

Design centrality, design investments and innovation performance: an empirical analysis of European firms

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Abstract

This article provides new evidence on the relationship between design and innovation performance at the firm level. In particular, we integrate previous analyses of the link between design investments and innovation by considering the extent to which firms put design at the center of their business activities. Moreover, we distinguish between the effect of design on innovation and its effect on the success of innovation, as captured by firms' innovative turnover. The use of the European Innobarometer survey, covering a unique set of questions on the topic, allows us to test a set of hypotheses about these relationships on a large sample of firms. The results show that a firm's approach to design plays an important role in its propensity to innovate: the more central the role of design within a firm, the higher the likelihood it innovates. The same holds true when considering the share of turnover from innovation. However, sales associated with innovation do not increase linearly with design investments, as we find a positive effect only for firms investing intensively in design. Overall it emerges that the centrality of design is strongly associated with firms' innovation performance, while design investment *per se* has a more nuanced role.

JEL classification: O31, O32, O33

1. Introduction

The role of design in driving innovation and economic performance is receiving increasing attention in both the academic literature and the policy/management debate. There is growing evidence that the competitiveness of some companies is based on an innovative use of design. On a worldwide basis, the extraordinary success of Apple's products is a remarkable example of innovations based on a strong commitment to design (Thomke and Feinberg, 2009). The Nintendo Wii is another example of an iconic innovation centered on the role of design in changing the meaning that consumers attach to a product, in this case video game consoles (Verganti, 2009). In Europe, too, an increasing number of firms have been building their competitive position on innovations that, through design, enhance the usability and the desirability of their products.¹

1 A recent report by the UK Design Council (2015) provides a number of interesting case studies of a successful relationship between design and technological innovation, such as the free-form car modeling by Rolls-Royce Holding and the

Remarkable is also the number of European firms that can attribute their success to innovations that impart new meaning to products and elicit new consumer responses through design; the kitchen product lines of the Italian company Alessi and the audio-visual products of the Danish firm Bang and Olufsen are two notable examples (Dell'Era *et al.*, 2010; Ravasi and Stigliani, 2012).

This evidence shows that design could function as an important lever for successful innovations, but an understanding of how design functions in this way is crucial if it is to be exploited by more than just a few “design champions”. To this end, a new course of design-based innovation policy has been recently adopted in Europe, with the goal of accelerating the take-up of design in industrial and innovation activities.² This new policy scenario motivates a special attention to the relationship between design and innovation performance in Europe, which is the focus of the present paper.

More generally, this article is motivated by the need to deepen the academic investigation of a research issue that, in spite of its relevance, has not yet attracted widespread attention. As recent reviews of the literature reveal (Ravasi and Stigliani, 2012; Johansson-Sköldberg *et al.*, 2013; D'Ippolito, 2014), the initial focus on design and consumer behavior, marketing, and technology has only recently been extended to cover the impact of design on firm competitiveness and value creation (Roy and Riedel, 1997; Gemser and Leenders, 2001; Hertenstein *et al.*, 2005, 2013; Chiva and Alegre, 2007). Important results have been already obtained in this last respect, in particular about the effect of different design dimensions, e.g., design resources rather than design management practices (e.g., Filippetti, 2011; Czarnitzki and Thorwarth, 2012), on various performance indicators, such as financial scores or efficiency gains (Ravasi and Stigliani, 2012). Design investment has been shown to be an important driver of both firms' innovation and innovation performance, captured through firms' innovative turnover, in some countries (Danish Design Centre, 2003; Cereda *et al.*, 2005; Marsili and Salter, 2006; Tether, 2006; Vinodrai *et al.*, 2007). However, more needs to be known about if (and how) the engagement of firms in design affects their capacity to innovate and improves the marketability of their innovations. This is particularly so when considering the use firms make of design in their business activities. The degree of centrality that design finds within firms, i.e., whether design is limited to the aesthetic complement of new products (low centrality) or is a systematic ingredient of their business activities (high centrality), is an important aspect of firms' engagement in design that has received little attention so far in comparison to design investments (Galindo-Rueda and Millot, 2015). This is unfortunate, as increasing the centrality of design arguably involves design activities (e.g., enhancing the place of design in value proposition) that do not limit and reduce to investing in design (e.g., for enlarging the scale of new product development (NPD) processes), and which differ from the latter also for their greater impact on the “marketability,” rather than on the introduction of firms' innovations.

Exploring the nuances of the relationship between design investments, design centrality, innovation, and innovative turnover represents the main novelty of this article. Combining design management with innovation studies, we build up a set of hypotheses about the relationship between design and innovation, and submit them to a systematic empirical application.

Going beyond the initial dominance of case-based research in the field, recent studies have obtained more systematic evidence by making use of survey-based data, mainly from the Community Innovation Survey (CIS). Evidence from individual countries has been confirmed and complemented by the few multicountry studies so far carried out on secondary European data (Ciriaci, 2011; Filippetti, 2011). In order to extend this evidence, we will test our research hypotheses on a sample of more than 12,000 European firms from the Innobarometer 2015, covering a unique set of questions on the topic. Encompassing the 28 European Union (EU) Member States and firms of any size and age, in a wide set of industries, such an empirical application represents the first study of design and innovation performance that can be deemed amenable to generalization.

new Aero 8 sport car by Morgan Motor Company. Other European examples can be found in the 2012 report of the European Design Leadership Board, *Design for Growth and Prosperity* (<https://publications.europa.eu/en/publication-detail/-/publication/a207fc64-d4ef-4923-a8d1-4878d4d04520>).

- 2 In 2011, the European Commission launched a series of projects under the title of The European Design Innovation Initiative. In 2013, this initiative was translated into The Action Plan for Design-Driven Innovation, and, in 2016, a more specific programme, Design for Enterprises, aimed at fostering the adoption of design for innovation by small and medium-sized enterprises, was introduced.

The remainder of the paper is structured as follows. In Section 2, we review the relevant literature and formulate our research hypotheses. Section 3 illustrates our empirical application, the dataset and the econometric strategy. In Section 4 we discuss the results, while in Section 5 we discuss some concluding remarks.

2. Background literature and research hypotheses

The impact that design can have on firm performance first came to attention in the late 1980s and in the 1990s, when design was placed at the center of notable research projects such as Market Demands that Reward Investments in Design (MADRID) and Commercial Impacts of Design (CID).³ A significant number of studies undertaken around that time recognized that commercially successful products are linked to a firm's endowment of professional design competencies/skills and to their intensive use in NPD (Roy and Potter, 1993; Roy and Riedel, 1997; Ulrich and Pearson, 1998). These design aspects were found to affect firm turnover and profitability in different geographic and industry contexts (Black and Baker, 1987; Walsh *et al.*, 1992).

Over the next two decades, economic and business research on design evolved substantially (Gemsers and Leenders, 2001) and the conceptualization of design was enriched by new definitions (for a review, see D'Ippolito, 2014).⁴ In particular, the capacity of design to evoke an emotional response among consumers and to trigger new needs and consumption patterns (De Vries, 2008) was identified as an additional source of value for firms (Füller, 2010; Bogers and Horst, 2014). With this richer conceptualization, design investment (Chiva and Alegre, 2007, 2009), and managerial design practices (Hertenstein *et al.*, 2005, 2013) have been shown to be important drivers of firm competitiveness.

Moreover, drawing from some pioneering innovation studies (e.g., Freeman, 1983; Walsh, 1996), design activities have been extensively shown to be a crucial source of both internal and external knowledge underpinning learning and innovation (Verona and Ravasi, 2003; von Stamm, 2003a,b, 2004; Verganti, 2008). Design has been even conceptualized as an "element of innovation" (Candi, 2006) or as "*the part of the innovation process which enhances and communicates the value inherent in products or services*" (*ibid.*, p. 354). At the same time, the impact of design on firm performance has been shown to depend on several different factors, including the monetary resources dedicated to design (Grob, 1990; von Stamm, 2003a), an "emphasis" on the manifold dimensions of design (Candi, 2006), and the management of design within rather than outside firm boundaries (von Stamm, 2003b; Filippetti and D'Ippolito, 2017).

