The CIS survey was also employed as the framework of reference by innovation studies in extra-European countries where there was no well-established approach to measure and analyse innovation, such as in South Korea (e.g. Lee et al., 2019) or Chile (e.g. Geldes et al., 2017).

For the Germany case here analysed, the dataset included responses about enterprise-level innovations from 6,328 manufacturing and service enterprises with more than 10 employees.

Germany represents a notable case of study because it is an innovation leader: Germany displays strong investments in innovation and is rich in innovative companies and intellectual assets (European Innovation Scoreboard, 2017). Notably, the highest proportion of innovative enterprises among the European Union (EU) member states from 2010–2012 was observed in Germany: 67% of all enterprises (Eurostat, 2015). Moreover, according to the World Economic Forum (2010), Germany

[1] The responsibility of all conclusions drawn from the data lies entirely with the authors.

has been ranked as 7th in the world in 2010 as far as the indicator "Extent of Marketing", that measures to what extent companies use sophisticated marketing tools and techniques.

3.2 Dependent and independent variables of interest

Our main objective was to study the role of marketing innovation types on technological innovation failure and success conditional to being an innovating enterprise. The dependent variables of the models were: i) an indicator of the failure of an innovation project or activity, ii) a measure of innovation success, and iii) an indicator of the innovation decision. As a measure of innovation success, based on the literature (see Belderbos et al., 2004; Roper et al., 2007, Cassiman and Veugelers, 2006) and data availability, we adopted a measure of innovative output, $y_{2i,SUCC}$, represented by the share of sales generated by innovative products. Following the literature (Ceylan, 2013; Schubert, 2010; Mothe and Nguyen, 2010) two measures were used and summed to estimate the percentage of total turnover derived from new products (OECD, 2005): a) the share of sales from new or significantly improved goods and services introduced during the last three years that were new to the market and b) the share of sales from new or significantly improved goods and services introduced during the last three years that were only new to the enterprise.

Based on CIS data, the failure was measured by a dummy variable, $y_{2i,FAIL}$, that assumed the value 1 if enterprises have abandoned or suspended innovation activities before completion during the three years from 2010 to 2012. Enterprises that have abandoned an innovation project might still have one or more ongoing innovation projects. Therefore, our focus was not on the failure interpreted as the end of the status of innovating enterprises but as the failure of a one or more innovation projects conditional to being an innovator. The innovation status was represented by a dummy variable, $y_{1i,INN}$, denoting if the enterprise innovates or not. It was set equal to 1 if the enterprise i was engaged in either technological innovation (product and/or process) or if it has any innovation activities that did not result in a technological innovation because not completed.

To answer RQ1 and RQ2 and test our hypotheses, we specified two models: a double hurdle model (Cragg, 1971), for what concerned the continuous outcome (the share of sales generated by innovative products), and the probit with sample selection (Van de Ven and Van Praag, 1981), for the binary outcome (the indicator of the failure of an innovation project). Both models included a range of explanatory variables supported by the authors' review of the theoretical and empirical literature and data availability. Using measures of marketing innovation present in the CIS data, marketing innovation was first considered in the aggregated terms and then composed of four concepts: design and packaging, promotion, placement, pricing. In aggregated terms, marketing innovation was represented by a dummy that assumed the value 1 if at least one new marketing concept or strategy

has been introduced in the three years from 2010 to 2012. As determinants of innovation success and innovation failure, we considered the same set of variables.

3.3 Control variables

We considered variables representing firm specific controls, namely the size, and the financial input devoted to innovative activities is expressed as a share in total sales (including R&D, acquisition of machinery and external knowledge, marketing, training, and preparatory work for innovation). In the CIS sample, the size was represented by four dummy variables (small, medium-small, medium-large, large) that enabled us to consider its nonlinear effect on the success of innovation or on the failure of an innovation project. We also included the receipt of public subsidies for innovation, the export behaviour, the sector of activity, and its subclassification. Following the EUROSTAT industry classification on high-tech industries and knowledge-intensive services (OECD, 2003), we aggregated the manufacturing industries according to their technology intensity in four categories: high-tech, medium-high-tech, medium-low-tech, and low-tech. Service industries were aggregated in two categories: knowledge-intensive and low knowledge-intensive.

Furthermore, we considered the following as controls: variables denoting if the enterprise was engaged in R&D activities (Rammer et al., 2009), group membership, and foreign ownership. Group membership was considered, because belonging to a business group might influence the levels of innovation success (or the probability of failure). As a matter of fact, firms that are part of a group have access to greater financial and technological resources. Moreover, firms can access additional capabilities from partners (De Faria and Dolfsma, 2011).

To consider the internationalisation of an enterprise we also included a dummy variable taking the value 1 if the headquarters of the group to which the enterprise belongs was located outside its country. Following the literature on determinants of innovation success, we also considered if the enterprise was engaged in cooperation agreements with external partners (e.g. Rammer et al., 2009; Mothe and Nguyen, 2010). Specifically, we differentiated among three types of cooperation partners (see Badillo et al., 2014): *vertical* (suppliers and customers), *horizontal* (competitors), and *institutional* (consultant and commercial labs, universities, or other higher educational institutions, government, public, or private research institutes), and we used as reference category—henceforth excluded from the models—the *internal* cooperation, to be understood as cooperation within the enterprise group. We expected that the higher the enterprise's engagement in cooperation activity, the higher the innovation success. In addition, the percentage of employees with a university degree and if the enterprise has introduced any form of organisational innovation (e.g. Schubert, 2010; Mothe and Nguyen, 2010) were considered.

Due to the acknowledged role of external sources of information as determinants of innovation performance (e.g. Yam et al., 2011; Caloghirou et al., 2004), we next considered a set of dummies that capture how enterprises rate different types of partners as information sources. In the 2012 CIS survey, innovating enterprises were asked to rank the importance of different sources from 1 (not important) to 3 (very important). Next, we constructed 11 dummies, one for each information source, assuming the value 1 if the enterprise rated information sources as of high importance for innovation activities (=3) and zero otherwise. Following Mothe and Nguyen (2010), we constructed a variable that tracks the importance ascribed to four objectives for innovation. To this end, we considered the sum of scores of importance of four enterprises goals, namely increase turnover, increase market share, decrease costs, increase profit margins—numbered between zero (unimportant) and three (crucial); next, we rescale between 0 and 1. We considered several dummies, one for each form of protection, assuming the value 1 if the corresponding protection form has been considered crucial and zero otherwise.

We also consider several factors hampering the fulfilment of enterprises goals that might influence the probability of abandoning an innovation project or the level of innovation success[2]. Therefore, we used eight dummies that assumed the value 1 if the corresponding obstacle was rated as crucial. We expect, in line with literature (e.g. Garcìa-Vega and Lopez, 2010), to observe a positive effect from all obstacles on the probability of abandoning innovation projects and a negative effect on the innovation success. Above all, the perception of inadequate finance might be positively related to the failure of an innovation project: at the initial stage of a new project, the enterprise might not be completely aware of the additional financial difficulties that could occur in the subsequent stages (e.g. Garcia-Vega and Lopez, 2010). Hence, the enterprise could develop a perception of inadequate finance that further results in the failure of the innovation project. In the selection equation of both models, following the literature on a firm's propensity to innovate (e.g. Hong et al., 2012) and based on data availability, we considered the following determinants of the innovation. As traditional enterprise characteristics, we considered the export status, group membership, foreign ownership, size, and sector. Size was expected to positively affect the decision to innovate because larger enterprises can take advantage of additional domestic financial resources and in-house multidisciplinary expertise. We further considered the enterprises' ability to absorb knowledge, measured by the percentage of skilled employees (e.g. Rammer et al., 2009). All the employed variables are described in Appendix A.

[22] Strong price competition, strong competition on product quality, reputation or brand, lack of demand, innovations by competitors, dominant market share held by competitors, lack of qualified personnel, lack of adequate finance, high cost of access to new markets, high costs of meeting government regulations, or legal requirements.

4. Descriptive statistics

Table 1 presents some descriptive statistics for our sample of 6,248 German service and manufacturing enterprises comprising 4,273 innovating enterprises and 1,975 non-innovating enterprises.

Table 1. Germany CIS 2012: Distributions of outcomes

Innovation				
Yes		**No**		**Total**
n. of enterprises	%	n. of enterprises	%	n. of enterprises
4273	68.39%	1975	31.61%	6248
Innovation failure				
Yes		**No**		**Total**
n. of enterprises	%	n. of enterprises	%	n. of enterprises
1039	24.32%	3234	75.68%	4273
Innovation success				
Positive values		**Zero**		**Total**
n. of enterprises	%	n. of enterprises	%	n. of enterprises
1994	61.60%	1243	38.40%	3237

Source: *Own elaboration of the Community Innovation Survey, 2012.*

The innovation success and failure are conditional on being an innovating enterprise. The average share of turnover related to new products among those 1994 innovative enterprises reporting values higher than zero is 23.69%. In the remainder of the analysis, the original sample size might further reduce because of the presence of missing values for some variables.

Table 2 displays the percentage of implemented marketing innovation types among innovative enterprises: 1739 innovative enterprises have undertaken at least one marketing innovation.

