Innovating successfully through design: Evidence from European firms

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Abstract

This paper investigates the impact of design on the turnover firms obtain from their innovations. We claim that investing in design can only make the firm more innovative in technological terms, while the related economic performance mainly depends on the position of design within the firm. Being innovative in non-technological terms can instead help in both respects. We test these arguments on a sample of more than 12,000 European firms from the last Innobarometer (2014) survey. Design investments confirm their expected role of innovation driver, along with any position of design within the firm. Innovative turnover actually increases the most by setting design at the centre of the firm, while it does not so by simply (i.e. not systematically) using it, as instead happens for becoming (techno-)innovator. Once design has been controlled for, non-technological innovations increase both the probability of innovating in the technological realm and its economic impact. Strategic implications are drawn accordingly, with the recommendation of managing design carefully in order to guarantee rewarding innovations.

JEL Codes: O31, O32, O33;
Keywords: design, innovation, firm performance

1. Introduction

The role of design in driving firm performance appears nowadays nearly guaranteed. Taking stock of some "benchmark" studies (e.g. Roy and Riedel, 1997; Gemsers and Lenders, 2001; Hertenstein et al., 2005; Chiva and Alegre, 2007), the contribution of design to firm's success appears, net-of-qualifications, unquestionable. Indeed, in the literature this is often considered the motivating argument to move the focus on its "intermediate" implications like, for example, design perception and consumer choice (e.g. Creusen and Schoormans, 2005), design thinking and strategy making (e.g. Cross, 2011), organisational design and organisational structures (e.g. Abecassis-Moedas and Benghozi, 2012), design-push knowledge generation and design-led innovations (e.g. Verganti, 2008). The last issue, in particular, has become pivotal in a growing field of management studies where design is considered to spur specific processes of creativity, customer management and organisational learning. These processes would in turn lead to newly conceptualized typologies of innovations, such as "aesthetic" and "design-driven" innovations (Ravasi and Stigliani, 2012; Verganti, 2008), whose performance impact has been largely supported by dedicated case studies (e.g. Dell'Era et al., 2010).

This paper addresses the generalisation of this last relationship, between design and innovation in broad terms, and assesses its impact on innovation-related firm performance. In particular, we try to enrich the extant analysis of the design-innovation relationship for the firm's performance in three different respects. First of all, rather than taking it for granted and/or rationalising its existence in an ex-post, confirmative manner, we search for the actual performance impact that the relationship between design and innovation could theoretically have. Second, instead of relying on a case-study methodology, we search for this impact by making use of a large sample of firms, with heterogeneous approaches and resources to design as well as diversified innovation and economic performances. Third, and most importantly, we extend the management perspective on design by integrating it with applied innovation studies - pointing to the role of design investments in driving innovation - and the literature on business models that focuses on the management of design for the successful marketability of innovations.

Using this integrated theoretical background, we put forward some research hypotheses that try to distinguish and coherently combine the different kind of innovation impact guaranteed by investing in design vs. managing design within the firm. From an empirical point of view,

we test these hypotheses on a sample of more than 12,000 European firms from the last Innobarometer (2014) survey.

Our results show that design investments confirm their driving role for technological innovations, but that a similar role is also played by the way design is managed within the firm, irrespectively from its centrality with respect to the other activities. On the contrary, design investments do not have an impact on innovative turnover, which requires a central position for design within the firm to increase. Once design has been controlled for, non-technological innovations increase both the probability of innovating in the technological realm and its economic impact, but to a lesser extent than the position of design within the firm. The strategic implications of these results are threefold: *i)* design investments should be used as a leverage to make the firm more capable of introducing technological innovations and benefiting from the market opportunities they offers; *ii)* to benefit from these opportunities the firm should manage design in a pivotal way with respect to other activities and possibly embed it within its business model; *iii)* adopting innovative practices of organisation and marketing is also a strategic choice to increase the innovativeness of the firm in the technological realm as well as their marketability, but to a lesser extent than design management.

The rest of the paper is structured as follows. In Section 2, we discuss the relevant literature and position our research hypotheses within it. Section 3 illustrates our empirical application, the dataset and the econometric strategy. In Section 4 we discuss the results, while Section 5 presents some conclusive remarks.

2. Background literature and research hypotheses

The impact that design can have on firm performance is not a new issue. In the '90s, the topic was investigated by remarkable research projects - like MADRID ("MArket Demands that Reward Investments in Design") and CID ("Commercial Impacts of Design") - following which a consistent amount of literature was produced (e.g. Roy and Potter, 1993; Roy and Riedel, 1997; Ulrich and Pearson, 1998). In general, supportive conclusions were drawn on the role of design for the competitive success of firms in terms of, for example, profitability and turnover (e.g. Black and Baker, 1987; Walsh et al., 1992).

In the last two decades, the research on design and performance progressed substantially, moving important steps ahead with respect to the still rudimentary "theoretical

underpinning, conceptualising, and measuring" issues of the first generation of studies (Gemsers and Lenders, 2001, p. 29). The conceptualisation of design has gone over the early focus on industrial design. The theoretical rationale of its impact has extended beyond its role for price vs. non-price competition. Different domains of design functionality have been recognised - the interpretation of consumers' needs, the organisational design of the company structure, the formulation of the firm's strategy, and its model of value creation, among the others - benefiting from the convergence of several disciplines like management, engineering and artificial sciences, creativity and arts, innovation and aesthetics. As the recent survey by D'Ippolito (2014) shows, this has entailed a proliferation of definitions and a substantial "multidimensionalisation" of the concept of design. With the inevitable risk of an excessive simplification, it seems to us these approaches represent important qualifications and integrations of a sort of "baseline" twofold account of design, which we embrace in the current study. In a nutshell, design can be meant as "… the creation of […] product shapes and styles, ... [and the] communicat[ion] of the firm's quality image and product integrity" (Yamamoto and Lambert, 1994). In other words, we refer to a concept of design that encompasses both "functionality" and "aesthetics", and retain its role in both the *creation* of new products and services and in their *commercialisation* (Moultrie and Livesey, 2014).