Our paper is conceptually close to this last set of studies, and to other related survey-based ones, which we will review in the following. In particular, we aim to disentangle two distinct elements of the relationship between design and innovation. First, we distinguish two dimensions of firms' engagement in design: *design investments* and the *design centrality* within a firm. Second, we examine the differentiated impact that these two dimensions of design engagement can be expected to have on *innovation* and on firm *innovative turnover*. Figure 1 schematically illustrates this conceptual model, which reflects the framework that Ravasi and Stigliani (2012) have recently proposed to reconstruct the evolution of design research in management studies.⁵

2.1 Design centrality versus design investment

Our first element of originality is that, in addition to design investments, we also consider another element of business commitment to design: the *centrality* that firms recognize to design in their economic activities. The concept of

- 3 These are two projects that the "Design Innovation Group" implemented by surveying two samples of UK firms over the periods 1987–1990 (CID) and 1996–1997 (MADRID). As Roy and Riedel (1997) illustrate, while focusing on the UK, these projects were precursors to the development of further research on design and innovation in other countries.
- 4 In the following, we will refrain from referring to any particular definition and conceptualisation of design among those proposed in the literature. As we will say in presenting our empirical application, our arguments and results do not require the reader to choose one theoretically inspired camp over another.
- 5 In brief, the Ravasi and Stigliani's scheme classifies design studies according to their focus on 'design activities' (encompassing our two forms of engagement in design), "design choices" (by which they mean the technological and stylistic innovation enabled by design) and "design results" (referring to different kinds of economic performance). The model then builds up an evolutionary relationship between these topics by looking at their mutual connections (see Ravasi and Stigliani, 2012; figure 1, p. 470).

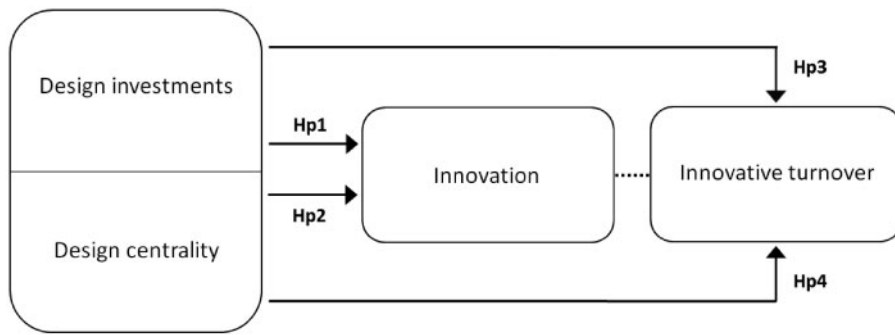


Figure 1. Design centrality, design investment, and innovation performance: the conceptual framework.

centrality was one first mooted by the Danish Design Centre (DDC) in 2001 (Danish Design Centre, 2015) as a way to account for the heterogeneity of companies' use of design. It was defined as the “*emphasis on design methods in product development and of the strategic position of design in their overall business strategy*” (ibid., p. 1). Drawing on the evidence collected for Denmark about a positive link between the importance of these aspects and firms' higher earnings (Danish Design Centre, 2003), the DDC proposed to ascertain the centrality of design by looking at its position on what it called the “design ladder”: a ladder made up of four steps of progressively more pervasive and important use of design within a firm.⁶

On the bottom step of the ladder — called “no-design” — the DDC positioned a first group of firms in which individual participants may eventually contribute their ideas about how design can improve the products' function and aesthetics, but which pay little or no organizational attention to design and to the users' perspective. At the second step, “design as form-giving,” design is considered explicitly, but exclusively in aesthetic terms, at the final “form-giving stage”. The firm may have professional designers, but “*design is typically handled by people with other professional backgrounds*” (p. 2). On the next step, “design as process,” the approach to design is integrated within the firm. Accordingly, design activities are spread across the firm and require the involvement of various skills and competencies (e.g., technical, marketing, and administrative). Finally, at the top of the ladder — “design as strategy” — design is part of the business vision and has a role in shaping the firm's areas of business and the configuration of the value chain (Danish Design Centre, 2015). Operationally, professional designers are in place and work inter-actively with both the owners/shareholders and the managers of the firm.

As with the analogy of the ladder, the concept of the centrality of design describes the strategic view and meaning that a firm attributes to design. This is a very specific and novel qualification of a firm's engagement in design, and one that is not necessarily correlated with the resources invested in design, which is what is generally considered in the literature. Indeed, the DCC's ladder model does not (necessarily) reflect a progressively more substantial investment in design. For example, “non-design” firms are not necessarily those that do not invest in design at all. On the contrary, such firms might spend both time and resources in design activities, just not explicitly in a formal design process. For example, design could be carried out by nonexpert staff and/or be outsourced, which in both cases would entail some investment. At the other end of the spectrum, a firm may invest substantially in “explicit” design activities, e.g., in hiring and/or training professional design experts, but such activities remain at the periphery of the firm's business strategy or be limited to aesthetic functions. Nor does the centrality of design or its position on the ladder necessarily coincide with design as internal or external to the boundaries of the firm, an issue that has recently attracted some attention (Filippetti and D'Ippolito, 2017). For example, design centrality could rise from the first to the second step of the ladder while remaining outsourced. Similarly, there is nothing to prevent a strategy of design as central to a firm (step 3) being achieved through a cooperative partnership between the firm's managers and a group/company of external designers.

6 Consistent with an open, process, view of design (see D'Ippolito, 2014), the DDC did not elaborate detailed definitions to identify the positioning of design on the ladder and rather provided some generic illustrative sentences for each of its steps. This was done on purpose, in order to leave the firm in question free to develop its own description of positioning. While it could appear superficial, our illustration of the model drawing on DDC (Danish Design Centre, 2015) reflects this methodological choice.

While the centrality of design denotes a positioning, as we will argue in the following, this should be viewed with respect to the “business model” of the firm rather than to its boundaries. In the light of these last considerations, we have neither the theoretical premises nor empirical evidence to formulate a testable relationship between design centrality and design investments, which we will therefore not address in our empirical analysis. On the other hand, we maintain that playing with design centrality and design investments involves different kinds of design activities by the firm.⁷ Moving the position of design up along the ladder requires the firm to enhance the centrality that design is given in its value proposition, and (or) to reconfigure the value chain making customer relationships more pivotal. These and other activities have an organizational nature and do not limit or reduce to investing in design, which is usually meant to enlarge the scale of NPD activities within the firm or testing the technical and commercial feasibility of new products. Given their different nature, and their different position along the innovation process, design investments and design centrality can be expected to have a differential impact on the firm’s innovativeness and on its innovative turnover, once an innovation has been introduced. Accordingly, this is an additional distinction that needs to be considered.

2.2 Innovation versus innovative turnover

The second element of originality of our approach is the distinction between innovation and innovative turnover in the analysis of design. As is widely recognized in innovation studies — consider for example the famous CDM model, an acronym from the authors’ names (Crépon, Duguet and Mairesse), proposed by [Crepon *et al.* \(1998\)](#) — introducing a new or improved product/process and getting an economic return (e.g., a productivity increase in the CDM model) from its exploitation are two different, although evidently connected, activities. On the one hand, in order to innovate, firms are required to follow a suitable and successful “innovation model” ([Jensen *et al.*, 2007](#)) that involves identifying and investing resources in a particular set of innovation inputs to achieve the desired set of innovation outputs (e.g., product, process, or even non-technological); these are both R&D and non-R&D inputs, among which design investments figure out prominently ([Montresor and Vezzani, 2016](#)). On the other hand, in order to benefit from their innovations, firms should take a set of other actions than investing in intangibles. Although it is not a guarantee of higher economic performances, which require considering the cost side of innovating ([Kleinschmidt and Cooper, 1991](#)), an important action in this direction could be to increase the firm’s innovative turnover. In spite of the biases and the “strategic noise” that can affect this variable ([Bloch and Graversen, 2008](#)), “[t]he shares of sales of new products and new services are direct monetary measures of the success of product and service innovations” ([Kirner *et al.*, 2009](#): 448), as they indicate “how well firms succeed in renewing their product portfolio and offering their customers improved solutions” (p. 451). In order to increase their innovative turnover, firms should deal with the “marketability” of their innovations and make their innovativeness more valuable rather than simply increasing it. More than an effective innovation model, this requires a viable “business model” ([Zott *et al.*, 2011](#)) to exploit innovation and achieve a competitive advantage. As some recent literature has revealed, this also passes through the way design is conceived in the business model ([Dell’Era *et al.*, 2010](#)) and, following the considerations of the previous section, depends on the centrality it is given within it. The design activities related to progressively higher steps of the ladder may have an important “additionality” in this last respect as they allow the firm to add a premium in terms of innovative turnover to that in terms of innovativeness.

On the basis of the previous arguments, although a higher innovation output might be expected to lead to a higher innovative turnover, it is not necessarily the case that design makes this relationship hold true. Indeed, a firm can exhibit a good innovation model where design is an effective innovation input, but also lack an equally good business model and therefore design might not contribute increasing the market success of the firm innovation output. In brief, innovation and innovative turnover refer to two distinct domains with respect to which design operates differently. Although a connection between the two exists conceptually, passing through the additionality of higher steps design activities, in this article we do not focus on it other than to address the risk of selection bias in their measurement (see Section 3 on this technical point). For this reason, in [Figure 1](#) we report only a dotted line between the two. Our focus is rather on the relationships between design investments and design centrality, on the one side, and innovation and innovative turnover on the other.

