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Uncertainty avoidance and the exploration-exploitation trade-off

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Abstract

Purpose – This study aims to investigate how a firm's uncertainty avoidance – as indicated by the headquarters' national culture – impacts firm performance by affecting exploratory (product innovation) and exploitative (brand trademark protection) activities. It aims to show that firms characterized by high levels of uncertainty avoidance may be less competitive in the exploratory product development stage, but may be more competitive in the exploitative commercialization stage by producing more durable brands.

Design/methodology/approach – The study uses data from US Software Security Industry (SSI) trademarks, registered by firms from 11 countries during 1993–2000, that provide 2,911 trademarks and a panel of 18,213 observations. It uses the SSI database to identify the number of product innovations introduced by firms.

Findings – Results show that uncertainty avoidance lowers the rate of product innovation, but helps firms to appropriate more value by greater protection of their brands. Uncertainty avoidance thus creates an exploration–exploitation trade-off.

Practical implications – This study provides useful insights for managers regarding where to locate a firm's front-end development (product innovation) activities and commercialization (brand trademarking protection) activities.

Originality/value – This is the first study to demonstrate the influence of a cultural trait on both explorative and exploitative stages simultaneously. As a methodological contribution, it shows how objective, longitudinal brand trademark data can be used to analyze the long-term impact of marketing activities on firm performance.

Keywords Cross-cultural research, Value appropriation, Trademarks, Longitudinal panel data

Paper type Research paper

1. Introduction

National culture acts as a common frame of reference or logic held by the members of a society (Hofstede, 1980; Saeeda *et al.*, 2015) and exerts its influence on a firms' innovative activity and performance (Melnyk *et al.*, 2014; Menon *et al.*, 1999; Prim *et al.*, 2017; Yang, 2005). National culture may drive a firm's ability or desire to develop and maintain dynamic capabilities and may reward product innovation differently, thus leading to differences in



firm strategies and performance (Yalcinkaya *et al.*, 2007). The increasing globalization of markets and the criticality of innovation for firm performance make the relationship between national culture and innovation an important area for academic research and managerial practice (Kreiser *et al.*, 2002; Lee and Peterson, 2000; Yang, 2005).

Extant research focuses on one important national cultural trait: uncertainty avoidance. A firm's uncertainty avoidance – that is, the degree to which a firm's managers feel threatened by uncertainty and ambiguity, and try to avoid these situations (Hofstede, 1991, p. 113) – limits a firm's creativity and innovation propensity (Shane, 1993). Uncertainty avoidant firms are less willing to take risks (Hofstede, 1980, p. 127), as its managers have a lower tolerance for ambiguity and change (Jones and Davis, 2000) and disfavor unpredictability or change in their lives or work (Efrat, 2014; Kreiser *et al.*, 2010), which results in lower creativity and fewer investments in risky, explorative activities.

Despite strong evidence that uncertainty avoidance negatively impacts a firm's explorative performance during the front-end of new product development (Ambos and Schlegelmilch, 2008; Nam *et al.*, 2014; Prim *et al.* 2017; Shane, 1993; Shane *et al.*, 1995), other research suggests – but this has not been empirically investigated – that it may benefit the exploitative capabilities during the implementation or commercialization phase (Nakata and Sivakumar, 1996; Rank *et al.*, 2004). As firms need to not only engage in explorative activities to create innovative ideas and products but also in exploitative activities to appropriate value from them (Bauer and Leker, 2013; Brexendorf *et al.*, 2015; March, 1991), merely focusing on one part of the innovation process may provide an incomplete picture of how national cultural traits impact innovative activity and performance.

Extant research focuses either on the explorative or exploitative stage, but not on both, and has thus investigated the influence of cultural national traits, such as uncertainty avoidance, in an incomplete fashion. This limits our understanding of how cultural traits may potentially create mixed and opposite effects across stages, and thereby create exploration–exploitation trade-offs. The aim of this paper is to depict a complete picture of a cultural trait's influence on firm's innovation activities by investigating both exploratory and exploitative stages. This delineation of innovation activities may help to explain some of the inconsistencies and mixed findings found in the literature linking cultural traits to innovation (Efrat, 2014; Prim *et al.*, 2017; Soares *et al.*, 2007).

Furthermore, with the exception of Melnyk *et al.* (2014), extant research takes a static approach, as it relies on cross-sectional data (Nam *et al.*, 2014; Prim *et al.*, 2017; Shane *et al.*, 1995), which limits our understanding of how firms, from different national cultures, may differ in how they update their innovation management decisions over time. To address this research gap, this study uses panel data to establish the relationships between a firm's uncertainty avoidance index (UAI), and its explorative (number of product innovations) and exploitative (brand trademark protection) innovation activities, as well as the performance consequences of these activities in terms of a firm's brand and financial performance. The use of trademark panel data helps to establish the marketing–performance relationship in an objective and longitudinal manner, and may overcome some of the problems inherent in using cross-sectional survey data (Podsakoff and Organ, 1986).

By explicating how cultural traits may exhibit themselves during a firm's front-end and commercialization phase of innovation management, we contribute to the literature by analyzing the possible mixed performance effects across stages. Our work thus makes explicit the exploration–exploitation trade-off that multinational firms encounter regarding explorative and exploitative activities, based on a firm's national cultural trait of uncertainty avoidance. As a second contribution, this paper demonstrates how – with the use of panel data on trademarking – the execution and impact of a firm's exploitative marketing

activities can be assessed using objective, longitudinal data gathered directly from registered trademarks, and how mutations in trademarks translate into brand and financial performance. Hence, the study provides a novel approach to linking a firm's marketing activities and capabilities with a firm's performance measures (Morgan *et al.*, 2009).