The most recent empirical analyses have also moved towards this comprehensive account of design and brought novel - and still generally supportive - evidence of its role for firm performance (e.g. Hertenstein et al., 2005; Candi, 2006; Chiva and Alegre, 2007; Candi and Saemundsson, 2011; Filippetti, 2011; Hertenstein et al., 2013). To be sure, along these studies, an evolution in the theoretical underpinning of the design-performance relationship and in its empirical qualification can be observed. One of the most important acquisitions is for sure represented by the crucial (though not exclusive) role of innovation for the impact of design on firm performance. On the one hand, design drives technological innovation. As underlined by Vivien Walsh (1996) in quoting Chris Freeman's seminal contribution, the two dimensions of the design concept (see above) are actually central in two important domains of the technological process: creativity and market-technology coupling. Indeed, evidence has been searched for and found on the role of design in leading technological innovations of both radical and incremental nature (e.g. Walsh, 1996; von Stamm, 2003; Perks et al., 2005; Marsili and Salter, 2006; Tether, 2006).[1] On the other hand, a large amount of studies have found that

[1] Radical innovations are the typical outcome of the first design domain, that is, of a radical new product development (Stigliani and Ravasi, 2012). Design-led incremental innovations, instead, can be allowed by the re-

technological innovations drive firm performance, both in terms of productivity (e.g. Hall, 2011) and profitability (e.g. Love et al., 2009; Leiponen, 2000). A combined reading of these two sets of results, suggests the opportunity of referring to an important specification of the relationship between design and firm performance, that is, the link between design and innovation-related performance. In order to do so, we focus on the returns firms can obtain from the commercialisation of their innovations, the innovative turnover. Furthermore, we claim this to be more than a simple intermediation relationship, for whose qualification we put forward some research hypotheses in the following.

Our core argument is that in dealing with design and with its innovation impact, a clear distinction should be made, on the one hand, between innovativeness and innovation-related performance, on the other hand, between investing money in design and managing design within the firm. More precisely, we claim that both dimensions of design could represent enablers of the firm's capacity to innovate in the technological realm. However, the firm's capacity of getting return from innovations – in brief, its innovation-related performance - is mostly driven by the latter and, in particular, by the choice of giving design a central role within the firm.

As far as the first bit of this argument is concerned, the role of design investments as technological innovation input has been largely recognised (see Moultrie and Livesey (2014) for a discussion). In synthesis, by investing resources in design activities firms can become more capable of mastering the inherent problems of industrial engineering entailed by devising new or marginally innovative products, services and/or processes (Walsh, 1996). Furthermore, they could also become more sensitive to market demands or opportunities and thus more prone to capture the need of new technological advancements (von Hippel, 1988). Following these arguments, design investments have officially entered in the country-specific surveys on the intangible inputs that drive technological innovation (Awano et al., 2010) and evidence of that has been found also for a large set of countries (Montresor and Vezzani, 2016). On this basis, following the literature on industrial design and combining it with innovation studies, we do expect that by investing in design the firm can acquire knowledge of both engineering and marketing nature, which increases its capacity of technological innovations and put forward the following hypothesis:

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innovation that design can communicate to the customers for even mature products (Rothwell and Gardiner, 1989).

Hp1: *Investing in design increases the firm's probability of introducing a technological innovation.*

More recently, management studies have added new insights on the innovative impact of design, arguing that such an impact is also driven by the way in which it is actually managed within the firm. In this literature, most of the attention has been attracted by the position that designers have within the firm, and by the firm's decision to keep design "in-house" rather than outsourcing the relative activities (e.g. Chiva and Alegre, 2007; von Stamm, 2008; Filippetti, 2010; Abecassis-Moedas and Berghozi, 2012). More in general, a higher innovation potential has been shown to accrue from firm's structures that are organised around an effective development of design and that use coordination mechanisms across the departments to do so (e.g. Bruce et al., 1995; Perks, 2007; Roper et al., 2016). Following this stream of literature, we expect that the firm's technological innovativeness depends also on the position that design is attributed by the firm with respect to the other business activities. This position varies in terms of importance, spanning from the limited recognition of one of its functions – e.g. aesthetics – to its manifold contribution to the firm's strategy. More precisely, we claim that the more "central" the position of design is within the firm, the more the firm is capable to make design interact with the other technological drivers that are needed as inputs in order to innovate. Accordingly, we put forward our second hypothesis:

Hp2: *The position of design within the firm affects the firm's probability of introducing a technological innovation, to an extent that increases with its centrality*.

When it comes to the second bit of our core argument, that is, the focus on the economic performance allowed by the firm's technological innovations, the role of the two decisional processes at stake changes. On the one hand, following the conceptual premises of the famous CDM model (Crepon et al., 2008), we claim that, like for R&D: "it is *not* innovation input [e.g. design investments] but innovation output that increases [performance]" (p. 2, our amendment for design instead of R&D, performance instead of productivity). In other words, a performance impact of design could only follow from "the use of innovations in [the firm's] production activities" (ibidem, p.2), which design investments have helped the firm to obtain, working as an input. Extending this logic to our case, we claim that *design investments* as such do not affect *directly* the firm's economic performance, but rather *indirectly*, through the direct impact they instead have on the firm's innovativeness. In order to test for this argument, we put forward two additional hypotheses. The first one simply states that:

Hp3: *Once controlled for the position of design with the firm, design investments do not affect its innovation-related performance.*

The second hypothesis in the same respect recalls and extends what we have said above about the importance of the management of design and recognises that, being part of "the use of innovations" (Crepon et al., 2008) within the firm, the position design accordingly finds in it is even more important for their economic returns than for their introduction.