2.3 The relationship between design and innovation: research hypotheses

The arguments developed in the previous two sections lead us to maintain that a generic hypothesis about the relationship between design and innovation is not suitable. In line with previous studies, developing and testing specific

7 We are indebted to one reviewer for having suggested us to make this aspect explicit.

hypotheses separately appears more useful to address the role of different design dimensions in different domains of the innovative process.

The first couple of hypotheses is intended to argue that the firm's innovativeness could be in principle expected to increase not only with design investments (Hp1) as the extant literature maintains, but also with design centrality (Hp2). The second set of hypotheses recognizes that, in principle, firms' innovative turnover could be affected also by design investments (Hp3), and not only by directly increasing the marketability of innovation through design centrality (Hp4). By submitting these hypotheses to empirical testing, we aim to ascertain whether differences emerge in their eventual holding along the dimensions discussed before (Sections 2.1 and 2.2).

The first relationship we consider is that between the *design investments* of the firm and its *innovation* capacity, meant as the probability of introducing new and/or improved products and/or processes at a particular point in time.

This relationship finds wide theoretical support in the literature. It is proposed that, by allocating time and resources to design activities (Grob, 1990; von Stamm, 2003a), firms could become more capable of mastering the problems of industrial engineering and aesthetics entailed by the introduction of innovative products and processes (Walsh and Roy, 1985; Walsh, 1996). Furthermore, through design investments, firms could acquire knowledge and competencies to become more sensitive to consumers' responses, more capable of shaping their needs and preferences, and to respond innovatively with new technological and non-technological advancements (von Hippel, 1988; Jones, 1991; Bloch, 1995). However, the impact of design investments on innovation might not hold in practice because of different contextual aspects related both to firm- (e.g., size and age) and environment-specific (e.g., industry and system of innovation) characteristics. Although some systematic evidence already exists at the firm level, additional econometric analysis is required to ascertain whether, going beyond the selected cases of successful firms and the investigated contexts, the relationship can be deemed generally true in statistical terms.

Recently, an increasing number of studies have actually gone beyond the initial case-based research on the topic and tested the relationship in large samples of firms within individual countries. For example, using the CIS-3 (covering the period 1998–2000)⁸ Cereda *et al.* (2005) found that, in UK firms, design investments — measured as a percentage of total investment in innovation — are significantly correlated with product innovation, but not with process innovation.⁹ Similarly, Marsili and Salter (2006), using Dutch CIS data (for the period 1994–1996), found that design expenditure — captured through its proportion on the firm's total sales — can increase innovation performance when it is coupled with R&D expenditure. A positive relationship also emerged from the only multicountry study on design and innovation of which we are aware, by Ciriaci (2011). Using the CIS-3 for 23 European countries, the author found that design investments — measured as the total amount of monetary resources spent on the design of new products — increase both incremental and radical innovations.¹⁰

Overall, sufficient theoretical and the empirical support seems to suggest a positive relationship between design investments and the innovation capacity of a firm. However, given the small number of multicountry studies, we consider it opportune to (re)test and validate on a wide scale the following hypothesis:

Hp1: Greater design investments are associated with a higher propensity of a firm to innovate.

Coming to the second relationship, between *design centrality* and *innovation*, given the novelty and specificity of the centrality concept, the arguments in support are fewer and more explorative than in the case of the first relationship.

- 8 It should be noticed that the studies based on the CIS-3 made use of a question that refers to a broad notion of design, which could provide confounded info about it, having the surveyed firms been interview about their "Design, other preparations for production/deliveries." In the subsequent waves (CIS-4, CIS 2006, and CIS 2008), the focus on design was collapsed into that on marketing innovations and intellectual property rights. Finally, it re-appeared more extensively in the recent ones (CIS 2010, CIS 2012, and CIS 2014), where design is defined as "[In-house or contracted out] activities [. . .] to improve or change the shape or appearance of new or significantly improved goods or services."
- 9 Again with respect to the UK, more recent supportive evidence of the same relationship has been found by Tether (2006) and Vinodrai *et al.* (2007).
- 10 A more recent study by Filippetti (2011), on a sample of European firms observed through the Innobarometer 2009, found that design investments play an important role in a cluster of firms following an "outward-oriented multifaceted innovation" (p. 16) model, which couples (among other things) the adoption of an open innovation strategy with the introduction of any kind of innovation (i.e., technological, marketing, or organizational).

Some insights can be obtained from the design management literature, which has shown that a firm's innovativeness can be increased by augmenting the importance of design in the NPD process (Roper *et al.*, 2016). Taking what Candi (2006) called "design emphasis" as a proxy for design centrality, this would entail a greater attention to the functional and formal properties of a new product and a greater chance of its potential success (Gemser and Leenders, 2001; Perks *et al.*, 2005). Similarly, a positive relationship between design centrality and innovation can be supported by referring to the idea of "design integration" in operations and production management (Abecassis-Moedas, 2006; Zhang *et al.*, 2011). Integrating design with other functions/divisions within the organization (e.g., R&D, marketing, and retailing) could in practice represent another element of design centrality, one that enables the firm to couple design with the other tangible and intangible inputs on which innovation relies (Dosi, 1988; Montresor and Vezzani, 2016). Finally, although central design does not imply necessarily in-house design, if we assume that internal management of design could be an element that increases design centrality, we can obtain further insights into its impact on innovation. In this last respect, keeping design internally would prevent the tensions that could otherwise emerge from using external designers to implement innovation projects (Filippetti, 2011; Filippetti and D'Ippolito, 2017). Indeed, using a sample of Belgian companies from the Flemish part of the CIS-5 (2004–2006), Czarnitzki and Thorwarth (2012) showed that only internal design leads to product innovations with successful novelties on the market.

Finally, direct support for the impact of design centrality on innovation can be found in the unique application of the design ladder model that has been made so far by Statistics Denmark. By translating the four steps of the ladder into synthetic descriptions of design use — the ones we will refer in our empirical application: "no design," "non-systematic," "aesthetic," "integral," and "central" — and plugging them into R&D and innovation surveys (for 2010 and 2012), supportive results were obtained with respect to Denmark. "[F]irms reporting to use design as an integrated element are found to be significantly more likely to introduce all of the standard types of innovation" (Galindo-Rueda and Millot, 2015: 29). Overall, the authors find that increased centrality tends to be associated with a higher probability to innovate. This country-specific evidence, along with the insights provided above, leads us to put forward and test more widely the following hypothesis:

Hp2: A more central role of design within the firm is associated with a higher propensity to innovate.

The relationship between *design investments* and *innovative turnover*, our third relationship, has already received considerable attention. From a theoretical perspective, according to the resource/competence-based view of the firm (Montresor and Vezzani, 2016), the marketability of innovation and the competitive advantage this could entail depends on a set of design capabilities that "have been often inferred from the investment of dedicated resources such as time and money (e.g. Swan *et al.*, 2005)" in design (see the review by Ravasi and Stigliani, 2012: 476). Following a related strategic management argument, design investments can be considered an essential ingredient of a firm's capacity to provide flexible products and production processes (e.g., modular). Such investments could guarantee "dynamic capabilities" that, in environments characterized by uncertainty and technological breakthroughs (Asan *et al.*, 2008), may also lead to a greater capacity of renewing the firms' product portfolio and to obtain a competitive advantage on this basis.

The above arguments have also found confirmation in some empirical studies that crossed the amount of resources spent on design with innovative turnover. Using the CIS-3 (1998–2000) with a European coverage, Ciriaci (2011) found that, by increasing design expenditure, sales of new-to-the-firm products increased, although to a limited extent. Cereda *et al.* (2005), in contrast, found that design expenditure is associated with more remarkable returns on innovative sales for the UK (CIS-3, 1998–2000), but with a very short payback period.

In spite of the previous elements of support, the relationship between design investments and innovative turnover does not appear to be guaranteed. From the conceptual point of view, the majority of design studies consider that the role of design in a firm's success is the result of its management and strategic use, rather than of the monetary resources dedicated to it. In other words, firms are expected to make money through "good" design rather than "a lot" of design. What is more, the design management literature has also shown that in some situations design investments are unable to bring about improvement in the economic performance of firms, as in some cases of small companies (Bruce *et al.*, 1995; Dickson *et al.*, 1995) and in some industries with low levels of technological innovativeness (Swink, 2000).