Table 2. Percentages of marketing innovation types introduced by innovative enterprises

Type of Marketing Innovation	**% of enterprises**
Product packaging and design	25.64%
Promotion	27.34%
Placement	31.16%
Pricing	18.40%

Source: *Own elaboration of the Community Innovation Survey, 2012.*

Based on a descriptive analysis[3] we found that 48.3% of service enterprises that introduced a technological innovation also introduced a marketing innovation, and 51.7% of manufacturing enterprises that introduced a technological innovation also introduced a marketing innovation. Enterprises that conducted marketing innovation also conduct organisational innovation: 36.3% of technological innovating enterprises conducted both organisational and marketing innovations.

Innovating enterprises were more likely to be exporters (57%) and members of a group (39%) than non-innovating enterprises (28% and 35%, respectively) and less likely to be a foreign multinational (70%) than non-innovating enterprises (80%). As expected, innovating enterprises were bigger in terms of number of employees with considerably higher percentage of qualified personnel than non-innovating enterprises.

Enterprises that abandon an innovation tend to be part of a group (48%) more than non-abandoning enterprises (27%), whereas the contrary occurs for foreign multinational. Enterprises that abandon an innovation project are generally bigger, show a higher percentage in the medium-high-tech sectors (25%) than non-abandoning enterprises (13%) and a higher percentage in the knowledge-intensive sector (28%) than non-abandoning enterprises (24%). Furthermore, they show a higher percentage of marketing innovations than non-abandoning enterprises: innovation in design and packaging (26% vs. 15%), innovation in new media/techniques for promotion (32% vs. 17%), in product placement and sales channels (32% vs. 19%) and in new methods of pricing goods or services (21% vs. 11%).

Enterprises that abandon innovation are more likely to engage in vertical cooperation (31%) and internal cooperation (18%) more than non-abandoning enterprises (11% and 4%, respectively).

5. Econometric methodology

To investigate our research questions, we analysed the role of introducing marketing innovation on the failure of an innovation project and the success of technological innovation. In both cases, we started from a baseline model that links the specific outcome to the marketing innovation indicator and a set of *k* control variables. The focus was on innovative enterprises because only among them we can observe the measures of the success of technological innovation and of the failure of an innovation project. The focus on innovative enterprises potentially poses the sample selection problem, especially if innovating and the innovation success (or failure of innovation project) are correlated. In the case of correlation, the estimates using only innovators would be biased. Therefore, on the methodological side, selectivity was considered in both models differently, depending on the outcome. To measure the role of marketing innovation on the failure, we used a probit model with

[3] Tables with descriptive results are available upon request.

sample selection. To study the role of marketing innovation on the success, a double hurdle model was used in the analysis.

5.1 Cragg's double hurdle model

To answer RQ1, we considered the success of innovation as an outcome represented by a left-censored continuous variable. The innovation success was measured as the percentage of sales derived from innovative products new to the market and new to the firms, where approximately 38% of innovative enterprises reported 0% between 2010 and 2012 (Table 1). Hence, estimating an econometric model of the determinants of the innovation success and the role of marketing innovation is complicated by the large number of zero observations in the dependent variable. On the one hand, in the presence of a non-negative and a continuous above-zero outcome variable with many observations at zero the use of an ordinary least squares (OLS) regression may lead to biased and inconsistent parameter estimates.

On the other hand, the standard Type I Tobit model, originally proposed by Tobin (1958), and developed to solve the general censoring problem, remains inappropriate for solving our sample selection problem because it assumes a single mechanism that affects the probability of a non-zero observation in the outcome and the level of a positive amount of the success of innovation indicator: in our case, an enterprise could introduce a technological innovation but could still have a turnover from the new introduced product equal to zero. Therefore, for our problem the double hurdle model originally proposed by Cragg (1971), that is a generalisation of the Tobit model, was applied. This model suggests a two-tiered model that, in our case, integrates the standard probit model in the first tier to determine the probability of innovating, and a truncated normal regression model in the second tier to model the level of the success of innovation. Thus, unlike Tobit, the model allows for the decision about whether to innovate and the level of innovation success to be determined by different processes. The double hurdle model can be specified as in equations (6a)–(6d) (Cragg, 1971; Blundell and Meghir, 1987):

$$y^*_{1i,INN} = w_i\alpha + u_{1i} \qquad Decision\ to\ innovate \tag{6a}$$

$$\begin{cases} y_{1i,INN} = 1 & \text{if } y^*_{1i,INN} > 0 \\ y_{1i,INN} = 0 & otherwise \end{cases} \tag{6b}$$

$$y^*_{2i,SUCC} = x_i\beta + u_{2i} \qquad Success\ of\ innovation \tag{6c}$$

$$\begin{cases} y_{2i,SUCC} = x_i\beta + u_{2i} & \text{if } y^*_{1i,INN} > 0 \text{ and } y^*_{2i,SUCC} > 0 \\ y_{2i,SUCC} = 0 & \text{if } y^*_{1i,INN} > 0 \text{ and } y^*_{2i,SUCC} \leq 0 \\ & \text{or } y^*_{1i,INN} \leq 0 \text{ and } y^*_{2i,SUCC} > 0 \\ & \text{or } y^*_{1i,INN} \leq 0 \text{ and } y^*_{2i,SUCC} \leq 0 \end{cases} \quad (6d)$$

where $\{u_{1i}, u_{2i}\}$ are assumed to be independent and identical distributed drawings from a bivariate normal distribution; $y^*_{1i,INN}$ is a latent variable representing the enterprise's decision to innovate; $y^*_{2i,SUCC}$ is a latent variable representing the enterprise's innovation success; $y_{2i,SUCC}$ is the observed dependent variable; w_i is a set of enterprises characteristics explaining the decision to innovate; x_i is a set of variables explaining the enterprise's innovation success in the second hurdle; and α and β are parameters to be estimated. It is further assumed that $\{y_{2i,SUCC}\}$ and $\{\boldsymbol{x}_i\}$ are observed for i $= 1,2, \ldots, n$, u_{1i} and that u_{2i} are random errors that are normally distributed. The double hurdle model is estimated using maximum likelihood techniques. The probability of a zero observation ($y_{2i,SUCC} = 0$) for the innovation success is expressed as in (7):

$$\begin{aligned} \Pr(y_{2i,SUCC} = 0) &= Pr(\, y^*_{2i,SUCC} \leq 0) + Pr(\, y^*_{2i,SUCC} > 0) Pr(y^*_{1i,INN} \leq 0) \\ &= 1 - \left[Pr(\, y^*_{2i,SUCC} > 0) Pr(y^*_{1i,INN} > 0) \right] \end{aligned} \quad (7)$$

and, therefore, the log-likelihood function (e.g. Jones, 1992; Moffatt, 2005) takes the form expressed in (8):

$$logL = \sum_0 log\left[1 - \Phi(w_i\alpha)\Phi\left(\frac{x_i\beta}{\sigma_i}\right)\right] + \sum_+ log\left[\Phi(w_i\alpha)\frac{1}{\sigma_i}\varphi\left(\frac{y_i - x_i\beta}{\sigma_i}\right)\right] \quad (8)$$

The first term in equation (8) corresponds to the contribution of all the enterprises with an observed zero level of innovation success. The second term accounts for the contribution of all the enterprises with a non-zero level of innovation success and is given by the product of the probability of passing the innovation hurdle and the density of observing the non-zero innovation success.

Different from the Tobit model, the Cragg model considers the innovation decision and level of innovation success in two separated processes. Also different from the Heckman model, zero observations occur due to the innovating decision and innovation success hurdle—namely, in our sample, zero observations in the innovation success indicator are also observed for innovating enterprises. The parameter estimates and correlation terms are obtained using maximum likelihood techniques. Specifically, we used the *craggit* Stata command (Burke, 2009) in Stata 14 (StataCorp, 2015). Marginal effects are then calculated using results obtained from the double hurdle model. See Burke (2009) for further details.

5.2 Probit model with sample selection

To answer RQ2, the failure of the innovation project was represented by a binary variable. Hence, we applied a probit model with sample selection (Van de Ven and Van Praag, 1981), where we first modelled the decision to be innovative as a function of a set of innovation drivers and then analysed the failure of an innovation project. Van de Ven and Van Praag (1981) applied a corrective method for sample selectivity analogous to Heckman's (1979) method in their probit analysis. The probit model with sample selection assumes an extant underlying relationship, $y^*_{2i,FAIL}$, such that we observe only the binary outcome,$y_{2i,FAIL}$. However, the dependent variable, $y_{2i,FAIL}$, is not always observed. It is observed for the enterprise i, who have decided to innovate ($y^*_{1i,INN} = 1$), where $y^*_{1i,INN}$. is an unobserved index of innovation propensity. Therefore, the probit model with sample selection can be specified as in 1(a)–1(b):

$$\begin{cases} y^*_{1i,INN} = w_i\alpha + u_{1i} \\ y_{1i,INN} \quad = 1\big(\, y^*_{1i,INN} > 0\big) \end{cases} \qquad \textit{Selection equation} \quad (1a)$$

$$\begin{cases} y^*_{2i,FAIL} = x_i\beta + u_{2i} \\ y_{2i,FAIL} = 1(\, y^*_{2i,FAIL} > 0 \; and \; y^*_{1i,INN} > 0) \end{cases} \qquad \textit{Probit equation} \quad (1b)$$

where $u_{1i} \sim N(0,1)$, $u_{2i} \sim N(0,1)$ and $corr(u_{1i}, u_{2i}) = \rho$. When $\rho \neq 0$ the standard probit techniques applied to the equation (1b) and (1b) yield biased estimates.