The previous argument has some important antecedents in the extant literature on design and firm performance in general. In the seminal work by Roy and Riedel (1997) commercially successful product development projects are associated to a specific "approach to design", rather than to a simple "attention to" (i.e. investment in) it, involving a "multidimensional focus" on "product performance, features and build quality, and [...] technical or design innovation" (p. 537). Similarly, Gemser and Leenders (2001) find that the impact of design on corporate performance is affected by the degree of emergence and novelty of the firm's design strategy. More recently, Chiva and Alegre (2009) conclude that a "good design [in terms of corporate performance] does not emerge by chance or by simply investing in design but rather as the result of a managed [design] process", where the reference is mainly to the construction of design management skills.

When it comes to innovation-related firm performance, rather than firm performance in general, the "way of dealing with design" immediately connects with the idea of business model (Zott et al., 2011; Wirtz, 2011) and with the role of innovation with respect to it.[2] Innovations and business models actually serve to each other in a mutual way, and design finds an important, though different role in each direction of the relationship. On the one hand, innovations can concern the firm's *business model* (Chesbrough, 2010; 2007; Demil and Lecocq, 2010), leading it to identify new sources of value creation and to define new strategic directions (Demil and Lecocq, 2010; Morris et al., 2005). In this last respect, design has been recently claimed to have an important role, but mainly with respect to "design-driven innovations" (Verganti, 2008), given its capacity of spurring the experimentation and prototyping of new business models.[3] On the other hand, more relevant for our argument is

[2] Apart from the several specifications in the massive literature on the topic, a business model can be meant as a model describing the way firms create and capture value (e.g. Baden-Fuller and Morgan, 2010; Demil and Lecocq, 2010; Teece, 2010). More pragmatically, a business model would result from a set of firm-specific and distinguishing components, the most recurrent of which being "the value proposition", "the value network" and the "revenue/cost model" (e.g. Johnson et al., 2008; Morris et al., 2005; Osterwalder et al., 2005).

[3] In particular, by proposing radical new meanings and creating visual representations, design-led innovations have been claimed to facilitate business model innovation: "conceiving novel business model 'propositions' that

"the role of the business model in capturing value from innovation" (Chesbrough and Rosenbloom, 2002), that is, its capacity of bringing a new technology to the market (e.g., Teece, 2010; Zott and Amit, 2010, 2007; Chesbrough, 2010). The role of design in this last respect is actually different and refers to the position the relative activities find within the firm following its extant business model. Focusing on this latter role, we expect that the firm's innovation-related performance depends on the extent to which design is recognised in the firm's business model – that is, the extent it enters in the definition of the relative components[4] – and on the position it is accordingly given with respect to the firm's business activities. Somehow extending the argument underlying our Hp2, we claim that the more "central" the position of design is within the firm, the more embedded design is in the business model, and the more design contributes to the role of the latter in creating value from innovation. Indeed, the central position of design would allow the firm to take stock of its manifold dimensions (i.e. functional and aesthetic) in creating value from the innovativeness, which design investments have helped the firm to obtain. Following this argument, we put forward our fourth hypothesis:

Hp4: *The position of design within the firm affects its innovation-related performance, to an extent that increases with its centrality*.

Another relevant aspect for the management of design within the firm, and for its expected impact on the firm's innovation-related performance, is represented by the firm's adoption of innovative practices of organisational and marketing nature. Indeed, these non-technological innovations could add to design in both driving the technological innovativeness of the firms and the marketability of their technological innovations.

As far as the first point is concerned, its supporting argument is represented by the idea that technological and non-technological innovations are very often complementary ones to the others: in particular, the introduction of new products/services and processes could greatly benefit from consistent changes in the way labour is divided and coordinated within the firm and from innovative ways of dealing with the customers in building up a market for them. This has actually appeared evident in the literature on the so-called innovation modes, meant

signify new 'meanings' for the customers" (Brunswicker et al., 2013, p. 146); [...] "through the creation of new business prototypes [...] centre on using artefacts to make both the novel business model and the process of business modelling more tangible." (p. 147); "facilitat[ing] and accelerat[ing] the process of prototyping and the exploration of 'disruptive' business models by engaging in 'deep' abstraction." (p. 147).

[4] For example, in its "value proposition", giving design a role also a source of value; its "value network", guaranteeing design a special attention in outsourcing and customer relation management; its "revenue and cost model", dealing accurately with the financial aspects of design.

as "firms' innovative behaviours synthetised into a manageable and interpretable set of typologies of innovation practices, strategies and performances" (Evangelista and Vezzani, 2010, p.1257). Searching for these modes through the use of the Italian Community Innovation Survey (CIS4) over the period 2002–2004 (CIS4), Evangelista and Vezzani (2010), for example, point to a notable group of firms that follow a "complex innovation mode". In this group technological innovations are coupled with non-technological (i.e. organizational and marketing) ones and with other distinguishing features (e.g. larger size and resource investments), among which a possibly design-related one like: "a product oriented and quality enhancement orientation of innovation activities rather than a cost-reduction rationale" (p. 1259). Similarly, using a sample of European firms from the Innobarometer 2009, over the period 2006-2008, Filippetti (2011) finds evidence of a cluster of firms following an "outward-oriented multifaceted innovation" (p. 16) mode. Here technological innovations are also coupled with non-technological ones, as well as with the adoption of an open innovation strategy and with the role of design among the relevant innovation inputs. All in all, "soft" innovations seem to make firms more capable of "hard" innovations, as well as the other way around, and the following hypotheses can be put forward:

