Gear Manufacturers as Contestants in Sport Competitions:

Breeding and Branding Returns

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Abstract

Several manufacturers make substantial investments to contest in sport competitions, using the gear they develop and market. However, no systematic analysis of the breeding (i.e., innovation) and branding (i.e., marketing) returns from such investments exists. In this study, the authors conceptualize and empirically estimate the breeding and branding returns such manufacturers obtain. They gather data for 30 car brands of 16 manufacturers over the period 2000-2015 regarding their participation, spending and performance in Formula One championships, annual patent citations, and R&D budgets as well as monthly vehicle registrations, advertising expenditures, and F1 TV-viewership. The authors find that only gear manufacturers with relatively high levels of R&D spending obtain a positive and significant breeding return from contesting in sport competitions. While most brands obtain positive branding returns, the lower the level of advertising spending for the brand, the greater the branding returns from contesting in competitions. Thus, research-intense gear manufacturers have more to gain from contesting in sport competitions, as compared to advertising-intense gear manufacturers. These findings may guide manufacturers in budget allocation decisions on sport competitions, R&D, and advertising.

Keywords: breeding effects; branding effects; competition; innovation performance; sales performance; advertising spending; R&D spending.
Many firms are sport sponsors in one way or another. Marketing researchers have posed a historical interest in examining the *branding* returns from such sponsorships and have shown that professional sport sponsoring increases the brand’s exposure, recall, recognition, affect, trust, loyalty, and sales (e.g., Chung, Derdenger, and Srinivasan 2013; Jensen and Cobbs 2014; Mazodier, Henderson, and Beck 2018; Mazodier and Merunka 2012; Olson and Thjømøe 2009; Speed and Thompson 2000; Walraven, Bijmolt, and Koning 2014). However, in quite a few cases, firms’ interest seems to go beyond such branding returns to achieve what we call *breeding* (i.e., innovation) returns from athletes using their gear in sport competitions.

Such breeding returns, beyond branding returns, from involvement in sports can be most easily envisioned in cases where gear manufacturers choose to go beyond mere sponsoring and become a contestant in a sport competition. A contesting manufacturer participates with its own team that uses the manufacturer’s gear, and competes head-to-head against other participating contestants. Gear manufacturers may use the extreme conditions under which athletes in the team use their gear and closely cooperate in developing and testing new technologies that may improve the contesting team’s performance, entailing breeding returns. Moreover, branding returns from contesting may be different from branding returns from mere sponsoring. For example, one may envision that the performance of the firm as a contestant may affect its branding return.

The breeding and branding returns firms may obtain from gear contesting in sport competitions is relevant to many firms. Race bike manufacturer Trek invests $14 million annually to contest with its Trek-Segafredo team in the UCI World Tour (Stokes 2015), car manufacturer Daimler invests around $200 million annually to contest with its Mercedes-AMG Petronas Motorsport team in Formula One (F1) Championship (Sylt 2018a), and ski manufacturer Atomic invests around $9 million annually to compete with its own team in the FIS Alpine Skiing World Cup (Sempelmann, Lampl, and Kramer 2018). Competing firms
may invest varying amounts in such sport competitions, as well as with varying success, both of which may affect their breeding and branding returns. The allocation of resources to contesting in sport competitions is likely not independent of the firm’s investment in other areas, of which R&D and advertising seem most relevant as one considers the breeding and branding returns of contesting. This, in turn, raises the question whether breeding and branding returns depend upon the firm’s R&D and advertising spending. Our key research question is therefore the following: To what extent do gear manufacturers contesting in sport competitions gain positive outcomes in terms of breeding, branding, or both, and are these outcomes contingent on the gear manufacturer’s R&D and advertising spending?

To the best of our knowledge, so far no study has conceptualized or systematically analyzed both branding and breeding returns gear manufacturers obtain from contesting in sport competitions, nor whether such returns depend upon the manufacturer’s R&D spending (for breeding returns) and advertising spending (for branding returns). This is what the current study aims to offer. Analyzing breeding and branding returns are of great interest to marketing managers, analysts and academics as they relate to accountability of board-level strategic investments (e.g., Rust, Lemon, and Zeithaml 2004).