The parameter estimates and correlation term were obtained using maximum likelihood techniques and the *heckprobit* Stata command in Stata 14 (StataCorp, 2015).

6. Empirical Results

The estimated coefficients and marginal effects of both models, by considering the marketing innovation and its separated components, are presented in the following subsections. Section 6.1 analyses the determinants of the success of innovation and provides estimates of the average partial effects of each independent variable on the conditional expected value of $y_{2i,SUCC}$ given $y^*_{2i,SUCC} > 0$ and $y^*_{1i,INN} > 0$ (see Burke (2009) for more details). Section 6.2 analyses the determinants of innovation failure and provides estimates of their marginal effects on the conditional probabilities of innovation failure when an enterprise is an innovator. They must be understood as average marginal effects obtained by using the *margins* STATA 14 command. Section 6.3 analyses the determinants of innovation decision resulted from the selection equation and the first tier estimations of both models: the probit model with sample selection and the Cragg model, respectively.

6.1 Determinants of innovation success

Table 3 presents the estimation results of the two Cragg models: one including a composite measure of marketing innovation (*Model 1*) and the other including the four different marketing practices (*Model 2*). The sigma coefficient of the inverse Mill's ratio included in the model for correcting left-censoring is significant and confirms the necessity of double hurdle model estimation.

Table 3 Germany CIS 2012: results for the success of innovation conditional on being an innovative enterprise.

Cragg Model 1			***Cragg Model 2***		
Covariate	**Partial Effects**	**Z**	**Covariate**	**Partial Effects**	**Z**
Marketing Innovation (aggregate)	-.007	-0.65	Marketing Innovation (aggregate)	-	-
Design & packaging	-	-	Design & packaging	.376	2.83***
Promotion	-	-	Promotion	-.030	-1.91*
Placement	-	-	Placement	.005	0.44
Pricing	-	-	Pricing	-.017	-1.14
gp	-.003	-0.11	gp	.002	0.09
fm	-.019	-0.77	fm	-.016	-0.57
manufacturing_ht	.078	3.61***	manufacturing_ht	.077	3.37***
manufacturing_mht	.047	2.35**	manufacturing_mht	.049	2.47**
manufacturing_mlt	.007	0.26	manufacturing_mlt	.010	0.43
service_kis	.033	1.66*	service_kis	.033	1.43
size2	-.003	-0.24	size2	-.005	-0.36
size3	-.014	-0.42	size3	-.021	-0.83
size4	-.038	-1.26	size4	-.040	-1.44
rrdinx_rat	.037	0.70	rrdinx_rat	.042	1.12
rrdexx_rat	-.227	-0.78	rrdexx_rat	-.262	-1.06
export	-.001	-0.05	export	-.007	-0.49
support	.008	0.54	support	.003	0.19
empud_valc	.001	1.84*	empud_valc	.001	1.95*
organisational_inn	.018	1.38	organisational_inn	.018	1.47
co_vertical	-.021	-1.51	co_vertical	-.026	-1.78*
co_institutional	-.001	-0.09	co_institutional	.002	0.928
co_horizontal	.002	0.10	co_horizontal	-.000	-0.01
co_int	.027	1.62	co_int	.029	1.59

sentg_crucial	.029	2.16**	sentg_crucial	.028	2.58***
ssup_crucial	-.004	-0.21	ssup_crucial	.000	0.02
sclpr_crucial	.001	0.11	sclpr_crucial	.001	0.13
sclpu_crucial	.006	0.31	sclpu_crucial	.003	0.19
scom_crucial	-.019	-1.48	scom_crucial	-.019	-1.30
sins_crucial	-.011	-0.54	sins_crucial	-.011	-0.46
suni_crucial	-.011	-0.80	suni_crucial	-.006	-0.38
scon_crucial	.029	2.20**	scon_crucial	.031	2.11**
sjou_crucial	-.004	-0.19	sjou_crucial	-.005	-0.24
spro_crucial	-.049	-1.68*	spro_crucial	-.045	-1.40
goals_scaled	-.065	-1.51	goals_scaled	-.070	-1.84*
cmpat_crucial	.000	0.01	cmpat_crucial	.002	0.13
cmrcd_crucial	-.010	-0.34	cmrcd_crucial	-.011	-0.41
cmco_crucial	.018	0.96	cmco_crucial	.017	1.08
cmctm_crucial	-.003	-0.15	cmctm_crucial	-.004	-0.28
cmltad_crucial	.003	0.22	cmltad_crucial	.005	0.40
cmcpx_crucial	.027	2.33**	cmcpx_crucial	.026	1.91*
cmsec_crucial	.023	1.84*	cmsec_crucial	.020	1.72*
obspr_crucial	.000	0.01	obspr_crucial	-.000	-0.03
obsql_crucial	.013	0.96	obsql_crucial	.015	1.12
obslde_crucial	-.012	-0.74	obslde_crucial	-.010	-0.66
obscp_crucial	.009	0.47	obscp_crucial	.011	0.55
obsdmk_crucial	.000	0.03	obsdmk_crucial	-.002	-0.12
obsprs_crucial	.011	0.85	obsprs_crucial	.009	0.64
obsfin_crucial	.024	1.50	obsfin_crucial	.022	1.18
obsamk_crucial	.032	2.01*	obsamk_crucial	.033	2.07**
obsreg_crucial	-.009	-0.63	obsreg_crucial	-.008	-0.65
Sigma	.626		Sigma	.601	
P>|z|	0.000		P>|z|	0.000	

**** 1% Significance, **5% Significance, *10% Significance. Partial Effects are Average Partial Effects. Sigma denotes the maximum likelihood estimation of the sigma coefficient of the inverse Mill's ratio included in the model for correcting left-censoring. APEs denote the partial effect of an independent variable on the expected value of the success of innovation conditional to be an innovator. For discrete explanatory variables it represents the absolute change in the conditional expectation of the innovation success when the value of the variable shift from zero to one, holding all the other variables constant. For the continuous explanatory variables, they represent the elasticities for the conditional level of innovation success.*

Source: *Own elaboration of the Community Innovation Survey, 2012*

Regarding marketing innovation, if considered as an aggregate measure, marketing innovation did not have a significant relationship with innovation success. Support is then found for H1a. If we consider the four marketing types separately, in contrast with Mothe and Nguyen (2010; 2012), two types have a significant relationship with the innovation success: design and packaging is positively related to the conditional expectation of the innovation success (+38%) and promotion is negatively related to innovation success (-3%). Introducing an innovation in product design and packaging is a visible change that takes place at the product level; thus, this marketing innovation has the potential to influence the consumers in the purchase stage in a very visible and tangible manner (Orth and Malkewitz, 2008; Creusen and Schoormans, 2005). Hypotheses H2a and H3a are then supported, while hypotheses H4a and H5a are not supported.

According to our results, the introduction, for instance, of a new brand, a new testimonial, or a new loyalty programme, might lead to a decrease of the share of turnover related to the technological innovation introduced: the dissatisfaction and frustration with the promotional innovation might negatively influence customer response regarding purchase behaviour, decreasing the interest for a new technological innovation. This finding is consistent with a stream of marketing literature that has highlighted potential drawbacks of marketing practices within the promotion domain (e.g. Peterson et al., 2015; Danaher et al., 2016 Esteban-Bravo et al., 2015). Innovations in placement and pricing are reported to have a nonsignificant effect on innovation success.

The conditional expectation of the success of innovation is higher for enterprises that operate in high-tech sectors (+8%) and medium-high-tech sectors (+5%) than in low-tech sectors. Notably, enterprises concentrated in high-tech sectors with a higher conditional expectation of innovation success might be interpreted in terms of the higher complexity and novelty of products. Furthermore, the conditional expectation of the success of innovation increases with the firm's knowledge absorptive capacity (+1%), and such a result confirms, in line with a knowledge-based view (e.g. Grant, 1996), the important role of absorptive capacity as strategic asset and critical resource for the enterprise's success (e.g. Bhatt, 2001; Valentim et al., 2015). Vega-Jurado et al. (2008) found that absorptive capacity measured in terms of competencies and capabilities is the most important determinant of enterprises innovative performance. At the same time, such empirical evidence of a positive relationship contrasts with some empirical findings (e.g. Cobo-Benita et al. 2016). Vertical cooperation has a slightly significant negative effect (-3%) on the conditional expectation of the success of innovation only when the marketing innovation is considered disentangled. These results are partially in line with Mothe and Nguyen (2010), who found a positive effect for cooperation with customers and a negative effect for cooperation with suppliers - having considered the two

components of vertical integration separately. The negative sign of vertical cooperation on the conditional expectation of innovation success might depend on the level of vertical integration, and this confirms the hypotheses and findings of Li and Tang (2010), who have shown a non-monotonic, inverted U-shaped relationship between vertical integration and firm's innovative performance. Furthermore, only vertical cooperation was found to significantly enhance evidence on the differing influence of the type of R&D collaboration on innovation performance.