On the basis of the previous arguments, and given the limited and somewhat conflicting support found in the literature, we deem that further insights could be obtained by testing the following hypothesis:

Hp3: Greater design investments are associated with higher innovative turnover.

The last relationship in our conceptual framework, that between *design centrality* and *innovative turnover*, finds some indirect support in the design management research about the performance impact of design practices. For example, from the pioneering work by Roy and Riedel (1997) emerges that the economic performance of NPD projects — to which the turnover share from new products is related — is associated with an arguably *central* approach to design, involving a “multidimensional focus” on “product performance, features and build quality, and [...] technical or design innovation” (p. 537). Also Candi (2006) shows that it is the emphasis that technology-based firms place on design, by recognizing its manifold dimensions (“behavioural,” “reflective,” and “visceral”), that leads to superior economic performance. Subsequently, Chiva and Alegre (2009) concluded that a “good design [in terms of corporate performance] does emerge by a properly managed [design] process” (p. 4242), which they define through the construction and importance of design management skills.

Support for the importance of design centrality to an innovation-related measure of performance — such as our *innovative turnover* — can be more directly found in the business model literature (Wirtz, 2011; Zott et al., 2011). The business model principally works by capturing value from innovation (Chesbrough and Rosenbloom, 2002), that is, in increasing the firm’s capacity to bring a new technology successfully to the market (e.g., Zott and Amit, 2007, 2010; Chesbrough, 2010; Teece, 2010). In other words, the impact of design on the turnover that firms get from their innovation may also pass through the position that design activities find within their business model. More specifically, one should look at the extent to which design is included in the definition of the business model’s components and at the centrality this entails for its position within the firm.¹¹

In spite of the previous insights, the only empirical evidence we are aware of comes from the work of Galindo-Rueda and Millot (2015), again using data on Danish firms. These authors show that “[u]sing design as an integrated element is found to be positively and significantly correlated to higher shares of innovative turnover” (p. 31). In other words, innovative firms with an integrated approach to design outperform their counterparts with no integrated design.

In synthesis, there are both theoretical and empirical elements in support of a positive relationship between design centrality within a firm (e.g., in its business model) and its innovative turnover. However, to the best of our knowledge, this relationship has not yet received sufficient systematic empirical investigation to be considered as generally ascertained.¹² We thus state and test the following hypothesis:

Hp4: A more central role of design within a firm is associated with higher innovative turnover.

Summing up, by crossing the distinction between design centrality and investment in design with the distinction between firm’s innovativeness and innovative turnover, we ended up with four hypotheses. These hypotheses will be tested through the empirical application illustrated in the following section.

3. Empirical application

3.1 Data

Our empirical application refers to a sample of more than 12,000 European firms from the Flash Eurobarometer-415 on “The Innovation Trends at EU Enterprises”: in short, Innobarometer 2015. Compared with previous empirical studies on the relationship between design, innovation, and firm performance, the sample is definitively larger and marked by a broader coverage in terms of countries, sectors, and firm characteristics (European Commission, 2015).

- 11 In the case of the Italian design-led furniture company Kartell, for example, enabling new product meanings through design and technology is part of the firm’s “value proposition.” In the same sector, design and technology are also an integral part of the “value network” of the firm Luceplan (Dell’Era et al., 2010).
- 12 Empirical studies have provided supporting evidence for the impact of the centrality of design on innovative turnover only with respect to complex innovators (both technological and nontechnological). Evangelista and Vezzani (2010) found that complex innovators, characterized also by a distinguishing design focus, have a higher proportion of turnover deriving from new or improved products/services. Similarly, Filippetti (2011) finds that a multifaceted innovation model, incorporating the explicit design association that we described above, is the only one (along with the ‘outward non-tech’ model) that significantly predicts the growth of turnover and that it is associated with faster rates of turnover growth than the other models.

This is an important distinguishing feature of our application. Indeed, taking into account the characteristics of the firms included, such a large sample will enable us to reach quite general conclusions and to extend those of the extant literature.

Like its previous waves, Innobarometer 2015 was a flash survey, and thus some caution in the management of the data and in the interpretation of the responses is warranted. In particular, as the survey was conducted using computer-assisted telephone interviewing, the problem of the right respondent (i.e., a respondent familiar with all the issues of the survey) could emerge. This poses the risk of a systematic response bias and of the emergence of outliers in the calculations of the relevant variables. However, these issues have been shown to generate limited distortions (see Montresor *et al.*, 2014). Furthermore, the Innobarometer is a cross-sectional survey, containing information for the period 2012–2014. Thus, the results of the econometric analysis of its data should not be interpreted as more than significant correlations (in passing, this motivates the formulations of our own hypotheses in terms of associations).¹³

The Innobarometer is usually a quite focalized kind of survey, with limited opportunities to elicit information outside the boundaries of the selected focal theme: for example, the focus of Innobarometer 2013 was on firms' intangibles. However, the Innobarometer 2015 represents an interesting exception. Its focus was broader and it comprehended questions on different aspects of firms' performance, including innovation drivers and obstacles; investments in tangibles and intangibles; and specific aspects of both company policy and company characteristics, such as that of interest for our study: the use of design within the firm.

In order to collect information on the above aspects, the Innobarometer 2015 drew on a number of questions from previous surveys; for example, it included the ordinal (i.e., classes of increasing turnover shares) question on tangible and intangible investments, encompassing design investments, inspired by the Nesta intangible survey for the UK (see Montresor and Vezzani, 2016). In this survey, intangible investments are classified into four classes, according to their proportion of firm turnover (intensity): nil (0%), less than 1%, between 1% and 5%, or more than 5%. Differently, questions related to a firm's innovation outcomes and performance are adapted from the CIS and responses are dichotomous (*innovation* introduced, yes/no) and captured by the share of turnover from innovation (*innovative turnover*), respectively. Finally, with respect to the centrality of design within the firm—our key variable—the question has been built up by drawing on the “designed ladder model,” which we have discussed in Section 2 (see Galindo-Rueda and Millot, 2015: 27). It should be noted that both the questions on design investments and design use are based on the “open” definition approach typical of the Innobarometer survey. An advantage of the open approach is that it does not impose a specific view of design (or, indeed, of innovation) on respondents, who, rather, may perceive it differently depending on the industry/firm in which they operate. This, however, has a corresponding price in that the answers may lack precision.

3.2 Variables and econometric strategy

3.2.1 Dependent variables and model

Our empirical application has two dependent variables. The first is *Innovation*: a dummy that takes value 1 if the firm has introduced a new or improved product (i.e., good or service) and/or process and 0 otherwise. Given the dichotomous nature of this variable, a suitable model to test the two hypotheses related to this aspect (Hp1 and Hp2) is represented by the probit model:

$$\Pr(y_1 = 1|X) = \Phi(x\beta_1) \quad (1)$$

where Φ represents the standard cumulative normal distribution, x a set of variables and β_1 the relative coefficients.

The second dependent variable is the firm's *Innovative Turnover*. This is the proportion of a firm's turnover that accrues from its innovative products and is divided into six classes: 0%, 1%–5%, 6%–10%, 11%–25%, 26%–50%, and 51% or more. In this case, an ordinal probit estimation represents the natural choice for testing the relative set of

13 The cross-sectional nature of the data also gives rise to the problem of the possible endogeneity of the regressors. However, the position/centrality of design within the firm—our focal variable—is likely to represent a structural characteristic of the firm, and one that is likely not to suffer from a contemporaneous correlation with its innovation performance.

hypotheses (Hp3 and Hp4). Accordingly, we can model the probability that the ordinal outcome y_2 of innovative turnover is equal to the value ν_b as:

$$\Pr(y_2 = \nu_b) = \Pr(k_{b-1} < x\beta_2 + u_2 < k_b) \quad (2)$$

where, for each firm, the probability of having *innovative turnover* in the range identified by the outcome depends on the score falling between the cutoff points k_{b-1} and k_b .

Innovative turnover is reported only by firms that have declared the introduction of a product/service innovation, thus our estimations might suffer from a selection bias. In other words, the errors determining whether our second dependent 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 estimated our relationship using a standard Heckman procedure. The likely ratio test for the independence of equations (covariance between the two error terms equal to zero) suggests that a selection problem does not subsist with the adopted specification ($\chi^2 = 1.39$, $P = 0.24$). The probability of introducing an innovation and the performance in terms of innovative turnover can be modeled as two independent processes, which we estimate using a probit and an ordered probit model, respectively.

3.2.2 Explanatory variables

As far as the regressors of the two models are concerned, we rely on the standard idea of the “knowledge production function” in innovation studies (Griliches, 1986). We thus suppose that a firm’s innovativeness and its innovative turnover are driven by a set of theoretically consistent variables, among which we include the design variables of our four hypotheses.