2. Background and conceptual model

Cross-cultural studies have investigated the impact of national cultural traits on innovation-related activities and outcomes at the country (Prim *et al.*, 2017; Shane, 1993) and firm level (Melnyk *et al.*, 2014; Nam *et al.*, 2014). Such studies find that innovation differs in scale and scope across countries, and that these differences can be explained by the manifestation of national culture within a nation's firms. National cultures influence organizational cultures via the nation's managers, which may influence a firm's innovation strategies and outcomes (Efrat, 2014; Hurley and Hult, 1998).

Hofstede's cultural dimensions are useful tools to explain firms' innovation strategies and outcomes (Budeva and Mullen, 2014; Nam *et al.*, 2014; Prim *et al.*, 2017; Shane, 1993; Soares *et al.*, 2007). Uncertainty avoidance (UAI) is one of the most commonly used cultural dimensions to explain innovation (Sarooghi *et al.*, 2015; Shane 1993; Soares *et al.*, 2007). Uncertainty avoidance is inherently linked to innovation, as it taps into the degree to which a nation's members are prepared to take risks in uncertain and ambiguous situations (Hofstede, 1984). While members of low-UAI societies tend to be more open to change and new ideas, members of high-UAI countries tend to perceive novelty and innovation as dangerous and suspicious and, hence, tend to resist them (Efrat, 2014). Not surprisingly, UAI has been deemed to reduce innovation indicators, including creativity (Fang *et al.*, 2016), patent activity (Ambos and Schlegelmilch, 2008; Shane, 1993), preference for use of champions (Shane *et al.*, 1995), R&D expenditures (Efrat, 2014), R&D productivity (Kedia *et al.*, 1992), product innovation (Nam *et al.*, 2014; Prim *et al.*, 2017) and trademarks (Shane, 1993). The overall empirical findings suggest that UAI tends to decrease innovation outputs, but insignificant or conflicting findings exist (Kedia *et al.*, 1992; Prim *et al.*, 2017).

Extant research has often assumed that Hofstede's dimensions have uniform positive (or negative) effects. Other research, however, suggests that the same cultural trait may produce opposite effects during the explorative and exploitative phases (Hofstede, 2001; Nakata and Sivakumar, 1996; Rank *et al.*, 2004). For instance, Nakata and Sivakumar (1996) propose that *within* the stage of new product development, lower UAI may facilitate the initiation phase through risk-taking and exploration, while hindering the implementation phase through poor planning and control mechanisms. Ambos and Schlegelmilch (2008) propose similar opposite effects of UAI within the exploratory R&D phase. They investigate the patenting performance of augmenting (explorative) and exploitative R&D labs in various cultural environments, and find partial support for their hypotheses. Although exploitation labs perform better in high UAI settings, augmenting labs do not perform worse in environments with low UAI. Finally, Černe *et al.* (2013) demonstrate that Hofstede's cultural trait Individualism has a positive impact during the exploratory front-end phase (a firm's introduction of new products), but a negative influence during the commercialization phase (percentage of total turnover because of a new product or service).

Despite evidence of the mixed role that national cultural traits may play, little is known about how cultural traits may create opposite effects during the exploration–exploitation stages. Thus far, no research has explored empirically how national cultural traits, such as uncertainty avoidance, influence both a firm's explorative and exploitative innovation-related activities and performance outcomes (see Table I). Much research has identified the important limiting role of uncertainty avoidance on explorative activities at the national- or

Author	Purpose	Data	Findings regarding UAI	Explorative Activities	Exploitative Activities	Firm performance	Longitudinal data
Shane (1993)	Testing effect of cultural traits on national rates of innovation in 33 countries in 1975 and in 1980	Patent and trademark data and Hofstede's cultural dimensions	UAI is strongest cultural variable, and reduces a nation's innovation rate	✓ (# patents per capita)	✓ (# trademarks per capita)	—	—
Shane <i>et al.</i> (1995)	Testing relationship between cultural traits and national preference for championing strategies in 30 countries	Survey data and Hofstede's cultural dimensions	UAI leads to lower national preference for champions to work through organizational norms, rules, and procedures to promote innovation	✓ (preference for use of champions)	—	—	—
Garrett <i>et al.</i> (2006)	Exploring how cultural traits impact marketing-R and D integration in new product development in two countries: New Zealand and Singapore	Case study data and Hofstede's cultural dimensions	UAI fosters higher use of formalization but lowers flexibility, risk-taking, and creativity. It also reduces communication and cooperation between functional units	✓ (marketing-R&D integration)	—	—	—
Ambos and Schlegelmilch (2008)	Testing how the fit among R&D laboratory mission and national culture impacts R&D performance in 21 countries	Data set of 139 R&D lab's mission statements and patents and Hofstede's cultural dimensions	Exploitation labs produce more patents per year in cultural environments with high UAI. Augmenting labs do not produce more patents in environments with low UAI	✓ (# patents per year)	—	✓	—

(continued)

Table I.
Illustrative cross-cultural studies on UAI, explorative and exploitative activities and firm performance

Table I.

Author	Purpose	Data	Findings regarding UAI	Explorative Activities	Exploitative Activities	Firm performance	Longitudinal data
<i>Nam et al. (2014)</i>	Testing effect of cultural traits on national rates of innovation of 26,859 firms in 27 countries	World Bank Survey and GLOBE study's scales	UAI leads to lower innovation rates	✓ (innovation initiatives)	—	—	—
<i>Melnyk et al. (2014)</i>	Testing effect of firm's characteristics and national culture on trademark prolongation in 11 countries	Trademark data and Inglehart cultural dimensions	Firm's culture of origin has a systematic effect on the firm's likelihood of prolonging trademarks	—	✓ (prolongation of trademark)	✓	✓
<i>Prim et al. (2017)</i>	Testing effect of cultural traits on national rates of innovation of Global Innovation indices of 72 countries	Global Innovation Index and Hofstede's cultural dimensions	UAI reduces capacity to create and disclose new technology and knowledge, but does not decrease capacity to create new goods and services	✓	—	—	—
This study	Testing effects of UAI on brand performance via exploitative and innovative in 11 countries	Trademark data and Hofstede's cultural dimensions	UAI reduces number of product innovations, but strengthens brand trademark protection, leading to longer trademark life	✓ (# product innovations)	✓ (brand trademark protection)	✓ (brand trademark life)	✓

Notes: ✓ examined in the study, — not examined in the study

firm-level, but has largely neglected its influence on exploitative activities (with the exception of Melnyk *et al.*, 2014). This lack of attention is remarkable given that the activities executed during the commercialization phase comprise about half of the total budget (Pavitt, 1985) and because this stage has the strongest effect on company value (Mizik and Jacobson, 2003). Table I presents an overview of the existent cross-cultural studies on UAI, explorative and exploitative activities, and firm performance.

