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Sena, V., Karim, S. and Ozdemir, S. (2025) Do brands boost the impact of patents on innovation performance among innovation collaborators? Evidence from the UK. Industrial Marketing Management, 127. pp. 74-87. ISSN 0019-8501

https://doi.org/10.1016/j.indmarman.2025.03.010

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Industrial Marketing Management 127 (2025) 74–87

Contents lists available at ScienceDirect

Industrial Marketing Management

journal homepage: www.elsevier.com/locate/indmarman

Research paper

Do Brands boost the impact of patents on innovation performance among innovation collaborators? Evidence from the UK☆

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ARTICLE INFO

Keywords:
Innovation
Performance
Trademarks
Brands
Patents
Resource-based view

ABSTRACT

The role of brands and innovations in a company's performance has been extensively studied. Yet, it is not very clear whether branding can enhance innovation performance among innovation collaborators. This paper tests whether branding boosts the performance of new product innovations among innovators collaborating with their suppliers or business customers. Drawing on the Resource-Based View (RBV), the empirical analysis is conducted on the ninth wave of the UK Innovation Survey (UKIS2015). The study found evidence that the impact of a patented innovation on its performance is enhanced by branding for businesses with radical innovation that collaborate with their suppliers and business customers. This effect is also observed for businesses that use codified knowledge and collaborate with their suppliers and business customers. Small firms collaborating with their suppliers and business customers appear to benefit the most from using brands, which differs from firms in the manufacturing industry. The research found evidence that the advantage conferred by branding is not eroded if competitors from the same industry adopt a similar strategy. This research contributes to the understanding of branding and innovation relationships by showing how combining branding with patented innovations may benefit collaborators depending on a range of internal or external influences.

1. Introduction

Developing new products and processes (or innovations) is at the heart of value creation and is one of the key drivers of a firm's competitive advantage. In a collaboration context, product innovations that developed with vertically connected value chain partners, including suppliers and business customers, can provide partners with a distinctive value proposition due to the integration of cross-industrial knowledge (Ozdemir & Kandemir, 2017). Commercially, successful innovations provide the innovators temporary monopolies that ultimately enable them to capture value from their innovations (Teece, 1986) and can boost their innovation performance. However, inventions and their novelty per se are not sufficient conditions for their commercial success as competitors will always try to imitate the new products (or services) (McEvily & Chakravarthy, 2002; Nieto & Pérez-Cano, 2004).

As a result, firms tend to use various strategies to enhance their innovations' commercial success. Branding is an important example of such a strategy. In this study, we define branding as a process for creating and managing brands which are legally protected by trademarks (Krasnikov, Mishra, & Orozco, 2009). We follow the literature in defining brands as complex symbols that tend to add value to product offerings by enhancing customer retention (Krishnan, 1996); they can help customers identify firms and products (Coleman, De Chernatony, & Christodoulides, 2011; Foroudi, Melewar, & Gupta, 2014) as they act as signals of the overall quality of new offerings when customers have limited knowledge (Erdem, Swait, & Valenzuela, 2006; Rao & Ruekert, 1994). Keller and Lehmann (2006) and Aaker (1991, 2004) also suggest that the development of a strong brand (even before the actual new product is commercialised) is paramount for the long-term commercial success of a new product or offering.

Still, whether branding can boost innovation performance needs to be clarified. Some authors suggest that it is not the brand per se that matters for innovation performance but rather the brand equity (Slotegraaf & Pauwels, 2008); others have suggested that innovation performance is indeed affected by the overall brand portfolio strategy (Beverland, Napoli, & Farrelly, 2010; Jüttner, Godsell, & Christopher,

☆ This article is part of a Special issue entitled: 'Brand Identity for Global Marketplace' published in Industrial Marketing Management.

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https://doi.org/10.1016/j.indmarman.2025.03.010
Received 31 July 2023; Received in revised form 21 February 2025; Accepted 27 March 2025
Available online 10 April 2025
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2006). While some scholars have observed that stronger brand equity may hurt innovation performance by hindering product innovation (Sharma, Davcik, & Pillai, 2016), others suggested that without a successful branding strategy, the innovations' life cycle can be significantly reduced (Aaker, 2007). According to the advocates of the latter view, branded innovations can provide a unique selling proposition by making an offering more distinctive and attractive while giving credibility to innovative offerings (Aaker, 2007).

In addition, prior studies have not explored whether other factors condition the relationship between branding and innovation performance, even if the literature suggests that the latter depends on the complementary assets required for the invention's commercialisation[1] (Teece, 1986). Finally, the existing literature needs to provide evidence on whether the economic benefit of branding is affected by the behaviour of competitors in the same industry. Brands are a source of competitive advantage as they shield products (and subsequent profits) from rival offerings (Appelt, 2009; Lancaster, 1990)[2]; however, in industries where branding is common practice, the benefit of adopting such a mechanism could be eroded if offerings are not sufficiently novel or distinct in the eyes of the customers. Equally, firms that innovate in collaboration with customers or suppliers may not capture value from their innovation through branding if the innovation partners use a similar strategy. Therefore, an important research question is whether branding is still positively associated with innovation performance in industries where branding is common practice.

Given these gaps in the literature, this paper aims to test whether branding enhances the innovation performance of a large cross-section of different innovators. In this study, we define innovators as firms developing product innovations that are new to the market or the industry (Rogers, 2003). We draw from the Resource-Based View (RBV) and consider brands as key firm resources. While the RBV highlights the significance of resource heterogeneity, existing studies offer a narrow perspective on innovative firms' heterogeneity. This limitation gives rise to uncertain assumptions and misconceptions about how different innovators can utilise resources to achieve specific outcomes (Zahra, 2021). These misconceptions are particularly reinforced by the widespread neglect of contextual factors that may shape the value of a firm's resources (Ozdemir, Kandemir, Eng, & Gupta, 2020; Zahra, 2021). For instance, brands may struggle to effectively deploy branding when different innovators have varying resource needs, accessibilities, and pools, influenced by their firm-specific knowledge base or wider, non-resource based influences such as the dynamics of their industries. In this study, our empirical analysis enabled us to contribute to the RBV by identifying the types of innovators, shaped by a diverse and heterogeneous set of contextual factors, that affect the value of branding as a key resource. Specifically, we explore how brands, as key resources, influence innovation performance across different types of innovators (or innovative firms), both independently and complementarily with patented innovations. We propose that the impact of patented innovation on innovation performance may vary depending on how innovators leverage branding, influenced by a range of contextual factors such as the nature of their innovations, knowledge, firm size, industry, and competitive environment. In this sense, we also provide some initial evidence on whether competitors' investment in brands may reduce the positive association between branding and innovation performance.

Our empirical analysis in the paper is conducted on the ninth wave of the UK Innovation Survey (UKIS2015) based on a stratified random sample of 28,000 firms with 10 or more employees. It covers all sectors of the economy, excluding agricultural businesses. We proxy brands with trademarks.[3] Although they are not synonyms, trademarks and brands are closely related as trademarks protect brands legally, and the former represents the legal basis upon which the latter is built (Sandner & Block, 2011); they protect the distinctive signs associated with brands and help to differentiate it from similar offerings[4] (Economides, 1988; Landes & Posner, 1987) and play a key role in boosting innovation performance of firms as any invention needs to be branded before it is commercialised.

Our empirical analysis is carried out on firms that innovate in collaboration with their suppliers or business customers. Branding can be particularly important for firms that innovate with other businesses along the supply chain. The literature has shown that firms collaborating with other firms to co-develop a new product or service are more likely to invest in developing new brands to extract value from their innovations and improve their bargaining power with partners. Empirically, we estimate an innovation performance equation where the relationship between innovation performance and the propensity to innovate is conditioned by the propensity to brand (where brands are proxied by trademarks). We find that businesses with a radical innovation who are innovating with either suppliers or business customers experience larger increases in innovation performance (following the commercialisation of their innovations) if they trademark than those measured among similar firms that do not do so. In addition, we test whether specific sub-sets of firms are more likely to benefit from branding than others. Among those, small innovators and innovators sourcing knowledge from codified sources benefit most from using trademarks. However, this result does not hold for innovators from manufacturing. Finally, we find evidence that the advantage conferred by branding may only be eroded if competitors from the same industry adopt a similar strategy if the innovators are from manufacturing.

The structure of the paper is as follows. Section 2 summarises the theoretical background, which provides an overview of the Resource-Based View (RBV, henceforth) and literature on branding and innovation, and Section 3 develops our set of hypotheses. Section 4 illustrates the empirical methodology, while Section 5 presents the data and variables we use for the empirical analysis. The empirical results are summarised and discussed in Sections 6 and 7, respectively, while some concluding remarks are offered in Section 8.