Hp5: *Adopting non-technological innovations affects the firm's probability of introducing a technological innovation.*

Non-technological innovations are even more crucial in the economic exploitation of the introduced innovations. The innovative use of design within the firm is actually multifaceted. On the one hand, far from representing the mere output of marketing activities, as suggested by the approach of some international organisations (e.g. the OECD and the Eurostat in the CIS implementation of the Oslo Manual),[5] design constitutes a process interlinked with that of marketing to guide the development of new products (Veryzer, 2005; Luchs and Swan, 2011). For example, design-pulled innovations[6] often requires to change the firm's brand strategy with a marketing operation (Beverland, 2005), if not even to modify the marketing communication of the firm's corporate identity (Gorb, 1990). More in general, the commercial exploitation of a design-pulled technological innovation often involves some kind of

[5] As is wel-known, CIS stands for Community Innovation Survey, an harmonized survey to measure innovation activities in Europe.

[6] With the term design-pulled innovations we refer to the role of design as a "standard" innovation input and we thus carefully refrain from using the concept of "design-driven innovation" put forward by Verganti (2008). The latter identifies a specific kind of innovation able to change the emotional and symbolic characteristics that consumers attach to products and services, as for the examples of the Swatch and the Wii by Nintendo.

marketing innovation, which could increase its economic returns.[7] On the other hand, the management of design can combine with organisational innovations too, to the extent at which setting design at work in new technological developments requires an effort of organisational design by the firm (Romme, 2003). As we said, most of the attention has been attracted by the organisational change in the firm's boundaries with respect to design, and by the possibility of getting higher returns in terms of technological/economic performance from "in-house" rather than "outsourced" design (e.g. Chiva and Alegre, 2007; von Stamm, 2008; Filippetti, 2010; Abecassis-Moedas and Berghozi, 2012).[8] An important focus has also been placed on those changes in the organisational structure that enable firms to make the most effective and innovative use of design (e.g. Bruce et al., 1995; Perks, 2007; Roper et al., 2016). Overall, a design-pulled process of technological innovation could be coupled with some organisational innovations too,[9] in addition to marketing innovations. These non-technological innovations could in turn contribute, together with the positioning of design with the firm, in driving the economic performance of technological innovations. Accordingly, we expect that:

Hp6: *Once controlled for the position of design with the firm, adopting non-technological innovations increases the firm's innovation related performance.*

We should notice that a positive test of Hp6 is also suggested by the previously recalled evidence on the identification of innovation modes across firms. In the study by Evangelista and Vezzani (2010), for example, complex innovators - with the implicitly associated design-focus we said - show higher shares of turnover related to the introduction of new or improved products/services. Similar results are obtained by Filippetti (2011), in which a multifaceted innovation mode - with the explicit design association we said - significantly predicts the

[7] In spite of the sub-specification of design that in entails, we hereby refer to the general idea of marketing innovation suggested by the last edition of the Oslo Manual, that is: "marketing innovations involve the implementation of new marketing methods. These can include changes in product design and packaging, in product promotion and placement, and in methods for pricing goods and services" (OECD, 2005, p. 17).

[8] Related to this is the focus on the reshaping of external relationship that design could entail, in particular in the management of the collaborations with external designers (companies) (e.g. Dell'Era and Verganti, 2010).

[9] Similarly to marketing ones, also organisational innovations are marked by non-unproblematic definitions and measurements (for a critical review, see Armbruster et al., 2008). Once more, in spite of its limitations, we hereby refer to the standard categories contained in the latest CIS survey and mean organisational innovations as one and/or more of the following: "a) new business practices for organizing work and procedures; (b) new knowledge management systems to better use or exchange information, knowledge and skills within your enterprise or to collect and interpret information from outside your enterprise; (c) new methods of workplace organization for distributing responsibilities and decision-making; (d) new methods of organizing external relations with other firms or public institutions" (CIS6, Eurostat-survey).

growth of turnover and shows higher rates of turnover's growth with respect to the other modes.

3. Empirical application

We test our hypotheses on a sample of more than 12,000 European firms from the Innobarometer 2014. In comparison to previous studies on the relationship between design and firm performance (see Section 2), the dimension of the sample is definitively larger and marked by a broader coverage in terms of countries, sectors, and firm sizes (http://europa.eu/rapid/press-release MEMO-14-384 en.htm). This is an important distinguishing feature of our application, which enables us to go beyond the simple *ex-post* rationalisation of the relationship at stake obtainable from an exclusive focus on successful firms. Indeed, taking into account the heterogeneity of the firms of such a large sample, results will enable us to reach general conclusions, with the potential of *ex-ante*, general predictions.

Like the previous waves, the Innobarometer 2014 is a "flash" survey requiring some caution in the management of the data and in the interpretation of the responses (see Montresor et al., 2014). Like the previous ones, it is still a cross-sectional survey - containing information with respect to the period 2012-2014 - so that econometric analyses on its data cannot be interpreted as more than significant correlations. Usually, the Innobarometer is also a quite focalised kind of survey, with limited opportunities of getting information outside the boundaries of the selected focal theme (e.g., in the Innobarometer 2013, that of the firm's intangibles), which would instead be crucial to build up control variables when testing relationships. The Innobarometer 2014 represents an interesting exception to this rule, as its focus is broader, encompassing questions on different aspects like: innovation drivers, obstacles and performances; tangible and intangibles investments; specific highlights on both policy (e.g. innovative procurements) and company issues, like that of interest for our study, that is the role of design within the company.