Based on the ecological imprinting approach (Tüselmann *et al.*, 2002, 2008), we assume that national culture exerts its influence by influencing managers' decisions. When they are founded, organizations take on elements from their environments, which are imprinted as fundamental features of the firm. These features shape the firm's culture, which in turn influences the managers' decisions (Tüselmann *et al.*, 2002, 2008).

We assume that a firm's UAI impacts branding and financial performance via its execution of explorative and exploitative innovation activities. Although some studies use patents to conceptualize the exploratory activities (Shane, 1993), we use a firm's rate of product innovation, as indicated by its number of product innovations. Patents may also indicate a firm's exploratory activities, but they serve more to measure invention rather than innovation, as many patented ideas or technologies never become viable products (Shane, 1993). We identify brand trademarking protection as exploitative activity, as firms use trademarking to secure and exploit the value of their *existent* innovations by protecting their branded innovations against imitation (Melnyk *et al.*, 2014; Shane, 1993). Trademark activities capture a significant portion of a firm's branding efforts and are strong indicators of its efforts to capture value from innovation (Mendonça *et al.*, 2004; Krasnikov *et al.*, 2009).

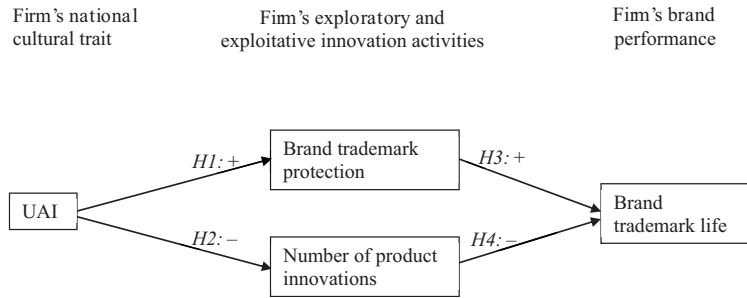
In a next step, we link the exploratory and exploitative innovation activities to a firm's long-term brand performance, as determined by the likelihood of prolonging a trademark: trademark life. Trademark life – the opposite of trademark termination – is a long-term brand performance indicator that represents a firm's continuous investments to distinguish the brand, as well as its prolonged success in making customers uniquely and strongly link the trademark to the brand. Firms engaging in more exploratory activities (product innovation) may face greater difficulties prolonging trademarks, while those engaging in exploitative activities (brand trademark protection) may be more likely to secure their valuable innovation and branding investments by preventing rivals from appropriating the value of owned trademarks through counterfeiting or imitation (Sandner and Block, 2011).

In sum, this paper investigates whether UAI may create opposite effects across stages: by reducing a firm's exploratory activities in terms of the number of product innovations, but by increasing its exploitative activities in terms of brand trademark protection. As such, it is possible to assess how UAI impacts the development of more durable brands and increase branding performance by reducing the number of innovations and increasing brand trademark protection. Our conceptual model is depicted in Figure 1.

3. Hypotheses

UAI is defined as a society's tolerance for uncertainty and ambiguity and indicates the extent to which a culture programs its members to feel either uncomfortable or comfortable in unstructured situations (Hofstede, 1991). In high-UAI societies, members are more risk averse and refrain from activities that involve high risk and uncertainty. As a result, members of high-UAI societies are more likely to experience anxiety when confronted with new and uncertain situations. To deal with uncertainty, high-UAI members tend to have a stronger need for protection and a desire for rules and laws (Efrat, 2014). They favor high levels of formalization and hierarchical organization structures to attain order and control (Hofstede, 2001).

Figure 1.
Conceptual model



Following Melnyk *et al.* (2014), who establish a link between a firm's culture and its trademarking effort, we hypothesize that UAI impacts brand trademark protection by influencing the firm's level of risk-taking and the corresponding need for protection. Higher levels of UAI prompt firms to more strongly distinguish and protect their new brands. As these firms have a stronger need for unambiguous, written rules and regulations (Hofstede, 1983), they favor trademarking as a formal protection measure. Trademarks provide them with a legal anchor to protect the brand from drifting away from its owner's control (Phillips, 2003) and allow them to control a brand's development and exploit its brand exclusivity.

To reduce the risk that competitors will imitate their branded innovations or use similar brand associations, uncertainty avoidant firms place great emphasis on producing brands that are protected by a greater diversity of trademark elements (richness) and for more potential product categories (breadth). With the aim of increasing brand protection, we expect that high-UAI firms place greater emphasis on investing in more and richer use of trademark elements, such as words, colors, sounds and movies, to more strongly protect and distinguish the brand from competition, as it makes it more difficult for the competition to imitate and dilute the clear brand positioning (Pullig *et al.*, 2006). Similarly, we expect high-UAI firms to have a stronger desire to protect the trademarks beyond their own product category to avoid potential brand dilution with competitors in related product markets (Pullig *et al.*, 2006). These high-UAI firms want to avoid a situation where a brand trademark cannot be expanded to new product categories, because a competitor has already claimed a similar trademark in the new product category. Hence, we expect high-UAI firms will aim to more strongly protect their brands.