2. Theoretical background

The RBV theory suggests that firm resources, which can be tangible or intangible, enable firms to build their competitive advantage if they are valuable, rare, inimitable and non-substitutable (VRIN) (Barney, 1991). While tangible resources include physical assets such as machinery or equipment that do not require any tacit knowledge, intangible resources are hard to codify and may consist of non-physical assets such as brands (Hughes & Morgan, 2007; Jiang, Jiang, Cai, & Liu, 2015) and radical innovation. As intangible resources, brands can boost firms' competitive advantage (Jiang et al., 2015) but cannot be easily imitated and substituted, such as tangible ones; the same applies to radical innovations, which cannot be easily imitated and may require tacit

[1] See Giarratana and Fosfuri (2007) and Huang, Ceccagnoli, Forman, and Wu (2013) for examples from the software industry. Thomä (2015) observed that the patent premium is positively associated to the presence of a trademark paired with the patent among medical and cosmetic products in line with the trademarks' inherent function of increasing the visibility of the new products among consumers. Dosso and Vezzani (2017) have investigated the relationship between the choice of the protection mechanisms of the top R&D investors and their valuation on the financial markets between 2005 and 2012. The results confirm the importance of patents and trademarks in influencing the firms' value as investors award a premium to firms that show both technical and commercial competencies as evidenced by patents and trademarks, respectively.

[2] Trademarks are also used by incumbents to block entry (Reitzig, 2004).

[3] A trademark is usually defined as any distinctive sign (a word, a logo, a phrase, etc.) used by firms to identify their products or services (WIPO, 2004).

[4] Thoma and Bizer (2013) find that trademarks are used in sectors characterized by non-price competition where distinctiveness of products is important.

knowledge for their development. However, like other assets, radical innovations and brands can boost firms' competitive advantage only if combined with other assets. Indeed, according to the extended perspective of RBV, firms with the dynamic capability to integrate and reconfigure bundles of tangible and intangible resources could better compete in changing market environments (Teece, Pisano, & Shuen, 1997). More specifically, firms that can "1) sense and shape opportunities and threats, 2) seize opportunities, and 3) maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring" their resources are likely to maintain their competitive advantage over time (Teece, 2007, pg. 1348). We argue that patents and trademarks (Ertekin, Sorescu, & Houston, 2018; Huenteler, Schmidt, Ossenbrink, & Hoffmann, 2016; Ozcan, Pickernell, & Trott, 2023) are examples of intangible assets which can be combined with other assets to support firms' competitive advantage. Indeed, while patents may provide "the legal right to exclude other firms from making, using, selling, or importing an invention or innovation" and are useful in protecting their new products from imitation (Amara, Landry, & Traoré, 2008, p. 1531), trademarks, as symbols or devices (e.g. brand name, logo, slogan) used to identify and distinguish a product or process innovation source (Galbreath, 2005) can help innovators to protect their competitive advantage by facilitating identification of branded products and enabling them to be distinguished from the competing products (Sandner & Block, 2011). Trademarks ensure that firms can differentiate their products from competitors and reduce customers' search costs by providing them with quality assurance, which may result in sales growth and the ability to charge premium prices (Block, Fisch, Hahn, & Sandner, 2015). Trademark holders can prevent competitors from counterfeiting and taking unfair advantage of their brands, and this way, they protect their marketing assets (Sandner & Block, 2011). Trademarks are sometimes defined as kin to brand equity since they enhance the value of brands by supporting brand positioning and endowing a distinctive brand identity (Krasnikov & Jayachandran, 2022). In other words, using trademarks to protect a brand may enable innovators to extract a greater value from their patented innovation (in terms of innovation performance) than otherwise.

Nevertheless, there is little evidence this is the case. While trademarks have been studied in the context of investment in intangible assets, there is a paucity of research on how brands may affect the relationship between innovation performance and innovation (Chung, 2022). In addition, currently, we do not have a deep understanding of how environmental factors such as competition may affect the benefits of branding (Bei, 2019), as previous research in the area relies predominantly on theoretical views and anecdotal evidence and is limited in providing evidence on the role of trademarks in the innovation process (Bei, 2019; Block et al., 2015).

When businesses collaborate (with other companies or their customers) and implement a co-branding strategy, shareholders may be interested in the ability of a brand to generate positive cash flows in the future (Guenther & Guenther, 2019) as well as some guarantee that the investment in developing the brand – which may include costs to file a trademark – may generate a positive return (Ohnemus, 2009). In this sense, trademarks constitute the key mechanisms to protect the future cashflows of brands, thus giving shareholders an assurance about the value of their brand. Furthermore, branding efforts may be influenced by collaborating partners or customers because such stakeholders often have a great degree of consideration about how associations with a brand may affect their image or reputation (Törmälä & Gyrd-Jones, 2017). For example, for industrial customers, engaging in transactions or collaborations with a reputable supplier brand may help them project enhanced perceptions of quality, can help communicate the product uniqueness, and offer better opportunities to charge premium prices (Leek & Christodoulides, 2011). Importantly, by assisting innovators to maintain their position in the market, trademarks and patents can help them develop long-term and trustworthy relationships with suppliers and customers.

3. Hypotheses development

Marketing literature emphasises the strategic importance of brands as they can help improve customers' perception and confidence in products (including services) and processes (Erdem et al., 2006). In the case of product or process innovations, brands can help firms signal to customers that their new offerings are of consistent quality. Unsurprisingly, firms are keen on investing in developing strong brands which may help create value for their businesses.

The literature offers several explanations for how brands positively influence innovation performance. First, brands help firms develop niches for product innovations by identifying their origin and differentiating them from competing offerings. This is particularly important in industries where price-based competition is not common, but the uniqueness of innovations is paramount for competition (Thomä & Bizer, 2013). In these industries, brands create a comparative advantage that helps firms position their new products. Rahman, Hasan, and Floyd (2013) suggest that brands influence innovation performance through their equity. Well-directed marketing effort creates trust in the brand and helps build a good reputation for the firm and its products (Keller, 2008). In turn, trust and a positive reputation may reduce the time needed for a consumer to purchase the search for information, which is replaced by expectations and experience-based inferences. Eventually, they may give new products a reputational value, allowing innovators to charge premium prices. Second, they reduce the incentive of customers to switch from one product to another and improve customers' loyalty by protecting the innovators' brand and its associations.[5] Finally, brands reduce the perceived risk associated with a new product. From the perspective of a firm, the risk is related to each stage of the innovation process when launching a new product. An important contribution of a brand is to mitigate the negative effects of risk associated with customers' expectations regarding product functions and performance (Liao & Cheng, 2014). Most studies show a smaller impact of innovation failure on customers' evaluation in the case of high brand equity (Choi & Mattila, 2008) than in the case of brands with small equity.

Branding can be particularly important for firms that innovate with other businesses along the supply chain. The literature has shown that firms co-developing a new product or services are more likely to invest in developing new brands to give their new product a distinctiveness that allows them to appropriate some value from the co-produced innovation. Importantly, trademarks – as devices recognised by the legal system and therefore protected by the law - can preserve the brand associated with the new product. Indeed, collaborating to develop a new product is a time-consuming process, and asymmetric information on the quality of the partner implies that businesses often rely on the brand value to identify new partners (Coleman et al., 2011; Iglesias, Landgraf, Ind, Markovic, & Koporcic, 2020). Crucially, businesses care about how associations with a brand may affect their image or reputation (Törmälä & Gyrd-Jones, 2017), as collaborations with a reputable supplier brand can help enhance the perceptions of quality of the new product as well as facilitate the signalling of its uniqueness while charging premium prices (Leek & Christodoulides, 2011). Indeed, trademarks are an important resource for joint ventures and cross-licencing agreements based on sharing IP rights (Amara et al., 2008; Markman, Espina, & Phan, 2004). For instance, in environments with poor technological barriers to imitation (because of the ease with which innovations can be reverse-engineered or because of the codified nature of the knowledge underpinning the new products), sharing knowledge may be problematic even if the focal firm uses patents to protects its IP regularly (Hoenig & Henkel, 2015). The implication is that while sharing knowledge and expertise can help collaboration to develop new capabilities through inter-organizational learning (Markman et al., 2004), at the same time,

[5] Krasnikov et al. (2009) find that trademarking accounts for the majority of a firm's efforts to create a brand identity.

it may make the focal firm vulnerable to future competition as sharing patents may facilitate the development of new resources and capabilities which may support the development of the next generation solutions built on existing patented innovations (Markman et al., 2004). Indeed, partners may be able to invent around existing patents relatively quickly, limiting the capability of the innovators to charge monopoly prices (Mansfield, Schwartz, & Wagner, 1981); the same happens in industries characterized by fast technological change (Hurmelinna-Laukkanen, Sainio, & Jauhiainen, 2008). If so, the advantage of joining a partnership may be limited and short-lived and therefore, innovators may find it advantageous to use brands that can help protect the future cash flow of brands, and thus offer partners a guarantee that the initial innovation investment will produce future positive returns (Ohnemus, 2009).