Regarding what concerns obstacles to innovation, contrary to the literature (e.g. Garcìa-Vega and Lopez, 2010), not all the obstacles are related to the success of innovation. Surprisingly, we only found an economic factor, namely the high cost of access to new markets, to be relevant in determining the success of innovation: the higher the importance ascribed to 'high cost of access to new markets,' the higher the incentive to overcome such a difficulty, leading to a higher average level of innovation success.

R&D expenditures and organisational innovation have no relationship with the success of innovation. Public R&D founding does not play a role in innovation success, although empirical studies have not been conclusive in this regard.

6.2 Determinants of innovation failure

Table 4 presents estimation results of the two probit models with sample selection. *Model 1* includes a composite measure of marketing innovation as a potential determinant of the probability of innovation failure conditional on being an innovative enterprise. *Model 2* includes four practices of such a type of innovation: design and packaging, promotion, placement, and pricing.

Table 4. Results for the probability of innovation failure conditional on being an innovative enterprise.

Probit with Sample Selection: Model 1			***Probit with Sample Selection: Model 2***		
Covariate	**Marginal Effects (dy/dx)**	**Z**	**Covariate**	**Marginal Effects (dy/dx)**	**Z**
Marketing Innovation (aggregate)	-.002	-0.10	Marketing Innovation (aggregate)	-	-
Design & packaging	-	-	Design & packaging	-.033	-1.39
Promotion	-	-	Promotion	.046	1.90*
Placement	-	-	Placement	-.019	-0.89
Pricing	-	-	Pricing	.017	0.68
gp	.098	2.77***	gp	.099	2.80***
fm	.027	0.79	fm	.029	0.83

manufacturing_ht	-.018	-0.43	manufacturing_ht	-.017	-0.40
manufacturing_mht	.030	1.01	manufacturing_mht	.030	1.02
manufacturing_mlt	-.002	-0.06	manufacturing_mlt	-.002	-0.09
service_kis	.063	2.15**	service_kis	.064	2.21**
size2	.033	1.53	size2	.034	1.57
size3	.030	0.76	size3	.030	0.76
size4	.136	3.66***	size4	.134	3.63***
rrdinx_rat	.027	0.91	rrdinx_rat	.025	0.88
rrdexx_rat	.262	1.02	rrdexx_rat	.277	1.09
export	-.010	-0.43	export	-.007	-0.31
support	-.026	-1.07	support	-.021	-0.87
empud_valc	-.000	-0.87	empud_valc	-.000	-0.97
organisational_inn	.004	0.23	organisational_inn	.002	0.12
co_vertical	.035	1.36	co_vertical	.039	1.49
co_istitutional	.008	0.30	co_istitutional	.008	0.27
co_horizontal	-.052	-1.44	co_horizontal	-.052	-1.45
co_int	.048	1.58	co_int	.046	1.53
sentg_crucial	-.025	-1.30	sentg_crucial	-.025	-1.29
ssup_crucial	.006	0.22	ssup_crucial	.006	0.21
sclpr_crucial	-.006	-0.32	sclpr_crucial	-.006	-0.31
sclpu_crucial	.006	0.19	sclpu_crucial	.007	0.24
scom_crucial	-.022	-0.83	scom_crucial	-.024	-0.94
sins_crucial	-.007	-0.20	sins_crucial	-.009	-0.24
suni_crucial	-.016	-0.53	suni_crucial	-.019	-0.66
scon_crucial	.028	1.03	scon_crucial	.024	0.88
sjou_crucial	-.013	-0.38	sjou_crucial	-.012	-0.36
spro_crucial	-.014	-0.36	spro_crucial	-.017	-0.46
goals_scaled	-.057	-0.99	goals_scaled	-.055	-0.94
cmpat_crucial	.0130	0.53	cmpat_crucial	.012	0.49
cmrcd_crucial	.003	0.08	cmrcd_crucial	.007	0.18
cmco_crucial	-.074	-2.31**	cmco_crucial	-.077	-2.39**
cmctm_crucial	.023	0.88	cmctm_crucial	.023	0.87
cmltad_crucial	.004	0.18	cmltad_crucial	.001	0.06
cmcpx_crucial	.020	0.89	cmcpx_crucial	.019	0.85

cmsec_crucial	.049	2.18**	cmsec_crucial	.050	2.23**
obspr_crucial	-.012	-0.58	obspr_crucial	-.012	-0.57
obsql_crucial	-.019	-0.88	obsql_crucial	-.020	-0.91
obslde_crucial	.021	0.85	obslde_crucial	.018	0.77
obscp_crucial	.034	0.98	obscp_crucial	.032	0.92
obsdmk_crucial	.043	1.59	obsdmk_crucial	.045	1.64
obsprs_crucial	.015	0.64	obsprs_crucial	.017	0.72
obsfin_crucial	.039	1.28	obsfin_crucial	.042	1.37
obsamk_crucial	.000	0.02	obsamk_crucial	.000	0.03
obsreg_crucial	.033	1.46	obsreg_crucial	.031	1.39
emp_growth	.006	0.44	emp_growth	.006	0.45
emp_growth²	-.0003	-0.44	Emp_growth²	-.0003	-0.45
Rho	-.198		Rho	-.190	
Wald Chi2	0.19		Wald Chi2	0.20	
Prob>Chi2	0.663		Prob>Chi2	0.653	

**** 1% Significance, **5% Significance, *10% Significance. Marginal effects are Average Marginal Effects. For factor levels they represent the discrete change from the base level. Rho denotes the estimated error term correlation across the two equations.*

Source: *Own elaboration of the Community Innovation Survey, 2012*

With regard to marketing innovation, the results indicate that the aggregate measure is not a determinant of the probability of innovation failure: hypothesis H1b is then supported. However, when the separated marketing innovations are considered, a significant positive relationship was found between the innovation in promotion and the probability of innovation failure. The conditional probability of innovation failure is higher (approximately +5%) when the enterprise introduces an innovation in promotion, such as a new media, a new brand logo, or a new loyalty programme. Hence, support for hypothesis H3b was found. An innovation in promotion might lead to confusion or frustration among consumers, for instance, a new celebrity promoting the products who does not match the preferences of the target consumers or a new brand logo that is mismatched with the enterprise. Hence, a promotion innovation risks being ineffective, leading to negative consequences regarding the enterprise's image and sales, which could prevent the enterprise from completing a subsequent innovation. All the other marketing innovations are found nonsignificant in their relationship with innovation failure. No support was found as far as hypotheses H2b, H4b and H5b are concerned.

In *Models 1* and *2* we found that the conditional probability of innovation failure is higher for enterprises part of a group (approximately +9%) and for enterprises concentrated in knowledge-intensive service sectors (+6%) compared to low knowledge-intensive service sectors. Such a result might be due to the innovation projects undertaken by high knowledge-intensive service enterprises being more complex. Also size positively affects innovation failure: consistently with Garcìa-Vega and Lopez (2010) and D'Este et al. (2016) innovation failure significantly increases (+13%) for enterprises with more than 500 employees.

Enterprise size might influence the balance between the capacity to innovate and flexibility to respond to challenges (e.g. Becheikh et al., 2006), with large firms undertaking projects of a higher complexity that usually involve a larger amount of funds and are more likely to be abandoned. The probability of innovation failure decreases (-7%) when enterprises rate copyright as crucial and increases (+5%) when enterprises rate is as crucial as secrecy. Copyrights are rights to claim payment for the use of copyright-protected products (OECD, 2005). Secrecy regards confidentiality agreements between enterprises and other organisations designed to protect R&D work (OECD, 2005). Remarkably, organisational innovation, R&D funding, exporter status, R&D cooperation, and all obstacles to fulfilling an enterprises goals were found to be not significantly related to innovation failure.

6.3 Propensity to innovate

The results are strong in terms of significance. Among the variables considered in the selection equation of the probit model with sample selection, the following were significant at the 1%, 5%, or 10% level: being part of a group, being a multinational enterprise, all dummies denoting sectors of activity, some dummies denoting size, export behaviour, percentage of skilled employees, and employment growth rate.

Table 5. Results for the propensity to innovate.