H1. Greater uncertainty avoidance in the firm's national culture leads to greater brand trademark protection.

Extensive support exists that shows that uncertainty avoidance limits a firm's creativity and reduces its innovation propensity (Ambos and Schlegelmilch, 2008; Nam *et al.*, 2014; Shane, 1993; Shane *et al.*, 1995). In low-UAI firms, managers demonstrate greater ease with unfamiliar situations and are assumed to be more tolerant of different ideas, approaches and concepts. In low uncertainty avoidant cultures, intra-organizational dissent is celebrated and does not threaten the organization's survival (Ambos and Schlegelmilch, 2008), while in high-UAI cultures, severe sanctions are imposed on those who deviate from the social norms (Erez and Nouri, 2010). Such normative cultural environments restrict improvisation and experimentation and lead to lower creativity and innovation levels. Similarly, Geletkanycz (1997) found that executives from cultural backgrounds high in UAI prefer a more stable

and conservative organizational environment that adheres to the status quo and does not innovate.

Innovation is a risky activity because it is subject ex-post, i.e. after the R&D investment is sunk, to at least two types of risks: a technology risk (i.e. the risk that the product is not technologically feasible) and a market risk (i.e. the risk that consumers will not accept the new product). A firm whose culture facilitates the acceptance of uncertainty favors its innovativeness, as innovation requires a high tolerance for risk. Hence, firms from a country of origin with a low UAI are more comfortable with novel and uncertain situations and are more likely to experiment and invest in risky R&D, which leads to a higher number of product innovations (Artz *et al.*, 2010).

H2. Greater uncertainty avoidance in the firm's national culture leads to a lower number of product innovations.

According to Park *et al.* (1986), the brand concept should be viewed as a long-term investment that has been developed and nurtured to achieve a sustainable competitive advantage because the successful development of an initial brand image has long-lasting effects for the life of the brand. Extant research has already shown that firms that are more protective and use stronger trademark protection achieve greater financial performance and firm value via the meaningful distinction of the brand against competitors (Krasnikov *et al.*, 2009; Sandner and Block, 2011). Greater trademarking efforts are associated with higher brand awareness and stronger brand associations and, hence, increase brand equity (Keller, 1993; Krasnikov *et al.*, 2009). Consumers react more positively and strongly toward the same marketing efforts and demonstrate greater customer loyalty for brands with higher brand equity (Krasnikov *et al.*, 2009). They are less prone to attitude change (Pham and Muthukrishnan, 2002) and are less vulnerable to competitors' persuasion attempts (Pechmann and Ratneshwar, 1991).

Firms with greater brand trademark protection more strongly secure their valuable investments made in brands by preventing rivals from unfairly appropriating the value of owned trademarks through counterfeiting or imitation (Sandner and Block, 2011). Competitors will face greater difficulties in directly challenging firms that use a richer set of trademarks and that extend the trademark to multiple product categories. Hence, greater brand trademark protection should extend the duration of trademarks because it reduces the overall imitation threat.

Although empirical research has established support for the link between trademarking efforts and financial performance, it has not yet explored the link between a firm's brand trademarking activities and the lifetime of individual trademarks. This relationship is important for exploring and understanding the mechanism through which trademark protection efforts influence brand performance. We hypothesize that firms that more strongly engage in exploitative trademarking activities generate more durable brands. That is:

H3. Greater brand trademark protection increases the lifetime of a brand trademark.

Although product innovation is generally beneficial for financial returns (Artz *et al.*, 2010), the frequent introduction of new products presents challenges for trademark protection. A high frequency of innovation implies a disruption of the existing connections between brand trademarks and products. Not surprisingly, innovative firms are more active users of trademarks, as they often register new trademarks for their newly introduced products and services (Mendonça *et al.*, 2004). The introduction of more product innovations implies that firms will have to make more frequent adjustments regarding their existent trademarks, as

innovations may introduce new product advantages and may require the protection of new associations via trademarks. Furthermore, owing to the firm's continuous stream of new products that are accompanied by new slogans, logos and other trademark elements, consumers face greater difficulty in establishing a strong association between the firm's trademark(s) and its products, as it requires cognitive effort to update existent associations stored in consumer memory. Hence, innovative firms face greater difficulties in establishing strong brand associations, which lowers the incentive to invest in the continuation of individual trademarks. Highly innovative firms are, therefore, hypothesized to have a higher rate of brand turnover with a shorter lifetime for their brand trademarks.

H4. A higher number of product innovations decrease the lifetime of a brand trademark.

4. Methodology

4.1 Industry and sample

We selected the Software Security Industry (SSI) as the setting for our study because it is an industry for which brands and innovation are crucial. The SSI is an important industry considering its sheer size: The world market reached US\$22.1 billion in sales in 2015, up from US\$21.3 billion in 2014 (Gartner, 2016). The USA constitutes a large part of the global market sales; together with Western Europe and mature Asia Pacific, these three markets account for approximately 83 per cent of SSI world revenues (Gartner, 2014). Currently, the industry features a wide range of products, from basic security software (e.g. virtual private networks, firewalls and virus scanning) to advanced security services (e.g. public key infrastructures, security certifications and penetration testing).

As the introduction phase of the SSI in the 1990s during which R&D expenditures and the rate of product innovation were high, the industry has matured and shifted toward a phase where both R&D and marketing are important. With a greater number of product offerings on the market, it becomes more difficult, but also more relevant, for firms to meaningfully distinguish and protect their new product offerings. In such highly competitive environments, brands are crucial, especially in terms of security and reliability reputations. A sales executive for IBM succinctly notes: "[M]any times, in security software, customers are brand driven" (ENT, 2001, p. 12). For example, Check Point, the world leader in firewalls, "has name recognition among everyone [. . .] people buying a security solution think they can't go wrong buying Check Point. It has a lot of mind share out there" (Computer Reseller News, 2001, p. 54). Because products in the industry have short lifecycles and new threats are continuously arising, strong brand knowledge can help firms extend their reputation over different generations of products (Qian and Li, 2003). Brand trademark protection is of vital importance because fierce competition has forced firms to increase the protection of their brands against the encroachment by copycats (Roster, 2014). Not surprisingly, firms within these information-intensive service sectors are heavy users of trademarks (Mendonça *et al.*, 2004).