In order to collect information on the above aspects, the Innobarometer 2014 has drawn a number of questions from previous surveys. This is for example the case of the "categorical" question on tangible and intangible investments - including design investments - taken and adapted from the previous Innobarometer 2013, in turn inspired by the NESTA intangible survey for the UK (see Montresor and Vezzani, 2016). Similarly, the questions on the firm's innovation outcomes and on its innovation-related performance, derives from the Community Innovation Survey. With respect to the position of design within the firm – indeed our key info

– the relative question has been built up by looking at some recent experiences of surveys on design carried out within the European research projects of the "Design for Innovation" initiative (http://ec.europa.eu/growth/industry/innovation/policy/design/index_en.htm).[10] In particular, the question on the centrality of design is based on the "open" definition approach typical of the Innobarometer survey, as opposed to the detailed instructions for definitions adopted by the CIS. An important benefit of this approach is that it does not impose a specific view on design (as well as on innovation) upon the respondents, while the main cost is a lack of preciseness of the answers.

3.1 Econometric strategy and variables

Given our interest for the firm's innovativeness in the technological realm and for its innovation-related performance, the focal variable of our empirical application are two. The first one is *Technological Innovation*: a dummy that takes value 1 if the firm has introduced a new or improved product and/or service. A suitable choice is therefore represented by the probit model:

$$\Pr(y_1 = 1|X) = \mathbf{\Phi}(x\beta_1)$$

where $\mathbf{\Phi}$ represent the standard cumulative normal distribution, x a set of variables and β_1 the relative coefficients. The second dependent variable is represented by the firm's *Innovative Turnover*, expressed in classes, according to the share of turnover deriving from innovative goods and services over the total turnover. In this case, an ordinal probit estimation represent the natural choice, therefore we can model the probability that the ordinal outcome y_2 of *Innovative Turnover* is equal to the value v_h as:

$$\Pr(y_2 = v_h) = \Pr(k_{h-1} < x\beta_2 + u_2 < k_h)$$

where for each firm, the probability of having innovative sales in the range identified by the outcome depends on the score falling between the cut-points k_{h-1} and k_h.[11] Given the structure of the questionnaire – innovative turnover is reported only by firms that have introduced a product and/or service (i.e. technological) innovation - our estimations might suffer from a problem of selection. That is, the errors determining whether our second

[10] Particular attention has been paid to the experimental questions on design introduced by Statistics Denmark in the CIS-2010. Similarly to the Danish experience, the Innobaroemter focused on the levels of sophistication and integration of the design function within the firm.

[11] The cut-off points are listed at the bottom of the table reporting the regression results in the column with ordered probit results. Their interpretation is similar to that of the intercept type parameters in other models.

variable of interest is missing may be correlated with the errors determining the fact that a firm has introduced (or not) an innovation. In order to control for the selection process, we have first estimate our relationship using a standard Heckman procedure. The LR test for the independence of equations (covariance between the two error terms equal to zero) however suggests that a selection problem does not subsist with the specification used (chi2 = 1.50, p-val = 0.22). Therefore, we can estimate the two relationships at stake by estimating the probit and ordered probit models independently. In the following we discuss the specification used.

At the outset, we draw on the standard idea of knowledge production function in innovation studies (Griliches, 1986) and we suppose that the firm's innovativeness and the related marketability are driven by a set of theoretically consistent variables, among which we plug those of our six hypotheses above. In particular, in line with previous and related (i.e. Innobarometer-based) evidence on the role of intangibles for the firm's innovativeness - and about the existence of a mapping between technological and non-technological innovations, on the one hand, and *Technological Intangibles* and *Non-Technological Intangibles*, on the other hand - we first consider two variables accounting for the firm's investments in each of the two intangibles categories. Following Montresor and Vezzani (2016), we build up the former (*Technological Intangibles*) by considering the average ratio of investments upon turnover declared by firms with respect to R&D and software, while we obtain the latter (*Non-Technological Intangibles*) by doing the same for investments in training and in organisation or business process improvements. We also look at the role of *Tangible investments*, with a dummy that refers to a positive incidence on the company turnover of the acquisition of machines and equipment. A set of standard controls as firm's age – captured through a dummy for *Young* firms (constituted after 1 January 2009) – size – retaining employment-classes – *International* – a dummy for firms with non-nil turnover outside the country where the company is located – and belonging to a *Group* are also considered. Finally, we include a battery of sector and country fixed effects.

As far as our hypotheses are concerned, in order to test Hp1 and Hp3, we make reference to the variable *Design Investments*: a dummy taking value 1 if the firm reports, among the possible categories, a positive incidence of them on its turnover. Our focal hypotheses, that is Hp2 and Hp4 are instead tested using the categories through which firms have been asked to "describe the business activities with regards to design", apart from the benchmark one ("Design is not used in the firm, it is not relevant"). The "flash" nature of the survey has detained an explicit reference to the notion of business model, or to any other "technical"

notion, whose illustration would have otherwise required detailed definitions, subject to the risk of systematic biases of response in order of their subjective understanding. The question has been rather formulated in an open manner and is thus able to provide information at most about the position of design within the firm, in generic terms. With the benefit of hindsight, we could think that the respondent could have had in mind an explicit (or implicit) idea of its firm business model when thinking about "the business activities with regards to design". Accordingly, the available info enables us to test Hp2 and Hp4, which refers to the position of design within the firm on a hierarchical ladder of importance. This ranges from a *Non-Systematic* use of design, to a merely *Aesthetic* function, moving to an *Integral* recognition of its manifold functionalities, up to a *Central* role for the firm's business activities. Should we find a differentiated effect of this hierarchical ladder on innovation-related firm performance, and considering the effect of the business model from a theoretical point of view (Section 2), we could infer to have indirectly captured the position of design also within it.