Empirically, we constructed a novel data set on car manufacturers’ participation, spending, and performance in the F1 World Championship. Our sample consisted of 30 automobile brands sold by 16 car manufacturers, among which ten brands from nine car manufacturers contested in F1 at least at some point during our sample period 2000-2015. To examine the breeding effect, we supplemented F1 data with information on these 16 manufacturers’ R&D spending, and on their innovation performance measured in terms of patent citations. To investigate the branding effect, we obtained the brands’ advertising spending and the brand’s sales performance in terms of number of vehicle registrations in five countries (France, Germany, Italy, Spain and the U.K.).
Our study provides the following new insights. First, contesting in sport competitions and R&D spending are complements. Contesting in sport competitions generates a significantly positive breeding return only for gear manufacturers with relatively high levels of R&D spending (more than €3.8 billion annually in our F1 context). Second, we find that contesting in F1 and advertising spending are substitutes. Brands with low levels of advertising budget obtain greater branding returns from contesting in sport competitions than those with high levels of advertising budget. While all brands in our sample obtain positive branding returns from participating and increasing their spending in F1, only brands with less than €10.6 million in monthly advertising benefit from improving their performance in F1. In sum, research-intense gear manufacturers (i.e., firms that spend heavily on R&D, but limitedly on advertising) have more to gain from contesting in sport competitions, as compared to advertising-intense gear manufacturers (i.e., firms that spend little on R&D, but heavily on advertising).

This paper contributes to the existing literature in several ways. First, it shows firms may obtain breeding and/or branding returns from their involvement in sport competitions, while the past literature only examined branding returns and, thus, offers only a partial view, at best. Second, it conceptualizes contesting by a firm in a sport competition as inherently different from merely sponsoring. It also provides an analytical framework for estimating the returns for contesting firms and provides the first estimates of such returns ever reported in the scholarly literature. Third, we show that returns from contesting in sport competitions cannot be assessed without accounting for other related decisions of the respective firms, such as R&D and advertising spending. Fourth, for brand exposure, we are the first to empirically demonstrate saturation effects to occur even across greatly dissimilar exposure vehicles (in our case, car advertising and F1 contesting by car manufacturers). This complements prior literature that has demonstrated such saturation effects only among fairly similar exposure
vehicles (e.g., Vakrata and Ambler 1999). It may also contradict managerial practice to leverage sport investments with greater advertising spending.

The findings in this paper are relevant to managers and analysts in the automotive industry specifically (including tier 1 suppliers), but also to other sport gear manufacturers, for which contesting in sport competitions is a relevant consideration (e.g., motorsports, cycling, skiing). They can use these findings to assess the potential economic outcomes of contesting in sport competitions. Moreover, these findings may guide gear manufacturers in a tradeoff of budget allocation between contending in sport competitions on the one hand, and R&D and advertising on the other hand.

**Manufacturers’ Investments in Sport Competitions**

Manufacturers’ investments in sport competitions can be classified in terms of the following two dimensions: the *type of involvement* in the competition – sponsor versus contestant – and the *type of deployed resources* that the manufacturer uses in the competition – gear or non-gear resources.

**Type of Involvement: Contestant versus Sponsor**

In line with the definition of a contestant in the Merriam-Webster dictionary, we define a *contesting manufacturer* as a manufacturer that participates with a team in a sport competition, and competes against other contestants. In contrast, we define a *sponsoring manufacturer* as a manufacturer that provides either financial and/or in kind assistance (e.g., a company’s products) to an individual athlete, a team, or a competition in return for access to the commercial potential of the sponsored object (Meenaghan 1983; IEG 2014).

Being a contestant in sport competition is different from being a sponsor in three ways. First, the contesting manufacturer *owns whole or part of the team*, and therefore, has a higher responsibility for and more control over the team than a sponsoring manufacturer. For
example, when Red Bull became the owner of the Jaguar F1 team instead of being a sponsor, it incorporated the company name in the team name, and gained control over the design of the car’s paint scheme, which helped in gaining a higher visibility (Foster and Hoyt 2007).

Second, contesting manufacturers compete head-to-head against other contestants participating in the sport competition. For example, Mercedes competes against other car manufacturers in F1, and Trek competes against other race bike manufacturers in the UCI World Tour. This is different in case of sponsors. For example, Wilson is racket sponsor of various tennis players, amongst them Roger Federer, but these players do not form a Wilson team that competes in tennis championships against, for example, a Babolat team, rather the individual tennis players compete against each other (e.g., Roger Federer competes against Rafael Nadal).