Innovation is also very relevant in the software industry given the launches of brand new products, and product line extensions, and its linkage to competitive advantage (Shapiro and Varian, 1998). We select our sample with a simple but specific criterion: Firms must have at least one security algorithm patent. As such, we select firms that have the ability to independently produce and market a new technology or product, and that are able to compete in the product downstream market. We rely on the LECG Corptech Patent database (www.lecg.com), which includes approximately 80,000 software patents granted by the US Patent and Trademark Office (USPTO) between 1976 and 2000. We select all patents in US technological classes 380 (Cryptology) and 705, subclasses 50-79 (Business Processing Using

Cryptography), which produced a sample of 87 multinational firms with at least one patented technology that were active in SSI during the period 1993-2000. They represent 11 countries: Canada, Finland, France, Germany, India, Israel, Japan, South Korea, Taiwan, The Netherlands and the USA. We combine this information with the SSI database, which includes all SSI product introductions obtained from the Gale Group's Infotrac Promt database – a new version of the Predicast database that has appeared in several earlier studies (Pennings and Harianto, 1992).

4.2 Cultural imprinting by multinationals' headquarters

Our sample of 87 multinational firms has indigenous firms operating in the US market. This study assumes that the headquarters' national traits play a pivotal role and strongly impact the execution of explorative (product innovation) and exploitative (brand trademarking) activities of the indigenous firms. The vast majority of multinationals use an internationalization strategy with low foreign investment (Melin, 1992) and use trading firms to distribute finalized software products rather than establishing US subsidiaries (Giarratana and Torrisi, 2010). But even when multinationals have subsidiaries, their headquarters often remain the primary source of ownership and maintain control over their subsidiaries (Beck *et al.*, 2009). Hence, the imprinted cultural norms and values from the multinational's home country influence the managerial decision-making of subsidiaries (Efrat, 2014). Multinational software firms often centralize activities to develop new software products in close vicinity of the headquarters to prevent valuable information leaking to competitors, and because it involves core activities that are essential for long-lasting success (Bartlett and Ghoshal, 1989). Multinational firms also tend to standardize branding activities in their internationalization strategy, as they are important for the creation of a coherent corporate identity and often involve strategic decisions with long-term effects (Melewar and Saunders, 1999). Thus, we expect the actions of the indigenous firms to be orchestrated and strongly influenced by the home country's national culture.

4.3 Data and descriptive statistics

We collect US trademark data using the USPTO, as it represents the world's most important office for brand protection in the SSI. The data set comprises a census of all the trademarks registered by our 87 firms in the sample period in the SSI in the USA. For each of 2,911 trademarks[1], which combine various elements, such as words, sounds and logos (see <http://tess.uspto.gov>), we extract information on the year of its introduction (i.e. registration) and its date of termination, if any. In contrast to patents that have limited life rights, a trademark can be renewed perpetually as long as it remains in commerce, and the maintenance fees are paid. If firms do not renew or cancel the trademark, they lose their registered trademark. This study determines that the firm's trademark life *ends* when the registered trademark is either not renewed or is cancelled voluntarily. The continuation or termination of the life all trademarks is observed within a time window of eight consecutive years, leading to a total number of 18,213 trademark observations. All the trademarks that die during our sample period are voluntarily cancelled by the companies.

4.3.1 Uncertainty avoidance index. We collect Hofstede's UAI scores (Hofstede, 1991) for the 11 countries of interest. In our sample, the UAI variable has a mean of 51.09 and a standard deviation of 14.10, ranging from a minimum of 40 to a maximum of 92. To test the effects of UAI on exploratory and exploitative activities, we use a median split.

4.3.2 Brand trademark protection. Brand trademark protection measures a firm's intensity to protect their products via trademarks. It comprises two components that capture the richness of methods used in the trademark (trademark richness), and the scope to which

it is protected (trademark breadth). Such composite measures eliminate some of the invalidities and biases that exist for using single-dimension output measures. To measure brand trademark richness, we use the score provided by USPTO. USPTO uses six codes to indicate the different types of marks, such as relatively simple forms like “typed drawings” to richer forms like “sound and image”. Rather than performing the challenging task of assigning the richness of individual trademarks, we simply assume that the simplest form is the first one (1 “TYPED DRAWING”) and it increases as the USPTO categories increase up to the last one (6 “SOUND AND IMAGE”). The assumption is that a video with sound and image is more difficult to replicate than, for example, a word in a special color and font art or simply a word without any special font or color. In our sample of trademarks, brand richness ranges from 1 to 6 with an average of 1.35 (SD = 0.93).

To measure brand trademark breadth, we look at the US product classes for which firms have asked protection. From a total of 60 available sectors, our sample trademarks span from 1 (a trademark protected in just one sector) to 10 (a trademark protected in 10 different sectors); its score ranges from 1 to 10 with an average of 3.67 (SD = 2.47). The overall brand trademark protection variable constitutes the sum of trademark richness and trademark breadth and ranges from 2 to 15 with an average of 5.02 (SD = 2.63). The reasoning behind this measure is that we assume that firms increase brand trademark protection when they increase in terms of richness according to the USPTO scale codes (trademark richness) and when the trademark is extended to more product category domains (trademark breadth). In other words, the two measures capture a similar propensity of a focal company to increase the protection of a trademark, thus the unified summing variable. In doing so, the firm makes it more difficult for competitors to imitate the brand name and offering.