These arguments can be particularly relevant to new products launched because the innovating firms want to enter new markets or increase their market share by gaining new customers (i.e., radical innovations). In these cases, the main features of the new product can be unknown to customers because of their novelty (Amara et al., 2008). Therefore, innovators may need to leverage their brand's reputation to gain new customers. In the case of radical innovations, firms frequently prefer to create a new brand and to invest in the development of the new brand equity (Florea, 2015): brands can provide a signal for enhanced strength and quality of new products through overall brand reputation and equity of the collaborating firms (Montgomery & Wernerfelt, 1992; Rao, Qu, & Ruekert, 1999) and firms can leverage their distinct value propositions thanks to the benefits of combining the partners' brand equity with their own (Bengtsson & Servais, 2005; Mohan, Jiménez, Brown, & Cantrell, 2017). The reputation generated by brands would increase the marginal benefit of innovating by expanding the innovation revenues through a combination of increased total sales and higher prices per unit[6] (Arora, 1997; Cohen, Nelson, & Walsh, 2000; Greenhalgh & Rogers, 2007; Jensen, Webster, & Buddelmeyer, 2008; Srinivasan, Lilien, & Rangaswamy, 2008). We therefore posit that:

Hypothesis 1a. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses with a radical innovation that co-innovates with their suppliers.

Hypothesis 1b. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses with a radical innovation that co-innovates with their business customers.

Innovators who acquire technical knowledge from other firms' patents or technical publications tend to be exposed to the risk of imitation, as competitors can access the same knowledge (Appleyard, 1996; Levin et al., 1987).[7] However, in these environments, extracting value from innovations may be difficult as the codified nature of the knowledge underpinning the innovation implies that the barriers to entry are not very high, with the result that competitors can easily compete with close substitutes (Howells, James, & Malik, 2003; Roper, Love, & Bonner, 2017). As a result, the incentive for partners to join the innovation partnership is limited. In these cases, the temporary monopoly power generated by the innovation can be strengthened by brands or trademarks, reducing competitors' incentives to enter the market while increasing the switching costs for some customers (Keller & Lehmann, 2006). Importantly, the opposite applies to innovators that use knowledge sourced informally; in these cases, competitors cannot easily access the knowledge used by the focal firm to innovate and therefore, secrecy and lead time may be sufficient to protect the innovation, as suggested by Anton and Yao (2008). Consequently, we posit that:

Hypothesis 2a. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses which use codified knowledge and co-innovate with their suppliers.

Hypothesis 2b. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses which use codified knowledge and co-innovate with their business customers.

According to Miles (2008) and Amara et al. (2008), innovations in manufacturing tend to be more tangible than services, and their tangibility may facilitate reverse engineering. In the context of early patenting (which is very common in manufacturing), patents would disclose details of an innovation which may enhance the risk of being exposed to earlier competitive responses, suggesting that the commercial success of a new product may be short-lived, so diluting the expected benefit of joining an innovation partnership. If so, brands (and trademarks) can help extract value from innovation and ensure that consumers associate some of the distinguishing technical features of the innovation to the innovating firm itself in such a way that a (reverse-engineered) close substitute cannot threaten the commercial success of the original products. Even better, if trademarks are embedded into vital components of the patented innovation,[8] the innovator will be able to create physical "bottlenecks" which can be used to claim trademark law infringement and so reduce competitors' incentives to develop competing products that are sufficiently close to its own. Vice versa, most innovations in services developed with customers or suppliers tend to be intangible and have a short life, resulting in limited use of branding to build brand equity and extract value from the innovation. Therefore, we suggest that:

Hypothesis 3a. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses which belong to manufacturing and co-innovate with their suppliers.

Hypothesis 3b. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses which belong to manufacturing and co-innovate with their business customers.

Small firms use trademarks more often than large firms (Greenhalgh & Rogers, 2007; Rogers, Greenhalgh, & Helmers, 2007). Several explanations have been put forward for these findings. Some authors have pointed out that because of their size, small firms tend to offer niche products for which they may charge higher prices because of their uniqueness and distinctiveness (Carter, Stearns, Reynolds, & Miller, 1994; McDougall & Robinson Jr, 1990). In the context of an innovation partnership, trademarks offer some additional benefits compared to patents. For instance, small firms may want to have some bargaining power when entering an innovation partnership. While patents may do so for a while, it is not feasible for small firms to do so by patenting continuously. Patenting is an expensive process, which is time-bound and needs to be renewed, as opposed to trademark applications, which are cheap and indefinite, implying that trademarks can offer protection even if the patent has expired. As a result, small firms may use trademarks to sustain existing niches first created with patents, so patents may raise the distinctiveness of their offerings in the eyes of the consumers and effectively make them reluctant to move to new products. Brands are then used to raise the visibility of the latest products and associated services among consumers, increasing the marginal value of innovation.[9] Finally, when innovating, trademarks may provide positive signalling to venture capitalists by demonstrating firms' upstream and

[6] Erickson and Jacobson (1992) have pointed out this may happen even if the products offered by competitors, are close substitutes.

[7] Non-codified knowledge includes tacit knowledge and oral tradition i.e. all knowledge which is not in manuals, books or technical documents.

[8] A well-known example is the Trademark Security System that was introduced by Sega on one of its consoles in the early Nineties.

[9] Thomä and Bizer (2013) suggest that trademarks may help SMEs to promote the services that complement their new offerings and that may in many cases be of great importance in the successful commercialization of innovation among small firms.

Table 1
Descriptive statistics and definitions of variables.

Variable	Description	N	Mean	Std. Dev.	Min	Max
Number of Innovators	Total number of firms that have introduced new or significantly improved goods or services between 2012 and 2014	3123				
Number of innovators with a new to market innovation	Total number of firms that have introduced new or significantly improved goods or services before competitors between 2012 and 2014	1092				
Patent use (1/0)	Dummy variable taking the value of 1 if an innovator has used patents to protect innovations between 2012 and 2014; 0 otherwise.		0.24	0.42	0	1
Collaboration with Suppliers (1/0)	Dummy variable taking the value of 1 if innovator has collaborated with Suppliers between 2012 and 2014; 0 otherwise.		0.46	0.49	0	1
Collaboration with Business Customers (1/0)	Dummy variable taking the value of 1 if innovator has collaborated with Business Customers between 2012 and 2014; 0 otherwise.		0.44	0.49	0	1
Trademarks use (1/0)	Dummy variable taking the value of 1 if an innovator has used trademarks protect innovations between 2012 and 2014; 0 otherwise.		0.29	0.45	0	1
Size (log)	log(Average number of employees of the firm in 2012)		4.30	1.43	2.30	11.65
Exporter (1/0)	Dummy variable equal to 1 if the innovator has exported between 2012 and 2014; 0 otherwise.		0.58	0.49	0	1
Continuous Innovator (1/0)	Dummy equal to 1 the firm has invested in internal R&D in 2012, 2013 and 2014; 0 otherwise.		0.60	0.48	0	1
Use of Codified knowledge (1/0)	Dummy variable equal to 1 if knowledge sourced from scientific journals and technical/trade publications (i.e. codified knowledge) is used to develop an innovation; 0 otherwise.		0.54	0.49	0	1
Obsolescence (1/0)	Dummy variable taking the value of 1 if the business is innovating to offset obsolescence; 0 otherwise.		0.37	0.48	0	1
R&D Intensity (log)	Log of firm-level R&D intensity in 2012		0.17	9.17		

Table 2
Average percentage of trademarking firms, 2012–2014 (mean, number of observations).

Trademarking firms with an innovation between 2012 and 2014	29 (2333)
Trademarking firms with a radical innovation and innovating with suppliers	33 (1279)
Trademarking firms with a radical innovation and innovating with business customers	35 (1206)
Small firms which have trademarked and innovating with suppliers	25 (486)
Small firms which have trademarked and innovating with business customers	28 (491)
Trademarking firms from manufacturing and innovating with suppliers	38 (374)
Trademarking firms from manufacturing and innovating with business customers	38 (377)

Note: Number of observations for each category in parentheses.

downstream capabilities, which is particularly essential for start-ups or firms that need capital investment (Castaldi, 2018; Thomä & Bizer, 2013), on the contrary, large firms may rely more on patents than trademarks to extract value from their innovations. They may depend on a mix of alternative methods to protect their innovation niches. Taken together, these arguments suggest that:

Hypothesis 4a. The impact of a patented innovation on product innovation performance is enhanced by branding for small businesses that co-innovate with their suppliers.

Hypothesis 4b. The impact of a patented innovation on product innovation performance is enhanced by branding for small businesses that co-innovate with business customers.