	Cragg Model		**Probit model with Sample Selection**	
	Model 1 and Model 2		**Model 1 and 2**	
Covariate	**APEs**	**Z**	**Marginal Effects**	**Z**
GP	-.094	-2.90***	-.075	-2.11**
FM	-.088	-2.46**	-.098	-2.72***
manufacturing_ht	.284	8.41***	.383	8.79***
manufacturing_mht	.223	8.46***	.234	9.15***
manufacturing_mlt	.085	3.96***	.123	5.62***
service_kis	.068	2.72***	.081	3.62***
Size2	.012	0.61	.016	0.86

Size3	.077	2.01**	.067	1.85*
Size4	.149	4.24***	.150	4.45***
Export	.209	12.14***	.207	12.62***
Empud_valc	.003	6.71***	.003	6.85***
Emp_growth	.081	1.87*	.069	2.67***
Emp_growth²	-.005	-0.55	-.003	-2.17**

**** 1% Significance, **5% Significance, *10% Significance. Average Partial Effects (APEs) and Average Marginal Effects (AMEs). For factor levels AMEs represent the discrete change from the base level. APEs for the discrete explanatory variables represent the absolute change in the probability of a positive value when the value of the variable shifts from zero to one, holding all the other variables constant. For the continuous explanatory variables they represent the elasticities for the probability of a positive success.*

Source: *Own elaboration of the Community Innovation Survey, 2012.*

Table 5 shows that the probability of being an innovative enterprise is lower for enterprises part of a group (-7%) or multinational group (-9%). The literature has not been conclusive regarding the relationship between being part of a group and propensity to innovate (Bartoloni and Baussola, 2015). Although a certain stream of literature has found a positive relationship between being part of a group and the propensity to innovate (e.g. Blanchard et al., 2013), other studies have not supported this conclusion (e.g. Peters, 2009): our results point to the latter stream of research.

When observing the magnitude of marginal effects, notably, manufacturing enterprises generally have a higher likelihood to innovate compared with service companies, and the probability of being an innovative enterprise increases as size classes increase (the smallest class dummy '1-49 employees' was the reference category excluded from the model). In particular, this probability is 7% and 15% higher, respectively, for medium-large and large enterprises.

Additionally, exporters have a higher probability of innovating (+21%). Notably, such a result is consistent with the 'learning-by-exporting effect' stream of literature (e.g. Grossman and Helpman, 1991), according to which, exporting enterprises can learn from internationalisation due to the firm's experience with foreign knowledge and technology and the opportunity to cover the fixed costs of their innovation efforts (e.g. Rodil et al., 2016). Furthermore, if either the share of qualified personnel or employment growth rate increase by 1%, the probability of innovating increases, respectively, by 0.3% and 7%. Conversely, the probability of being an innovative enterprise is lower when the squared employment growth rate is considered. Such a result let us conclude that the positive relationship becomes negative at higher level of employment growth rate.

Enterprises belonging to a group and foreign multinationals are less likely to innovate (-9% and -0.8%, respectively). According to the resource-based view, size was hypothesised to positively affect enterprises' decision to innovate because a larger enterprise can take advantage of more domestic

financial resources and innovative multidisciplinary expertise. For our sample of manufacturing and services enterprises in Germany, it can be assumed that the potential positive effect of a group membership and foreign ownership has most likely already been captured and cannibalised by size dummies. Similar results are found in the first tier of the Cragg model estimation (see Table 5).

6.4 Robustness checks

To check the robustness of our results, we conducted a series of additional analysis. For the sake of brevity, only estimation results concerning marketing innovation are presented. Estimation results related to other control variables introduced in the model are available upon request. In particular, we checked the robustness of our results with reference to size, industry and country and by accounting for potential endogeneity. Results are reported in the following subsections.

6.4.1 Robustness check by size

To check whether the role of marketing innovation and its separated components was robust across firm size, we cut our sample in small (49 employees or less), medium[4] (50-249 employees and 250-499 employees) and large enterprises (500 employees and more). Results are reported in Table 6.

The results by size were consistent with the main models reported in Table 3 and Table 4 as far as the importance of considering marketing innovation types: marketing innovation considered at the aggregate level was still observed not to play a significant role regarding innovation success and failure within size categories. When the four types of marketing innovations were disentangled and included in the analysis, several significant relationships emerged.

As far as the success outcome is concerned, the results concerning large enterprises mirrored those represented in Table 3. In contrast, with reference to small enterprises the promotion coefficient was no longer significant and regarding medium enterprises neither the design and packaging coefficient nor the promotion coefficient resulted to be significant.

As far as the failure outcome is concerned, the results related to small enterprises were consistent with those displayed in Table 4. In contrast, with reference to medium and large enterprises the promotion coefficient was no longer significant. Within large enterprises, the design and packaging and the pricing coefficients turned out to be positive and significant, thus differing from main results.

[4] Medium-small and medium-large enterprises were joined in a single size class in order to achieve a minimum sample size.

Table 6. Germany CIS 2012: results by size

SUCCESS: Cragg model						
	Small		**Medium**		**Large**	
	Partial Effects	**Z**	**Partial Effects**	**Z**	**Partial effect**	**Z**
Marketing innovation (aggregate)	**.007**	**0.43**	**-.013**	**0.58**	**.007**	**0.28**
Design & packaging	**.042**	**2.32*****	.030	1.18	**.097**	**3.27*****
Promotion	-.010	-0.57	-.040	1.53	**-.064**	**-2.05****
Placement	**-.021**	**-1.39**	**-.005**	**0.02**	**.042**	**1.31**
Pricing	**-0.17**	**-0.80**	**-.036**	**-0.03**	**.023**	**0.77**
FAILURE: Probit model						
	Small		**Medium**		**Large**	
	Partial Effects	**Z**	**Partial Effects**	**Z**	**Partial effect**	**Z**
Marketing innovation (aggregate)	**.027**	**1.02**	**-.025**	**0.66**	**.011**	**1.46**
Design & packaging	**.000**	**0.00**	**-.009**	**-0.22**	.016	1.81*
Promotion	**.057**	**1.76***	.051	1.19	-.001	-0.20
Placement	**.022**	**0.75**	**-.060**	**-1.50**	**.014**	**1.44**
Pricing	**.031**	**0.95**	**-.043**	**-0.91**	.023	2.58***

Notes. **** 1% significance, **5% significance, *10% significance. Results robust in terms of significance of the coefficient are reported in bold.*

Source: Own elaboration of the CIS 2012 data.

6.4.2 Robustness check by industry

As far as Germany is concerned, to check whether the role of marketing innovation and its separated components differed across industries we split enterprises in our sample by industry according to manufacturing industries and services industries: two different Cragg models were estimated for each sector under analysis. Our results (see Table 7) were consistent with the main findings in Table 3. The results by industry confirmed that introducing one marketing innovation without considering the marketing innovation type did not display a significant relationship with innovation success or failure. By contrast, the consideration of marketing innovation types in the analysis allowed to reveal significant relationships.

Specifically, as far as the success outcome is concerned, within manufacturing enterprises results mirrored those presented in Table 3. With reference to service enterprises, by contrast, the coefficient of promotion differed from the main analysis as it was no longer significant.

As far as the failure outcome is concerned, with reference to manufacturing enterprises results have similarities with those presented in Table 4, with the exception of the coefficients of the design and packaging and placement that turned out to be significant. However, we considered such a result

consistent with the success of innovation. As a matter of fact, the design and packaging coefficient was significant and positive for innovation success and significant and negative for innovation failure.

Table 7. Germany CIS 2012: results by industry

SUCCESS: Cragg Model				
	Manufacturing		***Service***	
	Partial Effects	**Z**	**Partial Effects**	**Z**
Marketing innovation (aggregate)	**-.010**	**-0.58**	**.013**	**0.53**
Design & packaging	**.036**	**1.82***	**.058**	**2.33****
Promotion	**-0.53**	**-2.81*****	-.010	0.33
Placement	**.005**	**0.36**	**-.002**	**-0.10**
Pricing	**.029**	**0.89**	**-.008**	**-0.37**
FAILURE: Probit Model				
	Manufacturing		***Service***	
Covariate	**Partial Effects**	**Z**	**Partial Effects**	**Z**
Marketing innovation (aggregate)	**-.024**	**-1.00**	**.023**	**0.50**
Design & packaging	-0.50	-1.66*	**.000**	**0.00**
Promotion	**.051**	**1.67***	.073	1.46
Placement	-.049	.-1.77*	.021	0.47
Pricing	**.029**	**0.89**	-.015	-0.27

Notes. **** 1% significance, **5% significance, *10% significance. Results robust in terms of significance of the coefficient are reported in bold.*

Source: Own elaboration of the CIS 2012 data.

6.4.3 Robustness check by country

The main analysis was based on Germany only, which prevented from identifying the extent to which results might differ across different countries. Therefore, to increase the robustness of our results we extended our analysis, based on the available data, to seven European countries: Bulgaria, Slovenia, Slovakia, Hungary, Croatia, Romania and Estonia. We considered all countries together in one single model. We controlled for the country effect by introducing three country dummies based on the country innovation index referred to the year 2012 (European Innovation Scoreboard, 2019). According to the summary innovation index in 2012 Estonia was a strong innovator as well as Germany. Slovenia, Slovakia, Hungary, Croatia were moderate innovators, while Romania and Bulgaria modest innovators.