4.3.3 Number of product innovations. We measure innovation activity by counting a firm’s number of product introductions. In particular, we use the SSI database which includes information on software security product introductions. We count the number of introductions that refer to new products and exclude new versions of existing products, such as “Version 2.1” of the Norton Security System.

4.3.4 Brand trademark life. Brand trademark life indicates whether the trademark remains active. The brand trademark life ends when the trademark is no longer in use and is terminated by the firm. By observing each year whether a trademark is still alive or not, we can infer the drivers of trademark life.

4.3.5 Control variables. As control variables, we include several firm characteristics, such as firm fixed assets and age, as proxies for size and experience; the firm solvency ratio (shareholder funds/total assets) as a proxy for firm risk; firm marketing intensity (marketing expenditures/sales); and the trademark age in years (year of running observation – year of trademark filing) (see [Krasnikov et al., 2009](#)). We calculate trademark age based on the year of the initial filing and the observation. We gather financial variables from Securities and Exchange Commission filings and Bureau Van Dijk’s data sets: Jade (Asia), Amadeus (Europe) and Icarus (USA). All variables are time-variant. As some variables demonstrate skewed distributions, we use log values for the non-dummy variables to reduce heteroskedasticity.

Table II provides the simple descriptive statistics. **Table III** provides *t*-tests of sample mean differences when using a median split to classify the observations according to high and low value of UAI. The high UAI subsample shows higher trademark age and protection, and a lower number of product innovations. These results provide initial evidence that higher UAI leads to stronger brand trademark protection.

Table II.

Descriptive statistics
of panel data sample

Variable	Mean	SD	Minimum	Maximum
<i>Dependent variables</i>				
Number of product innovations	0.465	1.588	0	8
Brand trademark protection	5.029	2.635	1	15
<i>Independent variables</i>				
UAI	51.090	14.108	40	92
Marketing intensity	0.095	0.066	0	0.598
R&D intensity	0.112	0.035	0.047	0.187
Fixed assets	8237095	14400000	100	4.70E+07
Firm age	34.976	30.284	0	123
Solvency ratio	1.042	0.917	0.456	2.654
Trademark age	46.104	67.812	0	108

Variable names	Low UAI	High UAI	Mean difference
Brand trademark protection	4.982	5.344	0.362**
Number of product innovations	0.539	0.329	0.210**
Trademark age	3.787	4.204	0.417**

Table III.

Mean differences
between low and
high UAI

Notes: A median split is used for Low UAI and High UAI. Two-sided *t*-tests are reported; ** $p < 0.05$

4.4 Data analysis

We first estimate two equations to test the effect of UAI on the strength of brand trademark protection (*H1*) and number of product innovations (*H2*). Second, we insert the *predicted* values of these equations into a final regression to test *H3* and *H4*, and see how these values affect brand trademark life. To estimate brand trademark life, we estimate a piecewise exponential hazard model that predicts the hazard of whether a focal trademark will die.

5. Results

5.1 Hypotheses testing

In support of *H1*, Table IV provides evidence that higher UAI countries rely more strongly on brand trademark protection ($\beta = 0.008$, SE = 0.001, $p < 0.05$). The controls also exhibit

Dependent variable	Brand trademark protection	
	Model I	Model II
UAI		0.008** (0.001)
Marketing intensity	2.106** (0.271)	2.838** (0.287)
Fixed assets	-0.009** (0.002)	-0.005** (0.001)
Firm age	-0.001 (0.000)	-0.002 (0.009)
Solvency ratio	0.407 (0.389)	0.421 (0.380)
Constant	7.128** (1.781)	4.896** (1.803)
Observations		18,213
Firm fixed effect		YES
R^2	0.420	0.427

Table IV.

OLS Regression
predicting brand
trademark protection

Note: ** $p < 0.5$

the expected effects: higher marketing intensity leads to greater brand protection. Fixed assets negatively impact brand trademark protection, while firm age and solvency ratio do not significantly influence the level of brand trademark protection.

In support of *H2*, Table V shows the results of the negative binomial regression predicting the number of product innovations and confirms that firms in higher UAI countries tend to produce fewer product innovations ($\beta = -4.251, p < 0.05$). Regarding the controls, we find that R&D intensity and a firm's fixed assets have a positive impact on the frequency of product launches, which is a confirmation of the presence of scale and scope economies. Firm age has instead a negative impact, suggesting that older firms innovate less frequently and rely on a more mature portfolio of products.

In our final estimation, we run a hazard model that predicts the probability of terminating a brand trademark using the predicted values of brand trademark protection and product innovation (see Table VI). This model represents the hazard of a focal trademark termination (the opposite of brand trademark life). Positive betas higher than 1 indicate a higher hazard of termination, while lower than 1 indicate a lower hazard of termination (i.e. the logarithm of a number between 0 and 1 is negative). The results support

Table V.
Negative binomial regression predicting number of product innovations

Dependent variable	No. of product innovations	
	Model I	Model II
UAI		-4.251** (2.054)
R&D intensity	11.559** (5.004)	12.547** (4.258)
Fixed assets	0.621** (0.061)	0.520** (0.066)
Firm age	-0.241** (0.009)	-0.230** (0.100)
Solvency ratio	-0.256 (0.546)	-0.325 (0.412)
Constant	-2.325** (0.128)	4.252* (1.668)
Observations		682
Dummy time		YES
LogL	-621.253	-618.215

Notes: * $p < 0.10$ and ** $p < 0.05$ significance levels. Robust heteroskedastic standard errors in parentheses