Coming to Hp5 and Hp6, their test is carried out by augmenting our estimation model with the variable *Non-Technological Innovation*: a dummy for those firms that have introduced a marketing and/or an organisational innovation.

Table 1 shows the descriptive statistics of the variables used in the empirical application.

Table 1 – Descriptive statistics

Innovative Turnover	**0**	**1%-5%**	**6%-10%**	**11%-25%**	**26%-50%**	**51% or +**
	9.0%	24.4%	26.6%	23.2%	9.9%	7.0%
	Yes	**No**			**Mean**	**St.d dev.**
Young	88.5%	11.5%	Technological intangibles		2.02	0.77
Group	75.2%	24.8%	Non-Technological Intangibles		2.10	0.91
Technological innovation	32.3%	67.7%				
Non technological innovation	44.3%	55.7%				
International	66.9%	33.1%				
Tangible investments	21.9%	78.1%				
Employees	**1 to 9**	**10 to 49**	**50 to 249**	**250 to 499**	**500 or more**	
	44.7%	30.7%	17.7%	3.6%	3.3%	

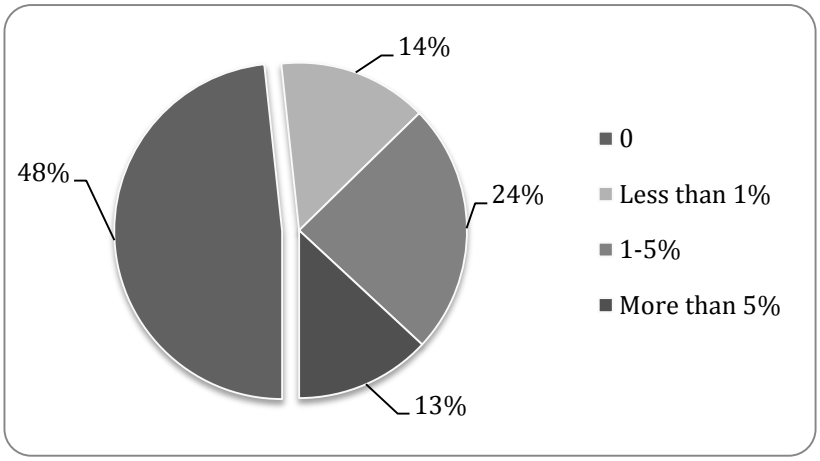
4. Results

Before moving to the test of our hypotheses, it could be interesting to see how firms of the Innobarometer-2014 sample are characterised in terms of design. First and quite surprisingly, given the recognised importance of design for innovation in Europe,[12] nearly half of the

[12] See the documents collected within the relative initiative at:
http://ec.europa.eu/growth/industry/innovation/policy/design/index_en.htm

sampled firms declared not to have invested in design in the relevant period (2012-2014), pointing to a possible informal and unplanned attention to it (Figure 1).

Figure 1 – Design investments as % of the firm's turnover



Source: *Our calculations on Innobarometer 2014 data*
Note: *Sample shares (un-weighted).*

Out of the remaining half, the largest share is represented by firms whose investments in design do not overcome the 5% of their total turnover, with only 13% of the sample above this threshold.

Looking at the position of design within the firm, about one third of the sampled firms declared not to make use of design, and to consider it irrelevant for their business activities. The second largest share (20.8%) is made of firms considering design as integrated in their business activities. Only 14% of them regard design as central, nearly as much as those that make an aesthetic use of it (Table 2).

Table 2 - Which of the following statements best describes the activities of your company with regards to design?

Design is *not used* in the firm, it is not relevant	34.1%
The enterprise does *not work systematically* with design	17.7%
Design is used as last finish, enhancing the *appearance and attractiveness* of the final, developed product	13.4%
Design is an *integrated, although not directing element* of the development work in the firm	20.8%
Design is a *central and directing element* in the firm's strategy	14.1%

Source: *Authors' calculations on Innobarometer 2014 data* - ***Note:*** *Sample shares (un-weighted).*

Overall, the attention to design emerging from the Innobarometer 2014 appears quite modest, the results of our analysis could provide important evidence for supporting its development across Europe. Table 3 reports the results of the econometric estimates.

Tab 3: Effect of design on product/service innovation and innovative turnover

	Product and/or service innovation	Innovative Turnover
Design position		
Non-Systematic	0.166***	-0.005
	(0.039)	(0.040)
Aesthetic	0.265***	0.107**
	(0.047)	(0.043)
Integral	0.308***	0.189***
	(0.043)	(0.038)
Central	0.419***	0.291***
	(0.054)	(0.044)
Design investment	0.200***	-0.030
	(0.043)	(0.039)
Non-technological innovation	0.972***	0.166***
	(0.030)	(0.030)
Technological intangibles	0.291***	0.213***
	(0.025)	(0.021)
Non-Technological intangibles	0.216***	0.246***
	(0.027)	(0.023)
Tangible investments	0.180***	0.020
	(0.035)	(0.036)
Young	0.007	0.223***
	(0.044)	(0.042)
10 to 49 employees	-0.014	-0.087***
	(0.033)	(0.032)
50 to 249 employees	0.024	-0.226***
	(0.046)	(0.040)
250 to 499 employees	0.006	-0.356***
	(0.092)	(0.071)
500 or more employees	0.015	-0.285***
	(0.104)	(0.075)
Group	0.149***	0.021
	(0.039)	(0.032)
International (dummy)	0.145***	0.204***
	(0.033)	(0.029)
Sector fixed effects	*Included*	*Included*
Country fixed effects	*Included*	*Included*
Constant	-1.639***	
Cut-point 1		-0.042
Cut-point 2		0.966***
Cut-point 3		1.718***
Cut-point 4		2.497***
Cut-point 5		3.065***
Observations	11,862	6,719
Chi2	4342	1154
Psuedo R-squared	0.289	0.0516