We did not employ the Cragg used in the main analysis due to the fact that the innovation success including a large number of zeros was a peculiarity of the Germany case only but not of all other countries. Notably, by considering all seven European countries, approximately only 8,82% of innovative enterprises[5] reported 0% of sales derived from innovative products between 2010 and 2012. Therefore, being the dependent variable a proportion, namely the proportion of sales generated by new products, and bounded between 0 and 1 ($0 \leq y_{2i,SUCC} \leq 1$), we estimated a fractional probit model (Papke and Wooldridge, 1996) that is an appropriate method in the presence of a continuous dependent variable expressed as a fraction or a proportion, as in our case[6]. The estimation procedure is a quasi-likelihood method (Papke and Wooldrige, 1996). The fractional regression is a model of the mean of the dependent variable conditional on covariates $E(y_i|\boldsymbol{x_i})$. Because *y* ranges in [0,1], the probit model ensures that $E(y_i|\boldsymbol{x_i})$ is also in [0,1]. The log-likelihood function for fractional model is:

$$lnL = \sum_{i=1}^{N} y_i ln\{G(\boldsymbol{x_i'}\beta)\} + (1 - y_i) ln\{1 - G(\boldsymbol{x_i'}\beta)\}$$

Where N is the sample size, y_i is the dependent variable, and $G(\cdot)$ here is a probit functional form $\phi(\boldsymbol{x_i'}\beta)$ where $\boldsymbol{x_i}$ are the covariates for individual *i* and ϕ is the standard normal cumulative density function.

By considering all seven countries together, about 1.65% of the $y_{2i,SUCC}$ takes on the value unity and about 8.82% of the $y_{2i,SUCC}$ takes on the value zero. Table 8 reports the results.

Table 8. Results for all the considered countries.

	SUCCES: Fractional Probit		***FAILURE: Heckman Probit***	
	Partial Effects	**Z**	**Partial Effects**	**Z**
Marketing innovation (aggregate)	**-.010**	**-1.60**	**.0112**	**0.84**
Design & packaging	.003	0.93	**.013**	**0.92**
Promotion	**-.010**	**-2.21****	-.007	-0.51
Placement	**.003**	**0.84**	**.024**	**1.51**
Pricing	**.000**	**0.11**	.038	2.58***

Notes. **** 1% significance, **5% significance, *10% significance. Results robust in terms of significance of the coefficient are reported in bold.*

[5] In some countries, when individually considered, this percentage is even zero.

[6] The inverse Mills ratio was derived from the selection equation and then included in the outcome model. It resulted not significant.

Source: Own elaboration of the CIS 2012 data.

Results from the analysis on the seven considered countries confirmed that introducing one marketing innovation, regardless of type, did not have a significant relationship with innovation success or failure. Considering each marketing innovation type leads to uncover significant relationships with innovation performance. As far as the success outcome is concerned, results on all the considered countries were consistent with those presented in Table 3, with the exception of the coefficient of design and packaging that was no longer significant. As far as the failure outcome is concerned, the results on all countries considered showed similarities with those presented in Table 4, apart from the coefficients of promotion that was no longer significant and from the coefficient of pricing that turned out to be significant.

To summarize, the employed robustness checks confirmed the importance of taking into account marketing innovation types instead of a general measure of marketing innovation. Support is also provided for the majority of findings, despite certain differences as far as industry and countries are concerned.

6.4.4 Robustness check: Endogeneity

Endogeneity occurs when the independent variable of interest (in our case the marketing innovation strategy) correlates with the residual in a model (Wooldridge, 2002). In such a situation the error term is not random and estimates are inconsistent and biased. Endogeneity bias might be due to the omission of variables, errors in variables and to simultaneous causality. In our case, endogeneity may occur in case of the omission of variables in our models due to data unavailability. For instance, the information on the amount of money assigned to the marketing budget of each enterprise might contribute to influence both the success of a technological innovation (such as a product innovation) and the introduction of a marketing innovation (such as the launch of an advertising campaign on a new media). If such information is omitted, the potential variation caused by it will be encompassed by the error term in the model, thus leading to endogeneity bias. Furthermore, endogeneity might be caused by simultaneous causality, i.e., when the marketing innovation and the two dependent variables simultaneously cause each other: the marketing innovation strategy may influence the innovation success or failure of the technological innovation, but the success or failure may also affect the decision to undertake marketing innovation. If successfully innovative firms are more likely to introduce a marketing innovation, the error term will result correlated with the marketing innovation indicator, thus leading to endogeneity problems.

Endogeneity is most commonly described in the context of ordinary least squares (OLS) estimation (Zaefarian et al. 2017) and one common approach to address it is the use of the instrumental variables'

(IV) techniques. Instrumental variables are variables that are uncorrelated with the error term in the model and correlated with the endogenous independent variable.

Several reasons have hampered the adoption of the IV approach in our main analysis. First, it is challenging to identify valid instruments for the marketing innovation overall and for each marketing innovation type: the data employed in this study is collected at the enterprise level, it is cross-sectional and does not offer extensive information on each marketing practice. Second, we adopted a double hurdle to model the success of innovation by taking into proper consideration the large presence of zeros and the two different mechanisms that have generated them. To our knowledge, there are few applications that combine the use of the IV approach with the double hurdle model and that can be accommodated to our case. Existing statistics to assess the possibility of weak instruments are available for the linear case only: as reported in Bettin et al. (2012), the Cragg and Donald statistics (1993) are not available for the nonlinear models, such as those employed in the present work.

Therefore, in order to check the robustness of our main analysis with reference to the potential endogeneity bias of the marketing innovation overall, we ran two extended regression models (ERMs) (one for the failure outcome, one for the success outcome) that took into account the sample selection (only technological innovators might success or fail in innovation) and the potential endogeneity of the marketing innovation variable as well, but that were not able to tackle the problem of the large presence of zeros in the success outcome. ERMs is a term that designates STATA commands for fitting several regression models (e.g., linear, probit) that allow several complications included continuous/binary and ordinal endogenous covariates and endogenous sample selection that can be used separately or in any combination (StataCorp, 2017; White, 1996; Wooldridge 2010).

Due to the abovementioned data limitations, we instrumented the marketing innovation overall with the variable that describes the importance of intensifying or improving the marketing of goods or services for reaching enterprises goals. Such a variable assumes the value 1 if the enterprise assigns a high degree of importance to improving the marketing of goods or services for reaching enterprises goal and the value 0 if the enterprise assigns a medium, low or no importance to it. We expected that this variable was correlated with the potential endogenous marketing innovation strategy and uncorrelated with the structured error term in the main equation. The degree of importance assigned by the enterprise to intensifying or to improving the marketing of goods can have an actual effect on the performance of the technological innovation (innovation success or failure) mainly through the introduction of a marketing innovation. Moreover, intuitively, this variable was supposed to be related to the introduction of a marketing innovation: if the enterprise attributes a high degree of importance

to improving the marketing of goods or services, a marketing innovation is more likely to be introduced.

Table 9 reports estimation results of an extended linear regression to model the success of innovation depending on all exogenous covariates considered in the main analysis[7], the potential endogenous marketing innovation covariate and the sample selection. Specifically, we used the eregress Stata command in Stata 15 (StataCorp, 2017).

Table 9. SUCCESS: ERM with sample selection and potentially endogenous marketing innovation

Main equation (Success outcome)	**Coefficient**	**Std.err**	**Z**
Instrumented: Marketing innovation (aggregate)	.085	.084	1.01
Auxiliary equation	**Coefficient**	**Std.err**	**Z**
Instrument: STMKT_high	.223	.050	4.49***
Corr (e.innovation, e.success)	-.283	.110	-2.57***
Corr (e.marketing_innovation,e.success)	-.228	.230	-0.99

*Notes. ***1% significance, **5% significance, *10% significance.*

Source: Own elaboration of the CIS 2012 data

The correlation estimates tell us about the endogeneity in our model. The "corr (e.innovation, e.success)" is an estimate of the correlation between the error from the selection equation and the error from the outcome equation. The estimation is significant, so we reject the null hypothesis that there is no endogenous selection. It is negative, so we conclude that unobserved factors that increase the likelihood of being an innovator tend to occur with unobserved factors that decrease the amount of innovation success. The estimated correlation between the error from the main and auxiliary equation was -.228 and was not significantly different from zero. Because endogeneity is defined as the correlation of a covariate with the error of a model, we can conclude that the marketing innovation covariate is not endogenous and that unobservable factors that increase the probability of conducting marketing innovation do not tend to increase the success of innovation.

The instrumental variable (STMKT_high) appears to meet the relevance criterion because it significantly determines the marketing innovation (Table 9). Therefore, we can conclude that the importance of intensifying or improving the marketing of goods or services for reaching enterprise goals is a strong instrument. By looking at the coefficient of the marketing innovation variable in the main equation we found that there the relationship between marketing innovation and innovation success is not significant, thus confirming results obtained in the main analysis (see Table 3, columns 2 and 3).

[7] Coefficients of control exogenous variables are not displayed in the Table 9 for readability purposes, but they are available upon request.

Table 10 reports estimation results of an extended probit regression to model the failure of innovation depending on all exogenous covariates considered in the main analysis[8], the potential endogenous marketing innovation covariate and the sample selection. Specifically, we used the eprobit Stata command in Stata 15 (StataCorp, 2017).