Table VI.
Piecewise-constant hazard rate model of trademark life

Dependent variable	Trademark life		
	Model I	Model II	Model III
Predicted brand trademark protection		0.767** (0.018)	0.808** (0.019)
Predicted number of product innovations	1.757** (0.033)		1.711** (0.032)
Marketing intensity	0.409** (0.154)	0.405 (0.421)	0.630 (0.441)
Fixed assets	1.005** (0.003)	1.001** (0.002)	1.004** (0.002)
Firm age	1.012** (0.001)	1.015** (0.001)	1.013** (0.001)
Solvency ratio	0.518 (0.625)	0.554 (0.587)	0.456 (0.812)
Trademark age	1.512** (0.052)	1.486** (0.046)	1.424** (0.045)
Observations		18,213	
Dummy year		YES	
LogL	3298.77	3331.13	3129.34

Notes: The hazard model represents the probability of trademark termination. Hence, a positive coefficient means quicker termination. Conversely, a negative coefficient implies longer prolongation. Betas higher (lower) than 1 indicate higher (lower) probability of termination. Standard errors in parentheses; ** $p < 0.5$

H3, as brand trademark protection increases the brand trademark life ($\beta = 0.808$, $SE = 0.019$, $p < 0.05$), and *H4*, as the number of product innovations decreases brand trademark life ($\beta = 1.711$, $SE = 0.032$, $p < 0.05$). In global terms, firms with high levels of UAI tend to compete through better development and protection of their trademarked brands and lower innovation tendency, which allow their trademarks to last longer. In terms of controls, firm fixed assets positively impact trademark life, while trademark age does so negatively. The positive impact of trademark age on trademark *cancellation* can be explained by the positive relationship between product age and termination likelihood (Khessina and Carroll, 2008). Solvency ratio and marketing expenditures do not significantly impact brand trademark life.

5.2 Additional and robustness checks

Although the results provide convincing empirical evidence of the impact of UAI on brand trademark life, researchers could question whether brand trademark life drives firms' financial performance. To address this concern and ascertain the important role of brand trademark life, in Table VII, we perform a firm-level regression to test the relationship between the average age and size of a firm's trademark portfolio and a standard measure of financial performance (return on sales). Controlling for firm and time-fixed effects, we find a positive relationship between financial performance and the average age of the trademark portfolio. As brand trademark life helps to increase the average age and size of a firm's trademark portfolio, it is indeed a meaningful performance indicator for branding activities that has important financial performance consequences.

To further check the robustness of our findings, we check the existence of non-linearity in our estimation by introducing square terms. The square terms for UAI and the number of product introductions are not significant, while the square term for brand trademark protection is significant at the 10 per cent level with a value of 1.015, suggesting a decreasing return effect of brand trademark protection.

To assess whether the uncertainty index drives our results and not any of Hofstede's other cultural traits, we replaced the uncertainty index for Hofstede's other cultural indices (masculinity, power distance and individualism). In a series of tests, we find that none of the other cultural variables exert any influence on brand trademark protection and number of product innovations (all p 's > 0.10), lending support to the important and specific role of uncertainty avoidance.

Although Hofstede's cultural dimensions are often used in the literature, other cultural classifications exist. As an additional check, we also performed the regressions using another cultural measure for UAI that resembles the uncertainty avoidance aspect. Specifically, we substituted UAI with the UAI measure "As Is" from GLOBE's data set (House *et al.*, 2004). GLOBE's UAI "As Is" captures the extent to which a society relies on social norms and rules to avoid unexpected events. Hofstede (2006) finds a negative correlation between Hofstede UAI and GLOBE's "As Is" values. In our data set, the UAI "As Is" measure has an average of 4.13 ($SD = 0.14$). In line with the negative association between

Dependent variable	Return on sales
Average age trademark portfolio	0.080** (0.013)
Total number of trademarks in portfolio	0.002** (0.000)

Notes: * $p < 0.10$ and ** $p < 0.05$ significance levels. Time and firm fixed effects included. $R^2 = 0.679$

Table VII.
Regression
predicting return on
sales

Hofstede's and GLOBE's UAI "As Is" variable, we find that it predicts brand trademark protection negatively ($\beta = -1.361$, $SE = 0.110$, $p < 0.05$) and the number of product introductions positively ($\beta = 2.546$, $SE = 0.231$, $p < 0.05$), while all the other variables maintain their signs and significance globally. Results, therefore, remain the same when using a different measure than Hofstede's UAI, which adds to the robustness of our findings.

6. Discussion and conclusions

6.1 Conclusions

This study analyzes the relationship between a cultural attribute, Hofstede's UAI, and the explorative and exploitive activities of a sample of firms active in the US security software industry. Using a data set on the trademarks and innovations of firms with different national backgrounds that operate in the US market, we find that UAI exerts its influence by altering the number of product innovations and the level of brand trademark protection. When analyzing these effects on an important brand performance measure, brand trademark life, we find that UAI has a positive impact on the survival probability of trademarks via two mediated effects: UAI lowers the number of product innovations, which, in turn, has a negative impact on brand trademark life, but increases brand trademark protection, which extends brand trademark life. Although previous literature focused mainly on the negative effect of high levels of UAI during the exploratory phase (Nam *et al.*, 2014; Shane, 1993; Shane *et al.*, 1995), we demonstrate that in a competitive, high-tech sector, UAI can improve economic returns by enhanced branding activity through a more effective protection and survival of brands. Thus, we demonstrate that cultural variables do not uniformly influence innovation performance outcomes, and that focusing on either the exploration or exploitation phase may provide an incomplete picture, as the same cultural trait can produce opposite effects across phases.