Several studies (Cohen et al., 2000; Somaya, 2004) find that the normal practice in the industry drives the preference for branding. If we translate this argument to our case, the implication is that competitors may invest in branding as much as the focal firm. This may not necessarily result in the advantage of using brands being eroded. Indeed, using brands gives innovators the possibility of behaving as monopolistic competitors (Chamberlin, 1933). In industries with many competitors offering close substitutes, firms may use brands to differentiate their new products and gain market power.[10] One implication of behaving as monopolistic competitors is that firms can decide on their prices independently of their competitors (unlike oligopoly) and act like monopolists (Demsetz, 1982). As a result, they will benefit from supernormal profits independently of what their competitors do, implying that the wider use of brands across the industry may allow the commercial success of its innovations. We can, therefore, hypothesise:

Hypothesis 5a. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses that co-innovate with their suppliers after controlling for the share of competitors in the same industry that also trademark.

Hypothesis 5b. The impact of a patented innovation on product innovation performance is enhanced by branding for businesses that co-innovate with their customers after controlling for the share of competitors in the same industry that also trademark.

4. Methods

To test for the possibility that trademarking businesses experience larger increases in innovation performance than non-trademarking businesses, ceteris paribus, we estimate the following innovation performance equation:

$$y_i = \alpha + \beta X_i + \pi_1 BOTH_i + \pi_2 PATENT_i + \pi_3 TRADEMARK_i + d_s + \nu_i \quad (1)$$

where y_i is the firm-level measure of innovation performance, X_i is a vector of firm-level variables associated with product innovation performance and d_s identifies the industries firms belong to. We also insert in the equation a dummy variable (PATENT) for firms with a patented innovation and a dummy variable (TRADEMARKING) for trademarking firms and their interaction (BOTH). We estimate the equation using Ordinary Least Squares (OLS). This implies we can calculate the net contribution (calculated as the difference the coefficient associated to PATENT net of the coefficient associated to the interaction term BOTH, when the variable TRADEMARKING is equal to 1) of the variable PATENT to innovation performance when the firm is trademarking as well. If the value of the net contribution is positive and significant, then trademarking enhances the contribution of a patented innovation to innovation performance.

[10] See McClure (1996) for a survey on how trademarks can be used for this purpose.

Table 3
Correlation matrix.

	Turnover from product innovations (%)	Patent use (1/0)	Trademark use (1/0)	Marketing expenses (log)	Employees (log)	Firms with product innovations which are new to the market (1/0)	Continuous innovator (1/0)	R&D intensity (log)	Export (1/0)	Innovate to offset obsolescence (1/0)
Turnover from product innovations (%)	1									
Patent use (1/0)	0.204	1								
Trademark use (1/0)	0.1225	0.4995	1							
Marketing expenses (log)	0.1623	0.1264	0.1558	1						
Employees (log)	−0.1327	0.1265	0.0725	−0.408	1					
Firms with product innovations which are new to the market (1/0)	0.3928	0.3031	0.2125	0.1423	−0.02	1				
Continuous innovator (1/0)	0.1815	0.1834	0.1593	−0.0002	0.0423	0.2851	1			
R&D intensity (log)	0.3179	0.2912	0.1792	0.5732	−0.2306	0.2401	0.0524	1		
Export (1/0)	0.014	0.236	0.183	0.1423	0.0987	0.1382	0.1477	0.0.2339	1	
Innovate to offset obsolescence (1/0)	0.063	0.099	0.1072	−0.0033	0.07	0.1331	0.3185	0.0389	0.066	1

Table 4
Innovation Performance – All innovators and sub-samples.

	All innovators	Non Innovators	Innovators with a radical innovation	Large firms who are radical innovators	Small firms who are radical innovators	Radical Innovators sourcing knowledge from codified sources	Radical Innovators not sourcing knowledge from codified sources	Radical Innovators from Services	Radical Innovators from Manufacturing
Employees (log)	−1.64***	0.010	−2.20***	−2.03	−8.04**	−1.97**	−2.90*	−2.47**	−0.55
	(−4.09)	(0.33)	(−3.09)	(−0.99)	(−2.11)	(−2.27)	(−1.95)	(−2.51)	(−0.59)
Continuous innovator (1/0)	4.88	0.066	12.66**	0.0001	12.32	11.91	15.13	15.91	−1.37
	(1.53)	(0.39)	(1.81)	(0.10)	(1.22)	(1.50)	(0.99)	(1.63)	(−0.16)
Proportion of employees with a science or engineering degree	10.20***	−0.035	10.99***	10.60**	8.12*	12.20***	2.96	9.07**	−2.05
	(6.50)	(−0.24)	(4.34)	(1.99)	(1.86)	(4.22)	(0.52)	(2.87)	(−0.36)
R&D intensity (log)	2.20***	0.002	3.49***	0.20	5.41***	3.66***	2.68**	4.22***	1.03
	(7.57)	(0.11)	(6.58)	(0.22)	(5.02)	(5.81)	(2.53)	(6.04)	(1.38)
Innovate to offset obsolescence (1/0)	0.09	0.06	−3.82	7.29	−8.61*	−7.97	−2.04	−5.56	4.54
	(0.06)	(0.66)	(−1.29)	(1.25)	(−1.64)	(−1.68)	(−0.50)	(1.51)	(0.98)
Export (1/0)	−4.09***	−0.080	−7.87***	0.12	−9.86**	−8.98***	−4.43	−8.59	−2.84
	(−3.81)	(−0.83)	(−4.17)	(0.03)	(−2.73)	(−4.02)	(−1.22)	(2.58)	(−1.14)
BOTH	−1.22	−0.093	3.43	−2.52	8.80	3.47	−0.02	−0.68	4.07
	(−0.49)	(−0.36)	(0.86)	(−0.34)	(1.10)	(0.74)	(−0.0001)	(−0.12)	(0.86)
PATENTS ONLY	7.45***	−0.037	4.65	−3.00	10.19*	6.19*	0.054	13.54	−4.30
	(3.93)	(−0.23)	(1.59)	(−0.53)	(1.69)	(1.82)	(0.01)	(3.05)	(−1.30)
TRADEMARKS ONLY	1.02	0.086	−2.97	−1.00	−4.61	−3.01	−1.65	−3.67	−2.84
	(0.70)	(0.50)	(−1.11)	(−0.19)	(−0.93)	(−0.92)	(−0.35)	(−1.03)	(−0.82)
Constant	9.65**	−0.07	16.29**	18.66	36.20**	19.93**	14.77	15.20	14.88
	(2.61)	(−0.33)	(2.14)	(1.36)	(2.33)	(2.15)	(0.96)	(1.44)	(1.57)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1310	501	631	137	246	471	160	392	239

The theoretical analysis conducted in Section 3 has identified a variety of firms that are more likely to benefit from trademarking. Therefore, we start by estimating eq. (1) for the whole sample of innovators (i.e. not only the innovators that innovate collaborating with suppliers and/or business customers). For each sub-sample of innovators (i.e., small innovators, innovators from manufacturing, radical innovators, and innovators that use codified knowledge), test whether the net coefficient of the variable PATENT is significant. Afterwards, we

Table 5
Innovation Performance – Collaborating with Suppliers.

	Sub-sample: Innovators with a radical innovation	Sub-sample: Small firms	Sub-sample: Innovators sourcing knowledge from codified sources	Sub-sample: Innovators from Manufacturing
Employees (log)	−2.93***	−5.80***	−3.20***	−2.00**
	(−8.39)	(−2.38)	(−9.32)	(−1.97)
Continuous innovator (1/0)	15.41***	13.80***	15.91***	4.94***
	(17.05)	(9.15)	(30.54)	(4.09)
Proportion of employees with a science or engineering degree	12.44***	11.83***	11.85***	−0.66
	(6.24)	(2.60)	(12.68)	(−0.30)
R&D intensity (log)	3.27***	5.35***	3.44***	2.06***
	(9.19)	(6.20)	(16.32)	(9.71)
Innovate to offset obsolescence (1/0)	−9.36***	−17.14***	−15.98***	−8.28***
	(−9.27)	(−5.28)	(−5.84)	(−5.03)
Export (1/0)	−9.01***	−14.15***	−9.29***	−5.17***
	(−3.58)	(−3.45)	(−5.25)	(−3.19)
BOTH	3.76***	14.04***	5.82***	0.019
	(2.38)	(3.14)	(2.73)	(0.02)
PATENTS ONLY	2.55***	7.65***	3.40***	−2.66**
	(5.03)	(3.97)	(3.71)	(−1.89)
TRADEMARKS ONLY	−4.80***	−11.92***	−6.30***	−1.48
	(−3.09)	(−7.82)	(−14.61)	(−0.86)
Constant	24.02***	40.75***	31.45***	27.78***
	(16.40)	(6.87)	(9.21)	(6.14)
Industry dummies	YES	YES	YES	YES
N	478	168	370	196

Note: OLS estimator. Dependent variables: percentage of sales generated by radical innovations. Results of the tests on the equality of coefficients suggest that the coefficients are significantly different across the sub-samples of firms.