Table 10. FAILURE: ERM with sample selection and potentially endogenous marketing innovation

Main equation (Failure outcome)	**Coefficient**	**Std.err**	**Z**
Instrumented: Marketing innovation (aggregate)	-.219	.675	-0.32
Auxiliary equation	**Coefficient**	**Std.err**	**Z**
Instrument: STMKT_high	.227	.049	4.62***
Corr (e.innovation, e.failure)	-.063	.539	-0.12
Corr (e.marketing_innovation,e.failure)	.097	.492	0.20

*Notes. ***1% significance, **5% significance, *10% significance.*

Source: Own elaboration of the CIS 2012 data

The "corr (e_innovation, e.failure)" is an estimate of the correlation between the error from the selection equation and the error from the outcome equation. The estimation was not significant, so we do not reject the null hypothesis that there is no endogenous selection. The estimated correlation between the error from the main and auxiliary equation is 0.097 and was not significantly different from zero. Because endogeneity is defined as the correlation of a covariate with the error of a model, we can conclude that the marketing innovation covariate was not endogenous and that unobservable factors that increase the probability of conducting marketing innovation do not increase the probability of abandoning an innovation project. The instrumental variable STMKT_high appeared to meet the relevance criterion because it significantly determined the marketing innovation (Table 10). Therefore, we can conclude that the importance of intensifying or improving the marketing of goods or services for reaching enterprise goals was a strong instrument. The coefficient of the marketing innovation variable was not significant and confirmed the results obtained in the main analysis (see Table 4, columns 2 and 3).

To conclude, the robustness check confirmed that marketing innovation considered at the aggregate level was not significant in determining the success or failure of a technologically innovative project and that it was not endogenous. Unfortunately, an IV analysis on each of the four marketing innovation types cannot be performed due to the aforementioned data limitations.

7 Discussion and Conclusions

This paper has investigated the role of marketing innovation with reference to innovation performance and measured in terms of innovation failure and innovation success. The results reveal the complex

[8] Coefficients of control exogenous variables are not displayed in the Table 10 for readability purposes, but they are available upon request.

role of marketing innovations in their relationship with innovation performance. Table 11 summarizes empirical support to the hypotheses.

Table 11. Summary of empirical support to hypotheses

	Support
Hypothesis	**Main analysis**
H1a) Marketing innovation (n.r.) Innovation success	Supported
H1b) Marketing innovation (n.r.) Innovation failure	Supported
H2a) Innovation in product design and packaging ->Innovation success (+)	Supported
H2b) Innovation in product design and packaging ->Innovation failure (-)	Not supported
H3a) Innovation in promotion ->Innovation success (-)	Supported
H3b) Innovation in promotion ->Innovation failure (+)	Supported
H4a) Innovation in placement ->Innovation success (+)	Not supported
H4b) Innovation in placement ->Innovation failure (-)	Not supported
H5a) Innovation in pricing->Innovation success (+)	Not supported
H5b) Innovation in pricing ->Innovation failure (-)	Not supported

Notes. *"n.r." means "not related";*

The introduction of one marketing innovation, regardless the type, is not related to innovation success and failure. Specifically, the results, both from the main analysis and from the robustness checks, show that introducing one marketing innovation is not significantly related to the percentage of total sales from innovative products for the market and the enterprise and to the likelihood to abandon an innovation. These findings support the stream of studies that did not observe any significant effect of marketing innovation on innovation success (e.g. Mothe and Nguyen, 2010; 2012; Pino et al., 2016; Geldes et al., 2017). However, in contrast with Mothe and Nguyen (2010; 2012), our study shows that analysing marketing innovation at the aggregate level and single marketing innovation level can lead to different conclusions: overall marketing innovation is observed to be nonsignificant, because the composite measure might be affected by different single marketing practices that display opposite signs. This finding should attract academics' attention and calls for a shift from an aggregate analysis of marketing innovation to a separate analysis of each marketing innovation.

Different results emerged as far as the role of each type of marketing innovation. First, marketing innovation in product design and packaging had a positive relationship with innovation success. Such result confirmed that the technological development and introduction of a new product can benefit from the support of an innovation in marketing to meet customers' changing needs. These results were in line with the literature that has highlighted that the appearance of a product influences consumer product choice (Creusen and Schoormans, 2005). Product package is a very influential

medium because it is present at the crucial moment when the purchase decision occurs (Orth and Malkewitz, 2008). For instance, Miller Lite introduced a change in the packaging in December 2013 by re-introducing the can shape employed in the 1970s. After the introduction, sales related to the new can shape were reported to increase more than 4% (Marzili, 2014).

Conversely, from our empirical analysis, a negative relationship was observed between innovation in promotion and innovation performance. Introducing an innovation in promotion has a positive relationship with the likelihood of abandoning an innovation and a negative relationship on innovation success. This could be the case of a promotion innovation such as the change in the brand logo. When Tropicana introduced a new logo, its sales dropped 20% in one month (Nisen, 2013). In 2010, the Gap performed a corporate rebranding that led to negative consequences such as antagonistic customer reactions (Tarnovskaya and Biedenbach, 2018). Even introducing a new loyalty programme could negatively affect sales. When Sears, a U.S. retailer launched its 'Shop your way' loyalty programme, the success of the programme led to over-rewarding customers, affecting the margins of the retailer and its profits (Danaher et al., 2016). Therefore, introducing a marketing innovation in promotion has the potential to harm the success of a technological innovation and decrease the sales and profits of an enterprise, hampering the completion of an innovation project. It is likely that innovation in promotion need probably more time to be assimilated by consumers due to its "surprise effect"; thus, a longer time window would be needed to assess whether its negative role could change and become positive in the long run.

In contrast with our hypotheses, marketing innovation in placement and marketing innovation in pricing, according to results from the main analysis, did not display any significant relationships with innovation performance. Our results show that, for instance, introducing a change in the pricing strategy or adding a new sales channel does not increase innovation success or decrease the likelihood to abandon the innovation. As far as innovation in sales channel, it might be that the introduction of a new online channel or of a new retail concept contributes to the overall sales but does not significantly influence the sales of a new product. With reference to price innovation we could expect that a new pricing system might play a role in developing sales and profits for existing products, that are supposed to display a more predictable demand and higher volumes and frequency of purchases. On the contrary, as far as new products are concerned, it could be that price innovations display some benefits only when the products are widely adopted within the customer base: according to Grewal et al. (2011), high frequencies and volumes allow a dynamic pricing software to better accomplish its tasks.

Our study also highlights the necessity for further studies to include marketing innovations as determinants of innovation failure. The implemented marketing innovations have the potential to

influence the likelihood of completing or not completing an innovation project. Enterprises might have limited budgets, human resources, time and organisational focus to devote to technological innovations. Hence, the introduction of a nontechnological innovation that results to be unsuccessful in increasing sales of an innovative product could negatively affect the availability of these resources, thus leading to project abandonment.

Results from the present study provide managerial implications. Findings encourage enterprises to rely on certain marketing innovations to boost sales of their innovative products. As marketing innovations entail lower costs than other innovation types (Medrano and Olarte Pascual, 2016), they represent an interesting mean to leverage innovation performance. However, not all marketing innovations have the same role. We found that introducing a product design and packaging innovation can have a positive relationship with sales for the innovative products. Enterprises might then increase their investment to finalise significant improvements in product design and packaging that could support the launch of a new product.

On a different note, enterprises should be careful with innovation in promotion because these marketing practices can backfire, at least in short run, thus resulting in decreased sales related to an innovative product and in a decreased likelihood that an innovation project would be completed. Hence, when introducing an innovation in promotion, it is key to evaluate all the possible negative consequences for the existing promotional activities in terms of customer response, especially as far as purchase behaviour.

This study has several limitations. First, given the cross-sectional nature of the data employed, this study was not intended to provide evidence for a causal relationship between marketing innovation and innovation performance. Second, the available information on marketing innovation concerned only the introduction of four types of marketing innovation. Each type is broad and includes different marketing practices that are undertaken with different goals, budget, timing, and efforts. Limitations related to data availability have also prevented the adoption of IV techniques to address the potential endogeneity of each marketing innovation type. Third, the present study has not measured the quality of each marketing innovation. The quality of marketing innovations might influence their related effectiveness in driving innovation performance and might be different across enterprises. However, measuring the quality of marketing innovation is indeed a challenging task and it would require an ad-hoc evaluation, both on the managerial and consumer side, of each marketing innovation. To partially overcome this limitation, the present work has employed a substantial number of relevant control variables that correlate to marketing innovation quality, such as the percentage of enterprise employees with a university degree, export, size, sector and group membership.

Fourth, regarding the abandoning of innovation, no information was available on which specific innovation project was abandoned. Future studies should explore whether the determinants of innovation failure play a different role depending on the type of innovation project that has been abandoned.

Further studies are required to extend knowledge on the role of marketing innovation. Understanding the synergistic roles of the types of marketing and organisational innovations that are the drivers of innovation success and preventing innovation failure would be beneficial. Second, it would be valuable to measure innovation performance with additional output measures, for instance number of patent applications. This would increase the robustness of previous findings and offer a more insightful perspective on innovation performance. Third, further research, with a different set of data, could study the role of marketing innovations by adopting a longitudinal perspective. This approach would allow for the extraction of findings on how marketing innovation can be successful across multiple time periods. Such results could guide practitioners and policymakers in their innovation strategies and policies in the short- and long-term.