In order to test Hp1 and Hp3, we measure *Design Investments* with three dichotomous variables. Using the three classes of the survey — less than 1%, between 1% and 5%, and more than 5% — these variables measure the intensity with which firms have invested in design relative to their turnover; these are compared with the benchmark case of nil investments (i.e., 0%).

Hp2 and Hp4, referring to *Design Centrality*, are instead tested by using four binary variables built according to the “ladder model” and describing the business activities with regards to design. In this case, the benchmark is that “design is not used in the firm; it is not relevant.” The retained categories along the ladder are: a “non-systematic” use of design, design as merely “aesthetic,” as “an integral aspect of the business,” and playing a “central” role in the firm’s business activities. By referring to these items, respondents are not explicitly asked about the extent to which design is actually embedded in the firm’s business model. This is done to prevent the risk of systematic biases in its understanding. Nevertheless, these categories are at least suggestive of a way of conceiving the role of design within a firm and likely to be related to its management and positioning in the business model too.

As far as the other independent variables are concerned, in line with previous evidence about the role of intangibles for the firm’s innovativeness, we consider two variables accounting for the firm investments in two categories of them: *Technological Intangibles* and *Nontechnological Intangibles*. While the Innobarometer contains categorical info (i.e., classes of invested turnover) about five typologies of intangibles other than design (i.e., R&D, software, training, reputation and branding, and organization and business process improvements), their individual and simultaneous inclusion would create a problem of multicollinearity in the estimates.¹⁴ On the other hand, a previous study using Innobarometer data (Montresor and Vezzani, 2016) has shown that the technological nature of intangibles—i.e., the distinction between technological (i.e., R&D and software) and nontechnological intangibles (i.e., training, reputation and branding, organization, and business process improvement)—is one of the principal components that account for the impact of intangibles on innovation. On this basis, we build up the intangible variables by considering the average ratio of investments to turnover declared by firms with respect to R&D and software (*Technological Intangibles*), and with respect to training, reputation and branding, and organization and business process improvements (*Non-technological Intangibles*).

- 14 Moreover, in order to consider all the categories of the different intangible investments separately, we would need to include 20 additional binary variables (intercepts) in the model; their inclusions would make the interpretation of the results less straightforward. Given that we want only to control for the main dimensions (technological vs. nontechnological) determining the impact of intangibles on innovation, for the easiness of interpretation we decided to reduce the dimensionality of the problem.

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	Std. dev.
Young	11.5%	88.5%	Technological intangibles		2.02	0.77
Group	24.8%	75.2%	Non-technological intangibles		2.11	0.91
Innovation	67.7%	32.3%				
International	33.1%	66.9%				
Tangibles	78.1%	21.9%				
Employees	1–9	10–49	50–249	250–499	500+	
	44.7%	30.7%	17.7%	3.6%	3.3%	

Source: Authors' calculations on Innobarometer 2015 data.

Note: Un-weighted statistics.

3.2.3 Control variables

The list of independent variables is completed by a set of standard controls: the firm's age, captured through a dummy for *Young* firms (constituted after 1 January 2009); its *size*, proxied by including standard employment classes other than that which describes micro enterprises (1–10 employees; used as benchmark); the presence of investments in *Tangibles*, captured through a dummy; its *International* status, a dummy for firms with non-nil turnover outside the country where the company is located; and its belonging to a *Group*, still captured with a dummy. Finally, we include a battery of sector and country fixed effects. Table 1 shows the descriptive statistics of the variables used in the empirical application.

4. Results

4.1 Main results

Before moving to the test of our four hypotheses, it is interesting to comment some descriptive statistics of the Innobarometer 2015 sample in terms of design. First of all, as shown in Figure 2 nearly half of the sampled firms claimed not to have invested in design during the 2012–2014 period. Furthermore, in the case of the other half of the sample, design investments were moderate: in the majority of firms design investments do not exceed 5% of total turnover, with only 13% of the sample above this threshold. Although somewhat surprising, given the recognized importance of design for innovation in Europe, this evidence is in line with that reported by recent surveys on intangibles. In the UK, for example, only 10% of companies surveyed in 2010 admitted to engaging in design investments, although the percentage is higher among private companies and in the services sector (Awano *et al.*, 2010; Field and Franklin, 2012).

When we consider the use of design within the firm and the centrality of its position, the picture appears even gloomier. About one-third of firms reported that they make no use of design and do not consider it relevant for their business activities. The second largest group (20.8%) comprises firms that consider design as integral to their business activities. Only 14% of the surveyed firms regard design as central, almost the same proportion as that make exclusively aesthetic use of design (Table 2). Interestingly, the profile that emerges from considering the European scenario is different from that revealed by the first application of the ladder model to Denmark. In the Danish case, the percentage of firms that do not use design at all (43%) is larger than ours of 9 percentage points (p.p.). Differences emerge with respect to the other categories: 6% of the interviewed Danish firms use design with a sole aesthetic purpose (with a difference of –7 p.p.), 14% as an integrated though not determining element (–6 p.p.), and 8% as central (–6 p.p.) (Galindo-Rueda and Millot, 2015: 28).¹⁵

Overall, the picture of the attention paid by European firms to design that emerges from Innobarometer 2015 signals a certain gap in its innovative use, which the results of our analysis could possibly help to interpret and address.

15 For the sake of comparison, the figures reported by Galindo-Rueda and Millot have been recalculated to take into account the fact that these authors also considered a "no answer" category when computing their statistics.

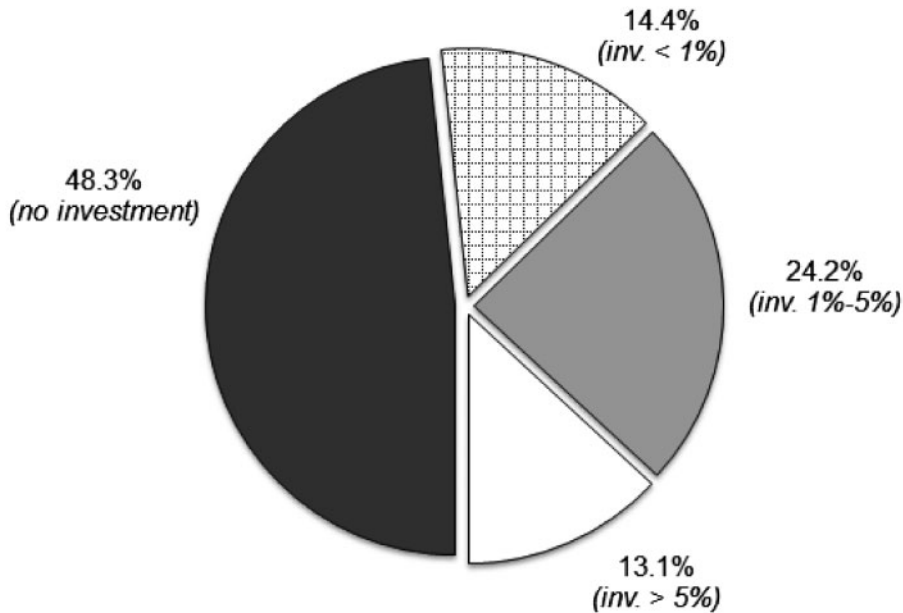


Figure 2. Design investments as % of the firm's turnover.

Source: Our calculations on Innobarometer 2015 data.

Note: Sample shares (un-weighted), classes of investment in brackets.

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

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

Source: Authors' calculations on Innobarometer 2015 data.

Note: Sample shares (un-weighted).

Moving to the econometric estimates, the upper part of [Table 3](#) reports the results of the regressions of firms' innovation (first column) and innovative turnover (second column) on design investments and design centrality (and the other controls discussed above). The specifications presented in [Table 3](#) encompass both these dimensions simultaneously. Because of space constraints, we instead report in the Appendix ([Table A1](#)) the results of other specifications where each design dimension at the time was excluded from the model, by restricting design centrality to be equal to zero and then doing the same for design investment. In the Appendix, we also provide a series of tests generally used to support the choice of a particular specification over other alternatives ([Table A2](#)). The results we are going to illustrate are robust to these different specifications and the choice of jointly considering design investments and design centrality is also supported from an empirical point of view.

The results show that our four hypotheses are confirmed to a different extent in our sample. First of all, as expected and controlling for other factors, firms investing in design show a significantly higher probability of introducing an innovation than non-investing firms ([Table 3](#), column 1). This holds true for all three classes of *Design Investments* relative to turnover with respect to the nil class (the benchmark). Furthermore, the correlation with innovation is higher for increasingly higher values of *Design Investments*. In brief, our H_{p1} about the role of design investments as an innovation input finds support. The more that firms invest in design, the higher is their probability of innovating.