Table 6
Innovation Performance – Collaborating with Suppliers.

	Sub-sample: Innovators with no radical innovation	Sub-sample: Large firms	Sub-sample: Innovators not sourcing knowledge from codified sources	Sub-sample: Innovators from Services
Employees (log)	−0.38***	−1.60***	−2.39*	−2.84***
	(−7.87)	(−2.25)	(−1.76)	(−4.86)
Continuous innovator (1/0)	0.47***	0.60***	7.10***	17.73***
	(6.38)	(6.15)	(5.03)	(16.10)
Proportion of employees with a science or engineering degree	1.99***	15.54***	7.73	11.35***
	(8.17)	(11.80)	(0.89)	(3.14)
R&D intensity (log)	0.065	0.58**	2.06*	3.80***
	(1.49)	(2.33)	(1.93)	(7.20)
Innovate to offset obsolescence (1/0)	0.53***	−4.26	−2.06	−9.95***
	(4.58)	(−0.84)	(−1.59)	(−6.91)
Export (1/0)	0.26***	0.11	−7.81	−9.78***
	(2.67)	(0.10)	(−1.47)	(−2.65)
BOTH	1.27	−3.26***	−5.89***	6.06**
	(0.78)	(−5.51)	(−4.27)	(2.41)
PATENTS ONLY	0.13	3.95***	−2.73	10.36***
	(0.89)	(3.95)	(−1.44)	(6.56)
TRADEMARKS ONLY	1.63***	2.53	1.05	−7.36***
	(4.53)	(0.97)	(0.22)	(−5.55)
Constant	1.71***	23.91***	22.46***	22.23***
	(12.68)	(3.78)	(4.34)	(7.35)
Industry dummies	YES	YES	YES	YES
N	665	113	108	282

Note: OLS estimator. Dependent variables: percentage of sales generated by radical innovations. Results of the tests on the equality of the coefficients suggest that the coefficients are significantly different across the sub-samples of firms.

focus only on innovators that do so in collaboration with suppliers and/or business customers and split this sample into sub-groups; finally, we ran our model (1) for each sub-group. The net coefficient of the variable PATENT to innovation performance when the firm is trademarking is then calculated. If this is significant (and positive) in a sub-sample of firms (for instance, small firms) but not for the whole sample, then we argue that the hypothesis for that specific sub-sample is confirmed. In addition, we are interested in providing evidence on whether the benefit of trademarking (in terms of innovation performance) disappears if their competitors do the same. For this purpose, for each firm in every sub-sample of innovators listed above, we compute the fraction of firms (excluding the firm under observation) in the same 3-digit industry and sub-sample that simultaneously uses trademarks and patents. This variable is then added to the innovation performance eq. (1), and we test its significance and the coefficient's sign.

5. Dataset and variables

5.1. UK innovation survey

For our empirical analysis, we use a sample of firms from the 9th wave of the UK Innovation Survey (UKIS), which is the main source of information on innovation in the United Kingdom. The 9th wave of the survey (UKIS2015) refers to 2012–2014. This survey has collected data on the innovating firms' characteristics and the protection mechanisms used to protect innovations between 2012 and 2014. For the survey, radical innovation is defined as new products (or services) and/or processes the firm introduced between 2012 and 2014 and were new to the market (that is, a similar product does not exist in the market). Finally, we focus on innovators who innovate with either suppliers or their business customers.

5.2. Variables

Our main dependent and independent variables are described in Table 1, along with their means and standard deviations.

Dependent Variable. The innovation performance measure used in this study is the percentage of sales generated by radical innovations launched by an innovator between 2012 and 2014.

Independent Variables. Among the independent variables, we distinguish among:

Propensity to patent or trademark and their combinations. The survey asked all innovators (in two separate questions) whether they had used either trademarks or patents between 2012 and 2014. The replies to these two questions allow us to generate two dummy variables: the first dummy variable (PATENT) takes the value of 1 if innovators have a patented innovation over the period 2012–2014 and 0 otherwise; the second dummy (TRADEMARK) takes the value of 1 if innovators with new to the market innovations have used trademarks over the period 2012–2014 and 0 otherwise. We interact with the two variables in our equation. It is important to note that, in our empirical setup, we do not consider innovations in development and only focus on the later stage of the innovation process, i.e., the moment when the innovation is patented and ready to be commercialised. In line with the literature, we assume that this type of innovation can impact the percentage of sales in a short time, and therefore, we focus on the percentage of sales over three years.

Other control variables. Our empirical specification controls for various factors that may influence innovation performance. More specifically, we include among the regressors the following control variables: a) the size of the firms (proxied by the log of the average number of employees in 2012); b) a dummy variable taking the value of 1 if firms

Table 7
Innovation Performance – Collaborating with Business Customers.

	Sub-sample: Innovators with a radical innovation	Sub-sample: Small firms	Sub-sample: Innovators sourcing knowledge from codified sources	Sub-sample: Innovators from Manufacturing
Employees (log)	−2.7*** (−16.41)	−6.65** (−2.43)	−2.41*** (−11.13)	−2.089*** (−4.31)
Continuous innovator (1/0)	14.71*** (22.47)	14.28*** (34.08)	13.85*** (24.32)	4.54*** (6.72)
Proportion of employees with a science or engineering degree	8.64*** (13.98)	5.69*** (5.03)	9.98*** (13.76)	−4.88*** (−3.49)
R&D intensity (log)	3.43*** (16.05)	5.34*** (12.16)	3.42*** (17.46)	2.19*** (15.38)
Innovate to offset obsolescence (1/0)	−12.71*** (−8.07)	−21.46*** (−4.28)	−20.43*** (−16.64)	−7.81*** (−8.39)
Export (1/0)	−8.85*** (−5.13)	−13.04*** (−3.71)	−8.12*** (−5.54)	−4.77*** (−4.17)
BOTH	5.03*** (9.58)	17.68*** (3.54)	6.94*** (10.11)	−1.42 (0.97)
PATENTS ONLY	4.35*** (5.78)	8.50*** (3.69)	4.99*** (5.40)	−3.56** (−2.57)
TRADEMARKS ONLY	−2.18*** (−3.44)	−2.35 (−1.28)	−2.50** (−2.49)	−4.62*** (−4.61)
Constant	26.19*** (15.41)	44.01*** (6.99)	32.08*** (29.76)	28.92*** (14.46)
Industry dummies	YES	YES	YES	YES
N	501	195	394	192

Note: OLS estimator. Dependent variables: percentage of sales generated by radical innovations. Results of the tests on the equality of coefficients suggest that the coefficients are significantly different across the sub-samples of firms.

Table 8
Innovation Performance – Collaborating with Business Customers.

	Sub-sample: Innovators with a non radical innovation	Sub-sample: Large firms	Sub-sample: Innovators not sourcing knowledge from codified sources	Sub-sample: Innovators from Services
Employees (log)	−0.37*** (−8.79)	−1.58* (−1.70)	−4.72*** (−10.28)	−2.39*** (−17.69)
Continuous innovator (1/0)	0.56*** (3.03)	1.00 (0.90)	11.57*** (15.00)	16.87*** (26.80)
Proportion of employees with a science or engineering degree	2.01*** (6.36)	12.43*** (11.34)	2.32 (0.83)	7.78*** (10.52)
R&D intensity (log)	0.014 (0.26)	0.60*** (2.86)	2.38*** (2.37)	3.95*** (14.90)
Innovate to offset obsolescence (1/0)	1.21*** (15.61)	−5.51 (−0.90)	−4.83 (−1.56)	−14.36*** (−7.33)
Export (1/0)	−0.08 (−0.30)	0.80 (1.33)	−11.48** (−2.90)	−9.74*** (−3.78)
BOTH	1.40 (0.90)	−4.47*** (−5.83)	−8.59*** (−19.35)	8.81*** (5.43)
PATENTS ONLY	−0.28** (−2.35)	−3.34*** (4.00)	−1.47 (−0.50)	12.77*** (34.34)
TRADEMARKS ONLY	1.66*** (4.86)	0.75*** (3.14)	1.38 (0.99)	−1.03 (−1.56)
Constant	1.070** (2.86)	25.76*** (7.45)	34.57*** (14.44)	23.99*** (21.20)
Industry dummies	YES	YES	YES	YES
N	651	113	107	309
Test on the size of the coefficients (p-value)	0.80	0.99	0.99	0.04

Note: OLS estimator. Dependent variables: percentage of sales generated by radical innovations. Results of the tests on the equality of coefficients suggest that the coefficients are significantly different across the sub-samples of firms.

have invested in R&D in each year of the survey; c) whether they have exported between 2012 and 2014 (a dummy variable taking the value of 1 if the firm exports and 0 otherwise); d) whether they have innovated between 2012 and 2014 to offset obsolescence (a dummy variable taking the value of 1 if this is the case and 0 otherwise), e) the R&D intensity (in log) and f) whether more than 50 % of their workforce has a degree in a science and engineering subject (dummy variable taking the value of 1 if this is the case and 0 otherwise).