Disclaimer

The anonymous data of the Community Innovation Survey 2012 (CIS 2012) used in the analysis of this paper was provided by EUROSTAT. All results and conclusions are given by the authors and represent their opinion and not those of EUROSTAT, the European Commission or any of the national authorities whose data have been used. The responsibility for all conclusions drawn from the data lies entirely with the authors.

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APPENDIX A: Description of Variables

Variable name	Definition	Description	Type
Dependent variables			
FAILURE	Abandoned or suspended innovation activities	=1 if enterprise has abandoned or suspended activities before completion during the three years from 2010 to 2012; =0 otherwise	Dummy
SUCCESS	Share of sales generated by new products	Sum of proportion of turnover due to innovative products new to the market and only new to the enterprise	Continuous (left-censored)
INNOVATION	Innovation	=1 if enterprise has introduced at least one product/process innovation or is engaged in innovation activities not completed or still on-going; =0 otherwise	Dummy
Explanatory Variables			
Marketing Innovation (aggregate)	Marketing innovation	=1 if at least one new marketing concept or strategy (design and packaging, promotion, placement, pricing) has been introduced during the three years from 2010 to 2012; =0 otherwise	Dummy
Design & packaging	Design and packaging	=1 if changes in design and packaging have been introduced; =0 otherwise	Dummy
Promotion	Promotion	=1 if new techniques for promotion have been introduced; =0 otherwise	Dummy
Placement	Placement	=1 if new techniques for placement have been introduced; =0 otherwise	Dummy
Pricing	Pricing	=1 if new techniques of pricing have been introduced; =0 otherwise	Dummy
Instrumental variable			
STMKT_high	Importance of intensifying or improving the marketing of hood or services for reaching enterprises goals	=1 if the enterprise ascribes a high importance; =0 otherwise	Dummy
Control variables			
ENTERPRISE SIZE			
Size1	Small	=1 if the enterprise has 49 employees or less; =0 otherwise	Dummy
Size2	Medium-small	=1 if the enterprise has 50-249 employees; =0 otherwise	Dummy
Size3	Medium-large	=1 if the enterprise has 250-499 employees; =0 otherwise	Dummy
Size4	Large	=1 if the enterprise has 500 employees and more; =0 otherwise	Dummy
SECTOR	*Manufacturing*		
Manufacturing_lt	Low-tech	=1 if the enterprise operates in a low-tech sector; =0 otherwise	Dummy

Manufacturing_mlt	Medium-Low-tech	=1 if the enterprise operates in a medium-low-tech sector; =0 otherwise	Dummy
Manufacturing_mht	Medium-high tech	=1 if the enterprise operates in a medium-high-tech sector; =0 otherwise	Dummy
Manufacturing_ht	High-tech	=1 if the enterprise operates in a high-tech sector; =0 otherwise	Dummy
	Service		
Service_kis	Knowledge intensive (KIS)	=1 if the enterprise operates in a knowledge intensive sector; =0 otherwise	Dummy
Service_lkis	Low Knowledge intensive (LKIS)	=1 if the enterprise operates in a low knowledge intensive sector; =0 otherwise	Dummy
RRDEX_RAT	EXTRAMURAL R&D expenditure	R&D extramural expenditure in 2012 (% of total turnover)	Continuous
RRDINX_RAT	INTRAMURAL R&D expenditure	R&D intramural expenditure in 2012 (% of total turnover)	Continuous
SUPPORT	R&D Subsidy	=1 if the enterprise received public funding to R&D; =0 otherwise	Dummy
EXPORT	Export	=1 if the enterprise sells goods and/or services in other European Union or associated countries or in other countries	Dummy
GP	Group membership	=1 if the enterprise belongs to an enterprise group; =0 otherwise	Dummy
FM	Foreign multinational	=1 if the enterprise's headquarter is located outside the own country; =0 otherwise	Dummy
EMPUD_VALC	Percentage of enterprise employees with a university degree	Central value of the class. 0: 0%; 2.5: 1% to 4%; 7: 5% to 9%; 17: 10% to 24%; 37: 25% to 49%; 62: 50% to 74%; 87.5: 75% to 100%	Continuous
ORG_INN	Organizational innovation	=1 if the enterprise has introduced a new business practices for organizing procedures, or new methods of organizing work responsibilities and decision making or new methods of organizing external relations; =0 otherwise	Dummy
EMP_GROWTH	Growth rate	(Total number of employees in 2012-total number of employees in 2010)/total number of employees in 2010	Continuous
CO_VERTICAL	Vertical cooperation	=1 if the enterprise engaged in an innovation cooperative activity with suppliers and customers; =0 otherwise	Dummy
CO_INSTITUTIONAL	Institutional cooperation	=1 if the enterprise engaged in an innovation cooperative activity with consultants, universities, government public or private research institutes; =0 otherwise	Dummy
CO_HORIZONTAL	Horizontal cooperation	=1 if the enterprise engaged in an innovation cooperative activity with competitors; =0 otherwise	Dummy
CO_INT	Internal cooperation	=1 if the enterprise engaged in an innovation cooperative activity with other enterprises within own enterprise group; =0 otherwise	Dummy

Sources of information

SENTG_CRUCIAL	Within the enterprise or enterprise group	=1 if the enterprise rates internal information source of High importance; =0 otherwise	Dummy
SSUP_ CRUCIAL	Suppliers of equipment, materials, components, or software	=1 if the enterprise rates the corresponding market source of high importance; =0 otherwise	Dummy
SCLPR_CRUCIAL	Clients or customers from the private sector	=1 if the enterprise rates the corresponding market source of high importance; =0 otherwise	Dummy
SCLPU_CRUCIAL	Clients or customers from the public sector	=1 if the enterprise rates the corresponding market source of high importance; =0 otherwise	Dummy
SCOM_ CRUCIAL	Competitors or other enterprises in your industry	=1 if the enterprise rates the corresponding market source of high importance; =0 otherwise	Dummy
SINS_ CRUCIAL	Consultants and commercial labs	=1 if the enterprise rates the corresponding market source of high importance; =0 otherwise	Dummy
SUNI_ CRUCIAL	Universities or higher education institutions	=1 if the enterprise rates the corresponding institutional source of high importance; =0 otherwise	Dummy
SCON_CRUCIAL	Conferences, trade fairs, exhibitions	=1 if the enterprise rates the corresponding “other” source of high importance; =0 otherwise	Dummy
SJOU_CRUCIAL	Scientific journals and trade/technical publications	=1 if the enterprise rates the corresponding “other” source of high importance; =0 otherwise	Dummy
SPRO_ CRUCIAL	Professional and industry associations	=1 if the enterprise rates the corresponding “other” source of high importance; =0 otherwise	Dummy
GOALS_SCALED	Importance of enterprises’ goals	Sum of scores of importance of four objectives of innovation, numbered between 0 (unimportant) and 3 (crucial): increase turnover, increase market share, decrease costs, increase profit margins. It is rescaled between 0 and 1	Continuous
Obstacles to meeting the goals			
OBSPR_CRUCIAL	Strong price competition	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSQL_CRUCIAL	Strong competition on product quality, reputation or brand	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSLDE_CRUCIAL	Lack of demand	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSCP_CRUCIAL	Innovation by competitors	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSDMK_CRUCIAL	Dominant market share held by competitors	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSPRS_ CRUCIAL	Lack of qualified personnel	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSFIN_ CRUCIAL	Lack of adequate finance	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSAMK_CRUCIAL	High cost of access to new market	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy
OBSREG_ CRUCIAL	High cost of meeting government regulations or legal requirements	=1 if the enterprise rates the corresponding obstacle of high importance; =0 otherwise	Dummy

Forms of protection			
CMPAT_CRUCIAL	Patents	=1 if the score of importance of the protection method “patents” is crucial; =0 otherwise (original scores between 0=not used and 3=crucial)	Dummy
CMRCD_CRUCIAL	Design registration	=1 if the score of importance of the protection method “design registration” is crucial; =0 otherwise (original scores between 0=not used and 3=crucial)	Dummy
CMCO_CRUCIAL	Copyright	=1 if the score of importance of the protection method “copyright” is crucial; =0 otherwise (original scores between 0=not used and 3=crucial)	Dummy
CMCTM_CRUCIAL	Trademarks	=1 if the score of importance of the protection method “trademarks” is crucial; =0 otherwise (original scores between 0=not used and 3=crucial)	Dummy
CMLTAD_CRUCIAL	Lead time advantages	=1 if the score of importance of the protection method “lead time advantages” is crucial; =0 otherwise (original scores between 0=not used and 3=crucial)	Dummy
CMCPX_CRUCIAL	Complexity of goods or services	=1 if the score of importance of the protection method “Complexity of goods or services” is crucial; =0 otherwise (original scores between 0=not used and 3=crucial)	Dummy
CMSEC_CRUCIAL	Secrecy	=1 if the score of importance of the protection method “secrecy” is crucial; =0 otherwise (original scores between 0=not used and 3=crucial)	Dummy