Table 3. Design, innovation and innovative turnover

	Innovation	Innovative turnover
Design investments		
Less than 1%	0.125*** (0.044)	-0.009 (0.043)
1–5%	0.310*** (0.052)	0.002 (0.047)
More than 5%	0.339*** (0.076)	0.209*** (0.064)
Design centrality		
Non-systematic	0.198*** (0.037)	0.007 (0.040)
Aesthetic	0.361*** (0.045)	0.130*** (0.043)
Integral	0.422*** (0.041)	0.209*** (0.038)
Central	0.529*** (0.051)	0.298*** (0.044)
Technological intangibles	0.380*** (0.024)	0.213*** (0.021)
Non-Technological intangibles	0.262*** (0.030)	0.196*** (0.028)
Tangible investments	0.235*** (0.033)	0.033 (0.036)
Young	0.013 (0.042)	0.220*** (0.042)
10–49 employees	0.034 (0.032)	-0.073** (0.032)
50–249 employees	0.116*** (0.044)	-0.200*** (0.040)
250–499 employees	0.165* (0.089)	-0.317*** (0.071)
500 or more employees	0.144 (0.101)	-0.247*** (0.075)
Group	0.193*** (0.037)	0.024 (0.032)
International	0.130*** (0.032)	0.201*** (0.029)
Sector fixed effects	Included	Included
Country fixed effects	Included	Included
Constant	-1.601***	
Cut-point 1		-0.175*
Cut-point 2		0.826***
Cut-point 3		1.579***
Cut-point 4		2.360***
Cut-point 5		2.930***
Observations	11,862	6719
Chi ²	3253	1150
Pseudo R-squared	0.217	0.0514

Note: Standard errors in parentheses.

*** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

Interestingly, and extending the results of the earlier empirical analysis on Denmark (Galindo-Rueda and Millot, 2015), the coefficients attached to the four variables measuring *Design Centrality* within firms are all positive and significant with respect to innovation, including that related to occasional (“non-systematic”) use of design (Table 3, column 1). In other words, even when the use of design is not systematic, undertaking design within the business model is associated with a higher propensity to innovate. Furthermore, the coefficients of the design-use variables increase as we climb the steps of the ladder of the retained categories: the more central design is, the more likely a firm is to innovate.

Given the limited direct evidence in support of Hp2, its empirical confirmation represents an important result of our analysis, at least in two respects. First, from a methodological point of view, it reassures us about the validity of the ladder model of design (Galindo-Rueda and Millot, 2015: 27). Second, from a conceptual point of view, having controlled for the role of design investments (Hp1), the same result provides us with genuinely new evidence about the relationship between design management and innovation.

When we look at firms’ innovative turnover (Table 3, column 2), the arguments about a possible association between design investments and the firm’s innovative turnover (Hp3) appear only partially confirmed. Investing in design significantly correlates with innovative turnover only when design investments are sizable, more than 5% of the firm’s turnover (Table 3, column, 2). This is an interesting result that adds new insights to the existing evidence about the dependence of the economic impact of design investments on a firm’s size and industry, for which we have also controlled (e.g., Bruce *et al.*, 1995; Dickson *et al.*, 1995; Swink, 2000).¹⁶ Presumably, it is only by investing extensively in design that firms can engage in wide-scale innovation projects, in which design can be used also for the sake of the marketability of innovation as reflected by a higher innovative turnover. In the face of the aggregate (i.e., firm level) nature of Innobarometer data, this is just a speculative argument at present, which further data at the project level could serve to confirm.

The fourth and final result of the econometric estimates regarding the importance of the centrality of design is confirmed (HP4), although only partially and conditionally. The extent to which design is incorporated in a firm and its positioning within a firm correlate with its innovative turnover, but only if its use is not occasional: the coefficient attached to the non-systematic use category of design is not statistically significant. In other words, there is no difference between the non-systematic use of design and not using it at all in terms of innovative turnover. This is a second important result about the implications of perceiving and possibly managing design within a firm. Resorting to design only occasionally, as if it were at the periphery of the business model, in fact appears to neutralize the association with the firm innovation performance (in terms of innovative turnover) that would otherwise emerge.

This is consistent with the importance that an increasing centrality of design within the firm can have for its innovative turnover, once it is at least systematic. While firms show a higher innovative turnover when adopting an integral rather than a purely aesthetic approach to design, this association is even stronger for the highest position on the ladder: that associated with the central role of design in the firm’s business model. Consistent with Hp4, climbing the ladder model of design does seem to be associated with an increasing innovative turnover for firms.

Overall, these results reassure us about the validity of our conceptual framework and hypotheses, albeit in the presence of important caveats. In addition, our results are robust to the inclusion of other non-focal regressors (control variables), with respect to which some novel insights also emerge (lower part of Table 3). First of all, when we look at a firm’s propensity to innovate (Table 3, column 1), we find that, in contrast to previous studies of industrial organization (e.g., Coad *et al.*, 2016), younger firms do not seem to be more innovative, though they are not less so either (*Young* is not statistically significant). Furthermore, it seems that neither the largest firms in the sample (those

16 It should be noted that when the sole presence of design investments is considered, by collapsing the ordinal variable *Design Investments* into a dummy, the relative coefficient is not statistically significant (results available from the authors on request). Without distinguishing the intensity of design investments, it would seem that the amount of resources firms allocate to design does not play a role in increasing the turnover share of innovative products and it is only the way in which design is managed within the firm that matters. Looking at the intensity of design investments helps qualify this conclusion: it is indeed the way in which design is managed within the firm that matters in terms of innovative turnover, but design investments do so also, when they are substantial.

with more than 500 employees) nor the smallest ones exhibit an advantage in this area: rather, interestingly, it is the medium-size firms that appear the most innovative.¹⁷

The picture of the controls changes when we look at the innovative turnover of our firms (Table 3, column 2). Younger firms now appear to have the advantage we did not observe in terms of innovation output. This result is consistent with the findings of previous studies showing that age negatively moderates the (growth) impact of innovation, rather than affecting innovation *per se* (e.g., Coad *et al.*, 2016). In the same way, in any firm larger than the benchmark, size is now negatively associated with the share of innovative turnover. This is possibly because larger firms spread the outcome of their innovative projects over a higher level of output. Belonging to a business group does not seem to provide the advantages we instead found for the probability of introducing an innovation. It could be the case that difficulties in diffusing, adapting and standardizing innovations across different organizational units before reaching the market counterbalance the advantages in terms of innovativeness. Finally, and as expected given the wider opportunities in (possibly more) competitive markets, firms operating in multiple countries are more likely to innovate and also tend to get a higher innovative turnover.

Interesting differences between innovativeness and innovative turnover also emerge by looking at intangible and tangible investments. On the one hand, intangibles correlate positively with innovativeness (Table 3, column 1), irrespective of their technological or nontechnological nature. So do tangible investments, providing evidence of a “fully augmented” knowledge production function for our sample. On the other hand, while intangibles are also correlated with *Innovative Turnover* (column 2), tangibles are not; suggesting that a higher share of innovative goods and services in the firm’s turnover might pass mainly through the use of a “softer” kind of capital assets.

Additional insights emerge when we look at the marginal effects (Figure 3) of design centrality on a firm’s innovativeness (Figure 3, top) and on its innovative turnover (Figure 3, bottom). First of all, the role of design management in making design central and in driving the firm’s innovativeness accordingly is definitively nontrivial. Retaining design as a central element in the firm’s activities increases the probability of innovating by more than 17 percentage points (p.p.) relative to not using it at all. Furthermore, a significant progression can be observed in passing through the different categories, with the largest gains accruing when moving from a nonsystematic use of design to the other categories.

Looking at the relationship between *design centrality* and *innovative turnover*, a “systematic” approach to design sharply decreases the probability that a firm gets a null or low (between 1% and 5% of their turnover) percentage of its turnover from innovations. This is particularly true when design is considered as a central element, as in this case the probability of belonging to the 0% and to the 1%–5% shares of innovative turnover decreases by 3.9 and 6.6 p.p., respectively (bottom of Figure 3, classes on the left).