5.3. Descriptive statistics

The dataset contains information on 15,091 firms; of these, 3123 firms introduced an innovation between 2012 and 2014. Table 1 reports the main descriptive statistics. Innovators that have produced a new-to-market innovation between 2012 and 2014 are 1092. On average, 29 % of the innovators have used trademarks between 2012 and 2014, while the equivalent figure for patents goes down to 24 %. The average percentage turnover from new-to-market goods and services in 2014 was 6.00 %. Around 20 % of the innovators have exported between 2012 and 2014. 37 % of innovators do so to offset obsolescence. Around 37 % of the innovators do so to offset the obsolescence of previous innovations. The mean value of R&D intensity is equal to 0.17. Around 60 % of the innovators invested in R&D continuously between 2012 and 2014 (i.e., they invested in each year covered by the survey), while around 54 % of the sampled innovators source knowledge from codified sources. Finally, 46 % of innovators collaborate with suppliers, while 44 % collaborate with industrial (or business) customers.

Table 2 reports the percentage of trademarking forms among innovators. 29 % of innovators with radical innovation have trademarked. The percentages increase for innovators that collaborate with business customers and suppliers. Among the innovators that use codified sources of knowledge and innovate with suppliers, 28 % use patents, while 33 % use trademarks. Among the small businesses that have innovated with their suppliers, 25 % have used trademarks. The percentages are similar for small firms that innovate with business customers, as 28 % use trademarks. Finally, 38 % of manufacturers collaborating with suppliers have used trademarks; similar figures apply to manufacturers who innovate with business customers.

Finally, Table 3 reports the correlations among the variables we use in our empirical analysis. Across all the independent variables, the correlation coefficients are never above 0.5, suggesting that the independent variables are not multicollinear (Gujarati, 2004).

6. Results

6.1. Main results

In line with the empirical methodology discussed in Section 4, we discuss the estimates of the innovation performance equation across the whole sample (Table 4). Afterwards, Table 5 and Table 6 report the estimates of the innovation performance equations for innovators that do so with suppliers, while Table 7Table 8 focus on firms innovating with business customers. Each table refers to innovators with radical innovation (non-radical innovation) (Column 1), small (large) size innovators (Column 2), innovators sourcing knowledge from codified sources (and non) (Column 3) and innovators from manufacturing (services) (Column 4).

In line with what described in the Methodology section, we start by checking the significance level of the variable BOTH for all the sub-

Table 9
Innovation Performance and competitors' strategies.

	Sub-sample: Innovators that collaborate with suppliers and have a radical innovation	Sub-sample: Innovators that collaborate with business customers and have a radical innovation
Strategies of competitors in the industry	−0.31***	−0.39***
	(−3.91)	(−12.88)
Employees (log)	−2.88***	−2.71***
	(−8.31)	(−16.49)
Continuous innovator (1/0)	15.36***	14.89***
	(17.78)	(24.05)
Proportion of employees with a science or engineering degree	12.89***	9.17***
	(6.32)	(17.30)
R&D intensity (log)	3.55***	3.72***
	(10.06)	(17.55)
Innovate to offset obsolescence (1/0)	−9.51***	−12.85***
	(−9.21)	(−8.12)
Export (1/0)	−8.43***	−7.84***
	(−3.21)	(−4.21)
BOTH	5.07***	6.69***
	(3.28)	(9.98)
PATENTS ONLY	4.12***	6.12***
	(8.16)	(11.07)
TRADEMARKS ONLY	−4.46***	−1.72***
	(−2.89)	(−2.39)
Constant	25.83***	28.35***
	(16.34)	(18.80)
Industry dummies	YES	YES
N	478	501

Note: OLS estimator. Dependent variables: percentage of sales generated by radical innovations. Results of the tests on the equality of coefficients suggest that the coefficients are significantly different across the sub-samples of firms.

Table 10
Innovation Performance – Heckman model.

	Collaborating with Suppliers		Collaborating with Business Customers	
	Sub-sample: Innovators with a radical innovation	*Sub-sample: Innovators with no radical innovation*	*Sub-sample: Innovators with a radical innovation*	*Sub-sample: Innovators with no radical innovation*
	INNOVATION PERFORMANCE			
Employees (log)	−0.35	0.16	−2.37	−0.65
	(−0.19)	(0.22)	(1.25)	(−0.77)
Proportion of employees with a science or engineering degree	7.17	−0.06	11.12*	3.23
	(1.11)	(−0.03)	(1.66)	(1.33)
Continuous innovator (1/0)	39.9*	2.98	38.90*	−1.52
	(1.75)	(0.55)	(1.68)	(−0.24)
R&D intensity (log)	4.89***	0.53	4.85***	0.066
	(3.93)	(1.46)	(3.70)	(0.13)
PROPENSITY TO PATENT (1/0)	7.56*	−0.42	6.84	0.47
	(1.73)	(−0.36)	(1.47)	(0.31)
Innovate to offset obsolescence (1/0)	−11.47	1.26	−4.83	2.83
	(−1.29)	(0.51)	(−0.42)	(0.72)
Export (1/0)	−7.24	0.88	−8.65*	−2.60
	(−1.47)	(0.47)	(−1.75)	(−1.08)
Industry dummies	YES	YES	YES	YES
	PROPENSITY TO TRADEMARK			
Employees (log)	0.16	0.29***	0.15	0.36
	(1.52)	(2.62)	(1.35)	(3.02)
Marketing expenses (log)	0.22***	0.15***	0.22***	0.17***
	(3.08)	(2.77)	(3.10)	(2.86)
Continuous innovator (1/0)	1.85**	1.85***	1.77***	1.64***
	(2.84)	(4.30)	(2.76)	(4.56)
Export (1/0)	0.16	0.60***	0.18	0.65***
	(0.83)	(3.16)	(0.92)	(3.38)
Industry dummies	YES	YES	YES	YES
Mills' ratio	13.67	0.46	2.05	−2.46
	(1.00)	(0.14)	(0.15)	(−0.58)
N	212	370	214	316

Note: Heckman two-stage estimator. Dependent variable Stage 1: percentage of sales generated by radical innovations. Dependent variable Stage 1: firm-level propensity to trademark.

samples of innovators that do no innovate collaboratively. We find that this variable is not significant across all the sub-samples. We proceed to compare these results with the significance level of the same variable for the innovators that do so in collaboration with their suppliers (reported in Table 5). Table 5 shows that the variable BOTH is significant and positive for innovators with radical innovations (confirming H1), firms that source knowledge from codified sources (confirming H2) and small firms (confirming H4). The only exception is for innovators from manufacturing where the variable BOTH is not significant (not confirming H3). These results are confirmed by the last row of Table 5, reporting the *p*-value for the test on the significance of the interaction term coefficients. The tests show that the value of the coefficient associated with the interaction term is significant across all the sub-samples except the sample from manufacturing.

As for the size of the coefficients associated with our variables of interest, we notice that the coefficients are positive (ranging between 0.019 and 14.04) in the case of BOTH. They are largely significant and positive for PATENTS (with the only exception being the coefficient for the sample of businesses from manufacturing). In contrast, all the coefficients associated with TRADEMARKS are negative. The coefficients associated with BOTH are the largest in absolute among all models of the top panel (with manufacturing being the only exception), suggesting that the actual economic benefit of combining innovation and brands may be larger than the marginal benefit of innovating only. As for the other control variables, the firm's size is inversely related to innovation performance and the propensity to export and innovate to offset obsolescence. On the contrary, R&D intensity, continuous innovation, and a large proportion of employees from science and engineering are positively associated with innovation performance.

Table 6 shows that the variable BOTH is significant but negative for large innovators and for innovators who source knowledge from codified sources. The net contribution of the variable PATENTS to innovation performance is, therefore, negative. In the case of innovators from services, the coefficient of the variable BOTH is positive and significant; these results show that innovators from services which innovate in collaboration with their suppliers benefit from branding, unlike their counterparts in manufacturing. As for the innovators without a radical innovation, the coefficient of the variable BOTH is not significant.

As for the control variables, the size of the business continues to be negatively associated with innovation performance, while being a continuous innovator is positively associated with innovation performance for all types of innovators. The proportion of employees with a science degree is significantly and positively associated with innovation performance, except innovators from manufacturing. R&D intensity is not significant for innovators with a non-radical innovation, but it is substantial for all other innovators. The propensity to export is positively associated with innovation performance only among innovators with a non-radical innovation, while it is negative and significant for innovators from services.