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

As far as the probability of introducing a *Technological Innovation* is concerned, when controlling for the drivers normally used in the innovation literature, design investments appear to be positively associated to the introduction of product and/or service innovations. This result supports out Hp1 suggesting that investing in design actually increases the firm's technological innovativeness. Also our Hp2 get confirmed, the coefficients attached to the variables capturing the position of design within the firm are positive and significant, moreover they increase when moving from *Non-Systematic* to *Central*, thus with its centrality. Firms having introduced a *Non-Technological Innovation* have a higher probability of innovate "technologically"; this suggests that indeed innovations are very often complementary ones, supporting our Hp5.

Confirming previous related evidence (Montresor and Vezzani, 2016), dedicating resources to build up an intangible capital of design actually endows the firm with a higher capacity of dealing with the wide spectrum of issues that guarantees a technological advancement. Still in support of the same evidence, a driving role is also played by the other intangibles, irrespectively from their technological or non-technological nature: a result that confirms the need of "soft" competencies, in addition to "hard" ones, to innovate technologically. Still expected is the fact that also tangible investments have a role in accounting for the firm's capacity of introducing technological innovations, with respect to which the scale of the firm's production plants appears to matter.

Finally, the results on controls are mixed. Differently from previous studies in industrial organisation (e.g. Coad et al., 2016), younger firms do not seems to gain a premium in terms of innovation, though they are not disadvantaged either.[13] Larger firms do not seem to have an advantage in introducing technological innovations either. While somehow unexpected, this result could be due to the fact that the list of controls we include already capture innovation drivers related to the size of firms: in particular, *Group*, *International* and the different types of investments considered. Indeed, belonging to a group confirms innovation benefits that articulated organisational structures have been found to have in other studies (e.g. Iacobucci and Rosa, 2005). In line with previous finding is also the fact that firms operating on international markets show a higher probability of introducing technological innovations.

We now look at the results regarding the firms' innovative turnover. Coming to Hp4, when we consider the centrality of design within the firm, the underlying rationale of the hypothesis seems to find confirmation. A "systematic" use of design in the firm actually increases the

[13] A similar finding has been found also in a previous wave of the Innobarometer (Montresor and Vezzani, 2016).

marketability of its innovations, while a non-systematic one does not make any difference with respect to not using it at all. This is a very important result on the way design should be managed within the firm. Resorting occasionally to it, on a spot-like basis, like it were at the periphery of the business model, actually vanishes the role it could potentially have in helping the firm benefiting from innovation, precisely like if it were absent. The second important result concerns the importance that an increasing prominence of design within the firm has for its innovative turnover. Indeed, a central role of design, possibly associated to its centrality in the firm's business model, is the alternative that pays the most in terms of returns from innovation. Indeed, firms get a lower premium by adopting a purely aesthetic or integral approach to design. This result is also reinforced by the confirmation of our Hp3, on the fact that *design investments* as such do not affect the firm's economic returns from innovation.

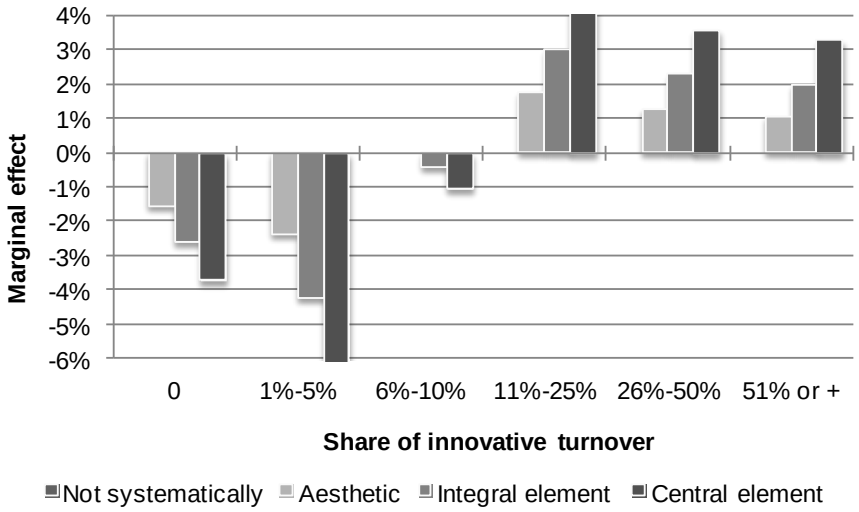
As far as Hp6 is concerned, quite interestingly, introducing *also* non-technological innovations is associated with a higher share of innovative turnover, supporting the rational of the same hypothesis. Indeed, this effect is found when the position of design within the firm is also taken into account. This confirms that innovative practices in the organisational and the marketing realm (encompassed by non-technological innovations) could actually bring to the firm competencies that add to the capacity of design management of leading to successful innovations.