The role that design can play in guaranteeing more marketable innovation is also evident when we consider the probability of having high shares of innovative turnover (bottom of Figure 3, classes on the right). In particular, compared with firms that do not use design or do not perceive it as relevant, in firms in which design plays a central role, the probability that the majority of turnover (>50%) will come from innovative product/services is 3.3 p.p. higher. Similarly, the probability that innovative turnover lies between 26% and 50% of total turnover is 3.7 p.p. higher for firms with a central design. To appreciate the important role played by *Design Centrality*, these “gains” should be compared with the sample averages reported in Table 2. Only 7% of firms get the majority of their turnover from innovative product/services, while 9.9% report figures between 26% and 50%. All in all, the marginal effect of *Design Centrality* on firms’ *Innovative Turnover* appears indeed to be considerable.

4.2 Design and innovation in manufacturing and in services

The Innobarometer sample encompasses both manufacturing and service firms, which, it has been argued, take a different approach to design and innovation. Relying on a standard Schumpeterian framework, early innovation studies argued that design as an input would be relatively less important for innovation in services than in manufacturing (Sirilli and Evangelista, 1998). Later, however, with the take-off of an “autonomous” and, subsequently, of a “synthetic” approach to innovation in services (Coombs and Miles, 2000), the recognition of the distinguishing

17 Although somewhat unexpected, the reason for this result could be 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, which do have the expected sign, as we will show in below.

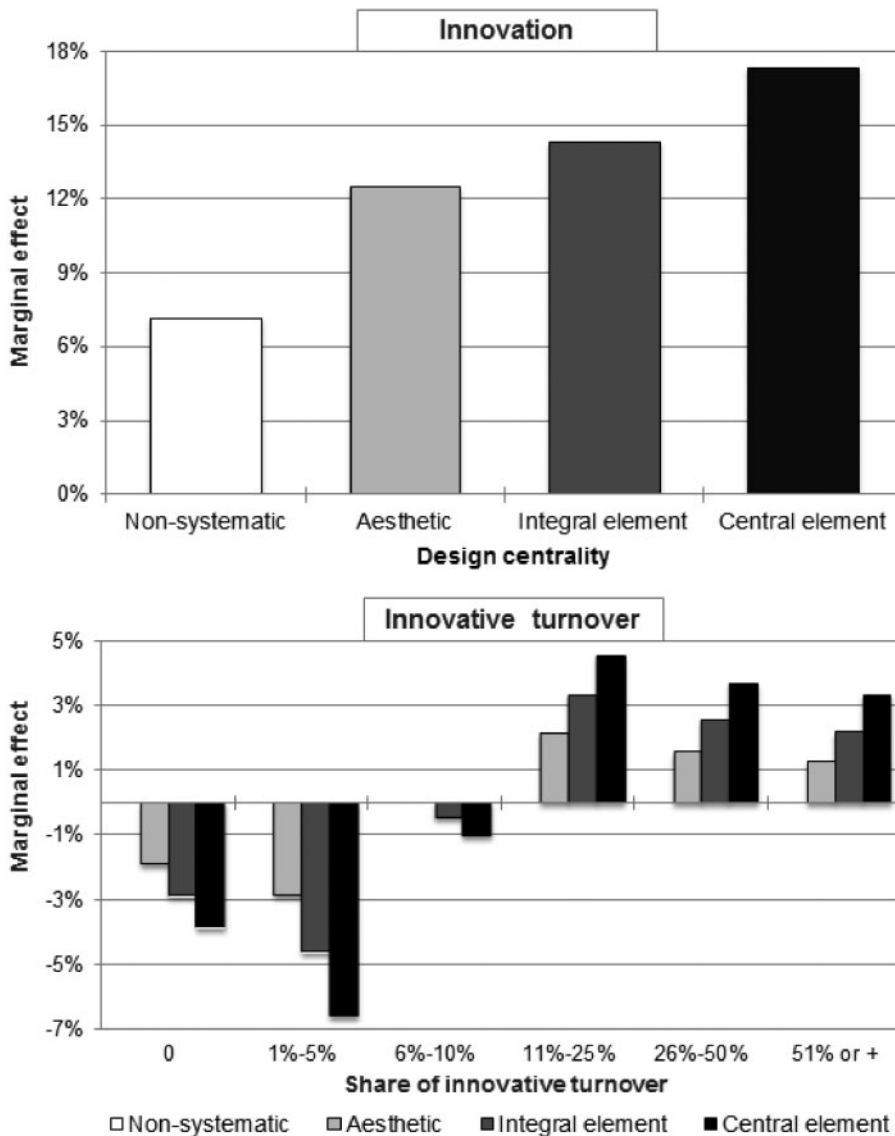


Figure 3. Marginal effect of design position on the probability to innovate (top) and on innovative turnover (bottom).

features of services — such as their perishable and intangible nature, the co-terminality of their production and consumption, and their information and organizational intensity — led to the consideration of design as an important innovation input. More recently, a case study-based approach to design for services has reinforced this insight suggesting that the innovation impact of design in services could pass through the central recognition of its role within the firm (business model). In particular, in services it is important to “design for something” rather than “design something” or to be “community centred” rather than simply “user centred” (see [Meroni and Sangiorgi, 2011](#)).

In the light of this growing debate, we also provide estimates of our model for the two macrosectors separately ([Tables 4 and 5](#)). These results could contribute to one of the research avenues that [Ravasi and Stigliani \(2012\)](#) have identified as useful for the progress of design studies. To what extent can the relationship between product design capabilities and innovation be extended to services? Does the intangible nature of services alter the mechanisms we have identified in our four hypotheses, which mainly refer to tangible innovative outcomes? These are just two of a

number of research questions directly connected to those the authors rise in paving the way for future research in this area.

In spite of some interesting differences, the results of the aggregated analysis appear to be largely confirmed. First of all, when we look at firms' innovativeness, Hp1 is confirmed across both sectors. However, as expected, the role of design as an innovation input appears weaker for services than for manufacturing: that is, we do not find a significant relationship for service firms investing only marginally in design. This result confirms the softer nature of innovation in services (Sirilli and Evangelista, 1998), which is reinforced by the significant coefficient of non-technological

Table 4. Design and innovation, manufacturing versus services

	Manufacturing	Services
Design investments		
Less than 1%	0.251** (0.102)	0.079 (0.078)
1–5%	0.480*** (0.119)	0.256*** (0.094)
More than 5%	0.475*** (0.169)	0.275*** (0.130)
Design centrality		
Non-systematic	0.196** (0.091)	0.139** (0.067)
Aesthetic	0.309*** (0.103)	0.326*** (0.080)
Integral	0.349*** (0.092)	0.364*** (0.072)
Central	0.524*** (0.109)	0.455*** (0.087)
Technological intangibles	0.465*** (0.054)	0.359*** (0.039)
Non-technological intangibles	0.083 (0.073)	0.359*** (0.053)
Tangible investments	0.279*** (0.080)	0.221*** (0.058)
Young	0.069 (0.118)	0.029 (0.071)
10–49 employees	0.038 (0.079)	0.090 (0.058)
50–249 employees	0.224** (0.101)	0.209*** (0.076)
250–499 employees	0.166 (0.160)	0.369** (0.160)
500 or more employees	0.430** (0.205)	0.123 (0.147)
Group	0.038 (0.083)	0.183*** (0.063)
International	0.101 (0.068)	0.104* (0.054)
Country fixed effects	Included	Included
Constant	–1.554*** (0.211)	–1.778*** (0.148)
Observations	2540	3876
Chi ²	590.2	1196
Pseudo R-squared	0.212	0.242

Note: Standard errors in parentheses.

*** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

intangibles in services, but not in manufacturing: a result already found in previous studies using Innobarometer 2013 data (Montresor and Vezzani, 2016).

In general terms, our Hp2 is also confirmed both in manufacturing and in services. In both sectors, the coefficients are increased by moving up the design ladder.

Table 5. Design and innovative turnover, manufacturing versus services

	Manufacturing	Services
Design investments		
Less than 1%	0.043 (0.093)	-0.066 (0.078)
1–5%	0.013 (0.101)	0.046 (0.084)
More than 5%	0.235* (0.136)	0.208* (0.112)
Design centrality		
Non-systematic	0.072 (0.092)	-0.022 (0.072)
Aesthetic	0.208** (0.093)	0.010 (0.076)
Integral	0.297*** (0.084)	0.130* (0.068)
Central	0.491*** (0.093)	0.221*** (0.077)
Technological intangibles	0.223*** (0.045)	0.236*** (0.035)
Non-technological intangibles	0.207*** (0.059)	0.145*** (0.049)
Tangible investments	0.089 (0.083)	0.034 (0.063)
Young	0.325*** (0.105)	0.254*** (0.069)
10–49 employees	-0.109 (0.074)	-0.079 (0.055)
50–249 employees	-0.170** (0.085)	-0.210*** (0.068)
250–499 employees	-0.435*** (0.125)	-0.215* (0.120)
500 or more employees	-0.253* (0.136)	-0.252** (0.119)
Group	0.022 (0.066)	-0.023 (0.054)
International	0.227*** (0.060)	0.272*** (0.049)
Country fixed effects	Included	Included
Constant cut1	0.013	-0.108
Constant cut2	1.109***	0.814***
Constant cut3	1.959***	1.547***
Constant cut4	2.846***	2.292***
Constant cut5	3.494***	2.862***
Observations	1619	2211
Chi ²	328.9	418.6
Pseudo R-squared	0.0629	0.0558

Note: Standard errors in parentheses.

*** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

When we look at the hypotheses about design and innovative turnover, our general results are again confirmed, but with interesting differences (Table 5). The most relevant peculiarity, and indeed the most important result of distinguishing manufacturing and services, concerns Hp4. In order to extend the impact of design from innovativeness to innovation “marketability,” manufacturing firms confirm the importance of moving from an occasional to an at least systematic use of design. In contrast, the innovative turnover of firms in services appears to be significantly associated only with an integral and central position of design within the firm. Interestingly, and to some extent corroborating the emerging literature on “design for services,” it is only when design is placed at the core of the firm’s business model that design-driven innovation actually translates into a higher innovative turnover.

Finally, both in manufacturing and in services, when controlling for the use of design within the firm, design investments appear to be significantly correlated with the share of innovative good and services in the firm’s turnover only when investments are sizable. The partial support we found for Hp3 in general is thus confirmed across both sectors.

5. Conclusions

After two decades of research, the impact of design on firm performance still reveals some important unresolved issues. The way in which this impact manifests, and how it can be leveraged, is still relatively unexplored with respect to its complexity and requires further inspection. This is particularly so when the role of innovation is considered in the design–performance relationship.

Bridging innovation studies with a still fluid stream of research on design, we have argued that the relationship between design and innovation is manifold and should be thus carefully investigated in its different facets. Design investments can be considered not as an exclusive innovation input, but, rather, “exclusively” as an innovation input. On the one hand, their role as innovation driver is not exclusive, as innovation is also driven by the centrality of design within the firm, in particular through the choices around design management that the firm makes with respect to its business model. On the other hand, design investments should be considered, mainly, if not exclusively, an innovation input. Their impact on the firm’s capacity to successfully bring innovations to the market appears reserved to those firms investing intensively in design. The share of turnover that firms get from innovation is tightly linked to the centrality of design, providing it is used systematically within the firm. Moreover, the innovative turnover of firms increases with a higher centrality of design within the business model.

In addressing these design innovation issues, we have added systematic empirical evidence to a field of investigation that still mainly relies on case studies and country-specific analyses. Our arguments have been tested on a large sample of firms, marked by sufficient heterogeneity to go beyond the typical ex-post rationalizations of “design-using, winning firms.” In particular, we have exploited the advantages of the Innobarometer 2015 survey in the collection of design-related information for a large sample of both innovative and noninnovative firms. Furthermore, the wide coverage of the same dataset has also allowed us to investigate the extent to which our research hypotheses hold true when distinguishing manufacturing from service firms. As we said, design is a less compelling innovation input in the services sector than it is in manufacturing. In other words, we find a weaker empirical support to the importance of design investments for firms’ innovativeness in the service sector than in manufacturing. For service firms, instead, we find stronger evidence of the importance of treating design as central in the firm business model to ensure a higher innovative turnover.

The results we have obtained are generally supportive of our conceptual arguments and relatively rich in implications. In terms of academic research, our contribution increases the convergence of two disciplines, innovation economics and design studies, which, up until now, have, unfortunately, navigated parallel courses, converging only occasionally. By extensively combining the two fields, we have contributed to (i) the investigation of the determinants of firm’s innovation, by including design centrality along with design investments among its drivers; and (ii) the strategic analysis of design, by unraveling how its position within firms influences their capacity to increase the marketability of their innovations.

As far as the implications of the results are concerned, should they amount to actual causal relationships (see below), the investigated correlations do have some important ones. The problem of “sizing” design within the firm in terms of resources and investments should be considered only as a part of a firm’s innovation strategy. Design investments do not affect the innovation performance in terms of innovative turnover, unless they are sizable, whereas the way in which design is positioned within the firm does have an effect on it. In brief, policy-makers and managers

should consider that managing design is more viable than just investing in order to bring new technologies successfully to the market. The relevant recommendation is that of giving design a central role within the firm in order to increase its innovative turnover — especially when this is a service company — by ensuring that design is systematically intertwined with the other business activities. Dealing with design “occasionally” might increase a firm’s innovativeness, but it does not increase (on average) the extent to which this translates into a higher share of turnover from innovative products and services.

The present study is not free from limitations, among which three are more urgent to overcome with more refined data in future research. First, the present study still considers an aggregate measurement of innovation at the firm level, and would benefit from more disaggregated data at the project level to confirm and streamline its results. Second, the ladder model of design is only an initial, and possibly indirect, indication of the role of design within a firm’s business model. More detailed information would be needed in future to capture this role, keeping in mind the risk that detailed information will be obtained for only a limited number of firms and the possible systematic response biases this would entail. Third, the hypotheses we have tested about design and innovation refer to cross-sectional data and represent conditional correlations. A substantial effort would be required to measure design and its role for innovation by collecting longitudinal data. This would allow getting closer to determining the actual impact of design on innovation and on innovative turnover. However, as a partial attenuation of this limitation, it should be considered that the centrality of design within the firm — our focal regressor — is possibly a structural characteristic and, therefore, unlikely to suffer from reverse causality issues with innovation performance.

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Appendix

Table A1. Design, innovation, and innovative turnover: two alternative restricted models

	Innovation		Innovative turnover	
	Only design investments	Only design centrality	Only design investments	Only design centrality
Design investments				
Less than 1%	0.176*** (0.043)		0.011 (0.043)	
1–5%	0.344*** (0.052)		0.022 (0.047)	
More than 5%	0.360*** (0.075)		0.237*** (0.064)	
Design centrality				
Non-systematic		0.197*** (0.037)		–0.003 (0.040)
Aesthetic		0.372*** (0.045)		0.117*** (0.042)
Integral		0.430*** (0.040)		0.199*** (0.038)
Central		0.537*** (0.051)		0.302*** (0.044)
Technological intangibles	0.382*** (0.024)	0.381*** (0.024)	0.213*** (0.021)	0.221*** (0.021)
Non-technological intangibles	0.326*** (0.030)	0.396*** (0.020)	0.224*** (0.028)	0.249*** (0.018)
Tangible investments	0.230*** (0.033)	0.234*** (0.033)	0.026 (0.036)	0.026 (0.036)
Young	0.020 (0.042)	0.009 (0.042)	0.223*** (0.042)	0.223*** (0.042)
10–49 employees	0.034 (0.032)	0.032 (0.032)	–0.075** (0.032)	–0.081*** (0.031)
50–249 employees	0.129*** (0.044)	0.111** (0.044)	–0.196*** (0.040)	–0.215*** (0.040)
250–499 employees	0.190** (0.088)	0.169* (0.088)	–0.295*** (0.071)	–0.340*** (0.071)
500 or more employees	0.180* (0.100)	0.139 (0.100)	–0.224*** (0.075)	–0.272*** (0.075)
Group	0.211*** (0.037)	0.194*** (0.037)	0.037 (0.032)	0.026 (0.032)
International	0.132*** (0.032)	0.133*** (0.032)	0.204*** (0.029)	0.202*** (0.029)
Sector fixed effects	Included	Included	Included	Included
Country fixed effects	Included	Included	Included	Included
Constant	–1.544***	–1.735***		
Cut-point 1			–0.217**	–0.091
Cut-point 2			0.779***	0.913***
Cut-point 3			1.527***	1.663***
Cut-point 4			2.305***	2.441***
Cut-point 5			2.872***	3.008***
Observations	11,862	11,862	6719	6719
Chi ²	3077	3216	1084	1124
Pseudo R-squared	0.205	0.214	0.0485	0.0502

Note: Standard errors in parentheses.

*** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$.

Table A2. Comparing the full model (Table 3) with two alternative restricted models (Table A1)

	Innovation			Innovative turnover		
	Log likelihood	AIC	BIC	Log likelihood	AIC	BIC
Full model	-5880	21,337	21,752	-10,607	11,874	12,295
Only investments	-5968	21,395	21,783	-10,640	11,905	12,304
Only centrality	-5899	21,357	21,752	-10,620	12,042	12,434

Note: Results for the log-likelihood, the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) suggest that the full model presented in Table 3 should be preferred to the two alternative specifications where design centrality and design investments are restricted to be equal to zero, respectively.