We repeat the same analysis for businesses that innovate with business customers (Table 7 and Table 8). The results are broadly in line with those reported in Table 5 and Table 6. There are some exceptions, though. The variable BOTH is insignificant for innovators from manufacturing (H3 is not confirmed), and its range varies between −1.42 and 17.68. However, the coefficients are still significant for all types of innovators (including those from manufacturing). As for the innovators in the bottom panel of Table 6, the coefficient BOTH is

Table 11
Results of the Hypothesis Testing.

Hypothesis 1a. The impact of a patented innovation on innovation performance is enhanced by branding for businesses with a radical innovation that co-innovate with their suppliers.	Confirmed
Hypothesis 1b. The impact of a patented innovation on innovation performance is enhanced by branding for businesses with a radical innovation that co-innovate with their business customers.	Confirmed
Hypothesis 2a. The impact of a patented innovation on innovation performance is enhanced by branding for businesses which use codified knowledge and co-innovate with their suppliers.	Confirmed
Hypothesis 2b. The impact of a patented innovation on innovation performance is enhanced by branding for businesses which use codified knowledge and co-innovate with their business customers.	Confirmed
Hypothesis 3a. The impact of a patented innovation on innovation performance is enhanced by branding for businesses which belong to manufacturing and co-innovate with their suppliers.	Rejected
Hypothesis 3b. The impact of a patented innovation on innovation performance is enhanced by branding for businesses which belong to manufacturing and co-innovate with their business customers.	Confirmed
Hypothesis 4a. The impact of a patented innovation on innovation performance is enhanced by branding for small businesses that co-innovate with their suppliers.	Confirmed
Hypothesis 4b. The impact of a patented innovation on innovation performance is enhanced by branding for small businesses that co-innovate with business customers.	Confirmed
Hypothesis 5a: The impact of a patented innovation on innovation performance is enhanced by branding for businesses that co-innovate with their suppliers, after controlling for the share of competitors in the same industry that trademark as well.	Confirmed
Hypothesis 5b: The impact of a patented innovation on innovation performance is enhanced by branding for businesses that co-innovate with their business customers after controlling for the share of competitors in the same industry that trademark as well.	Confirmed

significant only for innovators from services (but not for other innovators) (H3).

6.2. Controlling for the competitors' choices

While the estimates of the innovation performance equation suggest that most innovators may benefit from branding when innovating, it is still being determined whether this is the case if competitors in the same industry do the same. Therefore, we decided to re-run the innovation performance equations estimated above for each sub-sample and control for the proportion of competitors innovating while trademarking in each sub-sample. We do so by computing the fraction of new to-the-market innovators (excluding the firm under observation) in the 3-digit industry (and sub-sample) that have used both trademarks and have a patented innovation over the period 2012–2014 in each sub-sample of firms and add this new variable to our innovation performance equations among the control variables.

The results are shown in Table 9. Generally speaking, the new variable is significant and negatively associated with innovation performance. However, the tests reported at the bottom of the Table suggest that trademarks can still benefit businesses that innovate with suppliers (H5) and collaborate with business customers (H5).

6.3. Alternative estimation procedure

To gauge the robustness of our results, we use an alternative approach to estimating the relationship between innovation performance and the likelihood of patenting among a sample of innovators. More specifically, we employ a two-stage Heckman model to assess the relationship between innovation performance and the possibility of patenting, conditional on the likelihood of trademarking. Indeed, the choice of trademarking is not exogenous, and not modelling such a choice may bias the relation between innovation performance and propensity to innovate. As a result, our alternative estimation procedure follows two stages. In Stage 1, the propensity to trademark is governed by the following equations:

$$tmk_{it} = 1 \; if \; tmk^{*} = w_{it}\alpha + e_{it} \; i = 1, \ldots, N \; t = 1, \ldots, T$$

$$tmk_{it} = 0 \; otherwise \tag{3}$$

where tmk^{*} is an unobservable latent variable, whose value determines whether the business is trademarking, and tmk is an observed indicator that equals zero for businesses that do not trademark and one otherwise. The error term e_{it} is assumed to be normally distributed.

In the second stage, conditional on trademarking, we estimate the innovation performance equation in our sample and correct for the sample selection bias via the two-stage Heckman estimator. The control variables in the innovation performance equation mirror those used in the main model. However, we do not introduce the dummy variable for trademarking innovators or its interaction with the dummy for businesses with a patented innovation. Among the variables we assume are associated with the propensity to trademark, we include the same variables in the main equation and the log of the marketing expenses incurred by the innovators as the identifying condition.

The estimates of the Heckman model for the two types of innovators are presented in Table 10. For simplicity, we only focus on the sample of innovators with radical innovations (the estimates for the other sub-samples can be found in the Appendix - Table A1 and Table A2). The results show that the Mills' ratios are not significant across all the models, suggesting that the residuals of the two equations are not correlated. The estimates of the first stage equation suggest that among innovators with radical innovation, those who invest in marketing and are innovating continuously are more likely to trademark than others. Conditional on the likelihood of trademarking, the innovation performance of these innovators is positively and significantly associated with the probability of patenting. In other words, among the innovators with radical innovation, there is a positive association between innovation performance and patented innovation.

7. Discussion

Our empirical analysis has addressed the issue of the effectiveness of branding in helping innovators extract value from their inventions when co-innovating with suppliers or business customers directly. What are the implications of these results for the literature on innovation and brands? While previous research has already analysed the choices made by managers around brands (Amara et al., 2008; Gallié & Legros, 2012, the limited number of studies has made it difficult to generalise their results to the whole economy. As a result, it was challenging to attribute improvements in the innovation performance to branding rather than to other factors (for instance, the novelty of the innovation). Our paper has overcome this limitation of the previous literature by directly showing that combining innovation developed with vertically linked collaborators (i.e. suppliers or business customers) and brands can contribute to the firm-level innovation performance in a dataset representative of the UK economy.

As for the results, Table 11 highlights the hypotheses that have been confirmed or rejected.

Our results show that most firms benefit from branding when innovating, confirming the interdependency between brands and innovation (Brexendorf, Bayus, & Keller, 2015). Indeed, the results confirm all

hypotheses but the ones on innovators from manufacturing. Unlike what was stated in Hypotheses 3a, manufacturers innovating with suppliers do not appear to benefit (in terms of innovation performance) from using trademarking when innovating. Indeed, the results have found significant differences between services and manufacturing among these innovators. These differences between the two types of industries in terms of their propensity to use branding contrast what has already been identified previously, and prima facie, they appear to be surprising (Amara et al., 2008; Howells et al., 2003). These results hint at the different quality of the innovation outputs. It is important to remember that our analysis focuses on a specific sample of manufacturing firms, i.e. those that cooperate with their suppliers. Among these innovators, innovation tends to be deployed within the supply chain or used by other businesses to solve specific issues they may face; indeed, the market for these types of innovation is small and limited, and as a result, the impact of branding on the innovation performance is limited. So, while it is reasonable to argue that innovators with highly innovative new products can benefit from combining patents and brands, for firms with innovations whose novelty step may be low, branding may not be profitable at the margin. In addition, services and manufacturing are the same. Indeed, services that collaborate with business customers in our sample may take advantage of trademarking as their innovation is mostly for the consumer market. Therefore, brands matter a lot as they signal to consumers and competitors the quality of the innovation. These findings have implications for RBV in the sense that different innovators may achieve different performance outcomes due to their existing resources and the alignment between these resources and the needs of their target markets. Previous research has acknowledged the importance of market sensing and market linking competencies in a firm's performance (Chen, Wang, Huang, & Shen, 2016). This study has confirmed prior empirical findings by observing that the effectiveness of a firm's existing resource, i.e., brands, would depend on the extent to which it meets the target market's needs.

Equally, it is interesting to notice that the marginal benefit from combining innovation and trademarks is larger for small firms than for large firms. This is one of the few studies investigating the impact of trademarking on small firms' economic and financial performance (Agostini, Filippini, & Nosella, 2016; Mendonça, Pereira, & Godinho, 2004; Rogers et al., 2007). Although it may sound counterintuitive, these results align with what Agostini et al. (2016) found. So, the question is why more small firms do not use trademarks systematically to build their brand equity. One possible reason is that small firms tend to be resource-constrained and, therefore, limited in their capability to create a strategy using patents and brands.[11] This may be relevant to managers from small companies lacking the needed skills (Agostini et al., 2016). In this sense, our study is confirms the main tenet of RBV by showing that resource constraints of certain types of innovators would influence the role of their resources (brands) or complementarity of their resources (complementarity of brands and innovations) in their performance outcomes (Mahoney & Pandian, 1992).