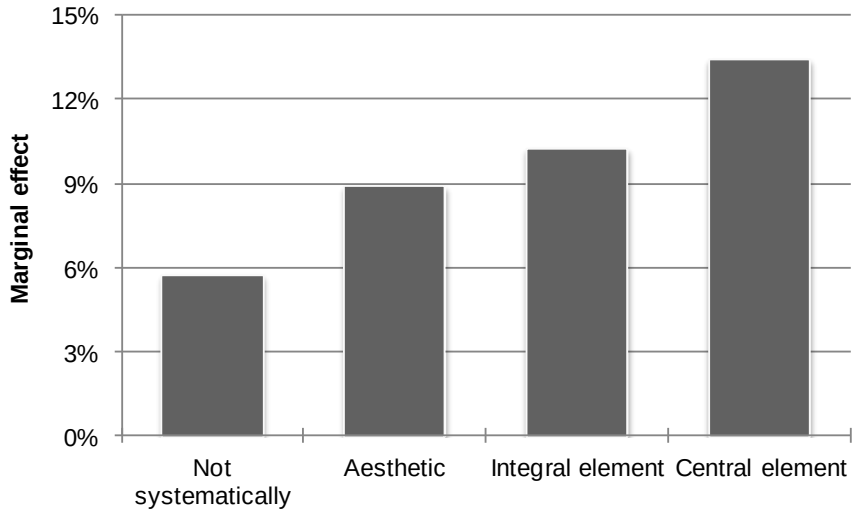
Coming to the controls used, it is interesting noticing that while both intangibles and tangibles investments seems to drive the firm innovativeness, the latters do not play a significant role when considering the returns it get from innovation. Younger firms appear to have the advantage we did not observe in terms of innovation output: a result that links with the role of age in negatively moderating the (growth) impact of innovation, rather than innovation *per se* (e.g. Coad et al, 2016). In the same respect, firm's size in negatively associated with the share of innovative turnover, possibly because larger firms spread the outcome of their innovative projects over a larger level of output. Belonging to a business group does not seem to provide here the advantages we found for the probability of introducing technological innovations. This could be due to difficulties in diffusing, adapting and standardising innovations across different organisational units before reaching the market, which counterbalance the advantages discussed above. Finally, and as expected, given the chances of wider opportunities in (possibly more) competitive markets, not only have firms operating in

different countries a higher probability of introducing technological innovations, but they also tend to get extra return from them.

Additional insights about the previous results can be obtained when we look at the marginal effects (Figure 2) of the design position within the firm on the probability of innovate – in the bottom panel - and getting (higher) returns from innovative products and services – in the top panel.

Fig 2: Marginal effect of design position on innovative returns (up) and on the probability of innovate (down)





A "systematic" approach to design sharply decreases the probability that a firm get null or low (between 1 and 5 percent of their turnover) returns from its innovations. This is particularly true when design is considered as a central element, as in this case the probability of belonging to one of the two groups decrease by 3.7 and 6.5 percentage points, respectively.

The role that design can play is particularly evident when considering the probability of having high shares of innovative turnover (the three classes on the right part of the figure). Also in this case, the importance of design increases when moving from an *Aesthetic* function to a *Central* role. In particular, firms in which design plays a *Central* role have a probability 3.3 percentage points higher to get the majority of their turnover from innovative products. This result is even more important when considering the effect of design in relative terms, that is by comparing the marginal effects with the distribution of firms among innovative sales categories (see Table 1). In relative terms, the probability of getting the majority of their turnover from innovative products increases by about 50% when innovative firms set design as *Central*, rather than not using it. A similar result is found when considering the probability of being innovative. Here the marginal effects range from 6% as for the case of a *Non-Systematic* use of design to 13% in the case design is set as a *Central* element within the firm.

5. Conclusions

The fact that design can improve the firm performance appears nowadays unquestionable, but the way it actually does so is still a black-box that deserves closer inspection. This is particularly so when the role of innovation in the same relationship is considered, by referring to the returns (e.g. innovative turnover) firms can get from it. Bridging innovation studies with the management literature on design, we have argued that the role of design in this last respect emerges as twofold. On the one hand, *investing* in *design* impacts on the firm's innovation-related performance mainly *indirectly*, by increasing its propensity to introduce innovative goods and/or services from which it can gain larger returns. On the other hand, the firm's innovative turnover is most *directly* affected by the *position* of *design* within the firm (business model), as the latter improve the capacity of creating and capturing value from its innovations. Both the outcomes, could be reinforced by accompanying the investment in and management of design with innovative marketing and organisational practices.

These arguments have been tested on a large sample of firms, marked by sufficient heterogeneity, that allowed us to go beyond ex-post rationalisations of 'winning firms'. In this paper, we have exploited the advantages of the Innobarometer (2014) survey in the collection

of design-related information for a large sample of innovative and non-innovative firms. This has permitted us to take into account differences between these two groups of firms in their propensity to innovate and to assess the role of design in guaranteeing successful performances of innovative firms.

Results are generally supportive of our arguments and quite rich of strategic implications. First of all, design investments and their positioning within the firm contribute to drive technological innovations, and should thus be used as a leverage to increase the opportunities of better economic performances, by making the firm more capable to create a potential to be commercially exploited. Secondly, benefiting from these technological opportunities in economic terms requires the firm to manage design in a pivotal way with respect to other activities, by possibly embedding it within the firm's business model and going beyond the simple commitment of investing in them. Dealing "simply" with design does not pay, unless this is done on a systematic basis, still by approaching it in an integral way, rather than in a purely aesthetic manner. Furthermore, the largest pay-off is obtained when considering design as central to the business activities of the firm. This result seems to support the opportunity of considering design in devising the components of the firm's business model, whose function is precisely that of creating and capturing value from the firm's innovation: a research question that deserves for sure further investigation. Finally, extending the spectrum of technological innovations to non-technological ones does also appear a strategic choice to increase the marketability of the former, but to a lesser extent than design management. This also points to the need of better addressing the complementarities between design and technological and non-technological innovations: still an issue to be placed on our future research agenda.

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