In terms of trademark literature, our study confirms earlier findings that trademark data are useful to explain firms' focus on exploitative innovation activities (Mendonça *et al.*, 2004; Srinivasan *et al.*, 2008) and that the use of trademarks can improve financial outcomes (Krasnikov *et al.*, 2009). By focusing on the trademark life of *individual* trademarks rather than focusing on firms' portfolios of trademarks (Krasnikov *et al.*, 2009; Srinivasan *et al.*, 2008), we demonstrate the mechanism of how a firm's national culture may indirectly, via a firm's explorative and exploitative activities, influence a firm's ability or desire to prolong or dismiss single trademarks, and, in turn, influence long-term brand performance. Our results show that a firm's national cultural trait, UAI, is imprinted in the marketing and R&D departments and impacts strategic decisions about the protection of brands and product innovation. Firms with a higher UAI use a richer set of trademark forms (sound and image instead of simple typed drawings), and apply for trademarks in a greater number of product categories; this increased commitment toward using trademarks to protect their brands prolongs the use of a trademark for a longer period. Furthermore, we find that firms with a higher UAI introduce fewer product innovations, which may extend trademark life. This may also explain why trademark use is higher for innovative firms than for less innovative firms (Mendonça *et al.*, 2004). Highly innovative firms also want to protect their innovations using formal means, but the higher number of product launches leads to shorter brand trademark life, which forces them to frequently update the protection of their innovations with new trademarks.

Finally, we advance the field of measuring the financial returns of an individual firm's marketing actions (Morgan *et al.*, 2009; Srinivasan *et al.*, 2008) by showing – at the brand trademark level rather than at the brand portfolio level (Krasnikov *et al.*, 2009) – that a greater protection via breadth and richness enhances the long-term brand performance

(brand trademark life). This approach may produce more fine-grained insights into the cost-effectiveness of brand trademarks, especially when the benefits can be related to the costs of maintaining these individual trademarks. This way of measuring the effects of trademarking also provides an opportunity to cross-validate earlier studies, as well as complement some of the findings of survey studies (Hurmelinna-Laukkanen and Puumalainen, 2007).

6.2 Managerial implications

Our findings have several managerial implications. Traditional literature has noted disadvantages for firms embedded in high UAI cultures that function in innovation-based sectors, but our findings suggest a useful complement. Such firms may suffer competitive weaknesses in terms of product innovations, but they also possess a counterbalance, in the form of their branding activities and brand performance. This strategy is particularly effective for sectors with very short lifecycles, such as the SSI, for which the implementation phase is important (Nakata and Sivakumar, 1996). In highly turbulent environments when there is little time to create radically new marketing strategies, high UAI firms can gain competitive advantages because they better protect and create longer lasting brands. To counterbalance the limiting effect on innovation, high UAI firms might benefit from consolidating the power and extendibility of their brands and might invest in low-risk R&D investments, such as product versioning (i.e. introducing new versions of existing products), while still fostering marketing efforts directed at creating long-lasting brands, stretched into horizontal or vertical extensions (Pitta and Prevel Katsanis, 1995). To benefit even more, multinational corporations – when the division between activities is possible – can take on a dual role (Hofstede, 2001), such that they develop ideas and new products using low-UAI entities for explorative activities, and then perform the exploitative activities, such as trademarking by high-UAI entities with high uncertainty-avoidance that are characterized by precision and punctuality.

Despite the positive effects of trademarking, our research findings also suggest that firms may be too committed to brand trademarking. The decreasing returns of brand trademark protection on trademark life suggest that increasing the lifetime of brand trademarks is no longer possible after a certain point, and that further increases lead to a higher likelihood of the termination of brand trademarks, lowering the financial returns. Our results also suggest that highly innovative firms face difficulties in generating durable brands, and capturing the financial returns from trademark protection. Launching many products is a costly strategy, as new products often require new trademarks. To make effective use of trademark protection, firms need to make substantive marketing investments to develop consumer associations with these new trademarks. Highly innovative firms thus need to assess whether the additional revenues created by product innovations are worthwhile given the additional costs of protecting these innovations via trademarking and the shorter trademark life.

6.3 Limitations and future research

Our research has certain limitations that must be addressed, and that may guide future research. Our findings are based on the US SSI using a sample of 87 firms from 11 countries. Future research needs to assess whether our findings are generalizable to other (e.g. low-tech) industries with varying levels of branding importance, using a sample with a greater number of countries.

Based on the ecological imprinting approach, we assume that the headquarters' national culture impacts the marketing and product innovation activities of the indigenous firms

located in the USA. Given the executional nature and low influence of these firms on the decisions made at headquarters, this assumption is likely to hold. Future research could still extend this research to multinationals that provide subsidiaries with discretionary power over their branding activities. To extend these findings to a strategic alliance context, future research can explore whether there are abnormal returns for joint ventures between firms where the exploratory activities are performed by partners low on UAI while exploitation activities are run by partners with high UAI, as compared to joint ventures in which the partners' UAI does not perfectly match their type of task.

Regarding the selection of firms, we only selected those firms with patents. Although this research strategy is not uncommon, as firms may simultaneously use patents and trademarks (Sandner and Block, 2011), this may have biased our findings toward firms that have intellectual property rights (IPR) divisions or that prefer formal protection over informal mechanisms. Furthermore, to measure the impact of UAI, we used trademark protection as an indicator of a firm's exploitative activity, but we did not investigate whether substitute or complementary effects may exist between the use of trademarks and other IPR protection mechanisms, such as copyright and patents (Graham and Somaya, 2006).

Regarding the measurement of brand trademark protection, we simply assume that it is a composite measure that results from trademark breadth and richness. Future research may assess the dimensionality of brand trademark protection[2], and – if the concept is multi-dimensional – assess whether the different dimensions of brand trademark protection may yield different branding and performance outcomes.

Finally, we assumed that brand trademarks provide value to a firm, but we did not have specific data on a firm's (perceived) value of individual trademarks and how strongly the firm protects trademarks after registration. Sandner and Block (2011) find evidence that the value of trademarks may differ across and within industries, and that companies more vigorously protect trademarks against rivals when they are considered to be more valuable. The use of surveys to collect data on the value of and a firm's effort to protect individual trademarks may complement this and other trademark panel data studies.

Notes

1. We select all software trademarks by our sample firms that include, in their brand descriptions, the terms "security," "antivirus," "protection," "reliability," or "firewall."
2. We thank the reviewer for highlighting this suggestion.

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