Finally, our empirical results also suggest that the benefit of combining trademarks with innovation only partially disappears if competitors do the same. Though these results are consistent with the RBV theory suggesting that the presence and sustainability of rents is contingent on the availability of competition in either acquiring or deploying VRIN resources (Barney, 1991; Mahoney & Pandian, 1992), our findings should still be considered exploratory in an area where few empirical studies support the notion that branding, combined with innovation, may eventually generate an economic monopoly that may hamper competition and harm social welfare. Similarly, firms that use trademarks tend to charge higher prices than we would expect, given their marginal costs, as a direct result of the market power that the two protection mechanisms create for the innovators. It is important to highlight that because of the cross-sectional nature of the data, it is not possible to conclude that such an advantage will be long-lasting. However, anecdotal evidence suggests that further product differentiation sustains and strengthens the market power over time.[12]

Overall, our results build on the RBV by demonstrating that the effectiveness of a specific firm-based resource, i.e. brand, may vary not only in the context of its complementarity with another resource, i.e. innovation, but also its deployment by different types of innovative firms (or innovators). These firms are characterized by various contextual contingencies but not necessarily the resource based contingencies. Furthermore, our findings extend previous findings of branding and product innovation (Flikkema, Castaldi, de Man, & Seip, 2019) relationships. These findings will help firms devise their branding strategy and protect their innovation for business performance. Indeed, they suggest that managers should take advantage of the opportunity to maximise their innovations' commercial success if they cannot assess the economic benefit of branding. In addition, they highlight that firms should not consider innovation in isolation but should try to develop a strategy for using brands to identify combinations with the potential of improving their innovation performance.

8. Concluding remarks

Previous literature on trademarking has shown that brands and innovation go hand in hand. However, hardly any economy-wide evidence suggests that combining trademarks with innovation may benefit innovators, although sectorial evidence suggests that innovative firms that build brand equity may gain an advantage over their immediate competitors. Our results indicate that while brands are commonly used by various firms, businesses co-innovating with suppliers or business customers may particularly benefit from using trademarks when innovating.

Our analysis can be extended in several directions. Our study needs to consider the costs associated with brand equity development; therefore, it is impossible to deduce whether differences may explain the results. Further research in this area would help identify a channel through which firms may be induced to adopt the most profitable combination of brands and innovation. Finally, our findings are restricted to firms based in the UK, and empirical analysis of data from other countries may deliver different interesting results.

CRediT authorship contribution statement

Vania Sena: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Shamsul Karim:** Writing – review & editing, Writing – original draft. **Sena Ozdemir:** Writing – review & editing, Writing – original draft.

[11] Agostini et al. (2016) suggest that small firms register a trademark only when sales have started.

[12] Schmalensee (1978) pointed that one common strategy is to develop a number of similar products but with different brands and trademarks so to segment the market, increases consumers' loyalty and reduce their incentive to switch from product to the other.

Appendix A

Table A1
Heckman model – Collaborating with Suppliers.

	Sub-sample: Innovators sourcing knowledge from codified sources	Sub-sample: Innovators not sourcing knowledge from codified sources	Sub-sample: Small firms	Sub-sample: Large firms	Sub-sample: Manufacturing	Subsample: Services
INNOVATION PERFORMANCE						
Employees (log)	−3.37*	1.84	23.65*	4.58	0.81	1.12
	(−1.99)	(0.04)	(1.72)	(0.88)	(0.16)	(0.47)
Proportion of employees with a science or engineering degree	9.19	−5.08	−17.25*	36.59***	–	2.05
	(1.29)	(−0.09)	(−1.64)	(4.15)		(1.24)
Continuous innovator (1/0)	20.01	0.000001	0.00001	37.82**	–	43.65*
	(0.94)	(0.00003)	(0.000001)	(2.45)		(1.73)
R&D intensity (log)	3.52**	2.80	7.30	−0.18	4.13**	6.12***
	(2.82)	(0.20)	(3.23)	(−0.13)	(2.50)	(3.54)
PROPENSITY TO PATENT (1/0)	9.35**	−19.43	40.28	−0.58	4.69	10.77*
	(2.03)	(−0.39)	(4.83)	(−0.11)	(0.73)	(1.70)
Innovate to offset obsolescence (1/0)	−3.65	13.37	−18.38	2.161	−15.24	−12.48
	(−0.37)	(0.19)	(−0.74)	(0.30)	(−0.97)	(−1.11)
Export (1/0)	−14.03**	10.49	−14.15*	3.77	−9.81	−3.88
	(−2.81)	(0.15)	(−1.68)	(0.69)	(−1.58)	(−0.58)
Industry dummies	YES	YES	YES	YES	YES	YES
PROPENSITY TO TRADEMARK						
Employees (log)	0.18**	0.029	−0.13	−0.018	0.48***	0.17*
	(2.12)	(0.13)	(−0.35)	(−0.06)	(3.00)	(1.83)
Marketing expenses (log)	0.24**	−0.10	0.25*	0.11	0.16	0.22**
	(2.91)	(−0.56)	(1.71)	(1.05)	(1.34)	(2.49)
Continuous innovator (1/0)	1.86**	5.61***	6.21	0.87	13.24***	1.36**
	(2.71)	(5.91)	(0.00001)	(1.15)	(13.35)	(2.18)
Export (1/0)	0.24*	−0.11	−0.40	0.42	0.67	0.18
	(1.07)	(−0.26)	(−0.98)	(0.95)	(1.28)	(0.66)
Industry dummies	YES	YES	YES	YES	YES	YES
Mills' ratio	−11.89	−111.4	−25.28	2.35	21.72	23.83
	(−0.88)	(0.34)	(−0.93)	(0.12)	(1.24)	(1.22)
N	166	46	76	84	87	125

Table A2
Heckman model – Collaborating with Other Businesses.

	Sub-sample: Innovators sourcing knowledge from codified sources	Sub-sample: Innovators not sourcing knowledge from codified sources	Sub-sample: Small firms	Sub-sample: Large firms	Sub-sample: Manufacturing	Subsample: Services
INNOVATION PERFORMANCE						
Employees (log)	−4.72**	1.48	−6.69	−1.53	−11.22	−0.12
	(−2.45)	(0.03)	(0.67)	(−0.61)	(0.39)	(−0.05)
Proportion of employees with a science or engineering degree	19.41**	16.17	−4.10	22.52***	–	2.24
	(2.71)	(0.27)	(−0.36)	(3.44)		(0.25)
Continuous innovator (1/0)	28.83	0.0000001	–	33.44**	–	41.99*
	(1.28)	(0.0000001)		(2.00)		(1.65)
R&D intensity (log)	3.06**	−5.46	8.69***	1.53	1.71	6.60***
	(2.18)*	(−0.24)	(3.34)	(1.26)	(0.59)	(3.60)
PROPENSITY TO PATENT (1/0)	9.24	−4.60	29.13***	−6.35	10.06	8.51
	(1.84)	(−0.08)	(3.22)	(−1.45)	(1.00)	(1.26)
Innovate to offset obsolescence (1/0)	−2.75	12.31	–	−1.75	−9.31	−9.08
	(0.22)	(0.14)		(−0.19)	(−0.35)	(−0.59)
Export (1/0)	−15.11**	88.8	−18.56**	2.41	−22.52	−1.51
	(−2.61)	(0.70)	(−2.26)	(0.33)	(−1.51)	(−0.18)
Industry dummies	YES	YES	YES	YES	YES	YES

(*continued on next page*)

Table A2 (*continued*)

	Sub-sample: Innovators sourcing knowledge from codified sources	Sub-sample: Innovators not sourcing knowledge from codified sources	Sub-sample: Small firms	Sub-sample: Large firms	Sub-sample: Manufacturing	Subsample: Services
PROPENSITY TO TRADEMARK						
Employees (log)	0.19**	0.073	−0.007	0.21	0.28**	0.28**
	(2.24)	(0.23)	(−0.02)	(1.74)	(2.03)	(2.69)
Marketing expenses (log)	0.24**	−0.12	0.27**	0.171**	0.12	0.24**
	(2.94)	(−0.53)	(2.07)	(1.93)	(1.16)	(2.66)
Continuous innovator (1/0)	1.70**	5.89	6.13***	1.034	13.03***	1.49**
	(2.45)	(0.00001)	(6.16)	(1.40)	(17.88)	(2.29)
Export (1/0)	0.34	−0.55	−0.21	0.54**	0.27	0.37
	(1.53)	(−1.06)	(−0.65)	(2.05)	(0.81)	(1.43)
Industry dummies	YES	YES	YES	YES	YES	YES
Mills' ratio	−16.82	−105.5	3.03	3.32	−35.69	6.39
	(−1.12)	(−0.48)	(0.12)	(0.21)	(−0.68)	(0.35)
N	169	45	89	125	84	130

Data availability

The authors do not have permission to share data.

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