Third, the contesting manufacturer’s brand name is strongly linked to its performance in the competition. Contestants are ranked based on their relative performance vis-à-vis competing brands in the competition (see e.g., https://data.fis-ski.com/alpine-skiing/brand-ranking.html, and http://www.skysports.com/f1/standings). In contrast, since sponsors do not contest in the competition, they are not ranked based on the performance of the athletes or teams they sponsor. For example, the ATP rankings show the official singles rankings of the ATP World Tour, featuring the world’s top ranked players in men’s professional tennis but do not show the names of manufacturers whose rackets the players used.

**Type of Deployed Resources: Gear versus Non-Gear**

In line with the definition in the Merriam-Webster dictionary, we define gear as clothing, goods, and equipment that are made by the contesting or sponsoring manufacturer to use in the sport. Thus gear sponsors or contestants provide the set of tools that will enable the individual athlete or team to compete in the competition, while non-gear sponsors or contestants do not. For example, Nike sponsored Tiger Woods by providing him with Nike
equipment, apparel, and shoes, and is thus a gear sponsor. Trek, providing its own team with Trek race bikes to compete in the UCI World Tour, is a gear contestant.

From the manufacturers’ point of view, two important, though related, differences exist between deploying gear and non-gear resources to a sport competition. First, for the manufacturer, there is a *strong fit* between the gear deployed in the sport competition and the gear sold in the commercial market, thereby bridging these two markets. For example, Nike sold golf balls in the main market similar to those used by Tiger Woods in the golf competitions. Second, in case of gear sponsors and contestants, resources and competences deployed for the competition may spill-over to the main market and vice versa, which may lead to *technology transfers*. As an example, Wilson and Roger Federer co-created a tennis racket, the Wilson Pro Staff RF97 Autograph, first to be used by Roger Federer in his matches, but later on, a commercial version of the racket was sold to the main market (Amer Sports 2018). In the past, we have also seen many technology transfers from F1 race cars to road cars (e.g., antilock brakes, electronic throttles, and traction control).

*Positioning in Prior Literature*

The previous distinctions we make help to understand the positioning of the present study in the existing literature on sport sponsoring. So far, most studies focus on *non-gear sponsors*, and show that sport sponsoring by means of providing non-gear support entails branding effects. Olson and Thjømoe (2009), for example, have shown that an extensive logo exposure due to sponsoring a sports league increases brand recognition and likeability equally strong as a 30-second TV ad. Walraven, Bijmolt, and Koning (2014) show that brand recall and recognition for the Heineken brand increases over the years of sponsoring the UEFA Champions League, with the largest increase in the second year. And, Mazodier and Merunka (2012) have shown that sponsoring a big sport event, such as the Summer Olympics, can increase brand trust and loyalty. The strength of such branding effects for non-gear sponsors
appears to vary depending on the fit between the sponsor and the brand, and the successes of the sponsored objects (Jensen and Cobbs 2014; Mazodier and Merunka 2012; Olson and Thjømøe 2009; Speed and Thompson 2000; Walraven, Bijmolt, and Koning 2014).

A few studies focus on the effects of being a gear sponsor. Chung, Derdenger, and Srinivasan (2013) is the first study to investigate the relation between sponsoring and the sales performance of the sponsoring brand. It shows a positive effect of being a gear sponsor, i.e., Nike being gear sponsor (amongst other golf balls) of Tiger Woods, on the brand’s sales performance of golf balls, and how this effect depends on Tiger Woods’ performance in the competition. In a subsequent study, Derdenger (2018) shows that this endorsement effect is stronger for novice golfers than for experts.

The potential outcomes of the investment of manufacturers to be a gear contestant has been completely ignored in the literature so far. This is an interesting context, though, as generally multiple gear contestants from the same industry participate in a particular sports competition (e.g., many large ski manufacturers participate with their own ski teams in the FIS Ski World Cup), with varying level of investments (e.g., ski manufacturer Head invests twice as much as ski manufacturer Atomic), and with varying levels of success (e.g., both Head and Rossignol outperformed Atomic in the overall world cup brand rankings in 2018). This provides a unique opportunity to investigate branding effects since brands are shown to the audience in direct comparison to competitors’ brands, which may lead to more pronounced branding effects. Additionally, this context offers the opportunity to investigate breeding returns of firms’ involvement in sport competitions. As gear contestants own participating teams, the teams’ performance is directly related to the gear contestant’s brand, and therefore, these gear manufacturers are most likely continuously searching for new technologies in their products that may help improving the teams’ performance. In line with these considerations, this study contributes to the literature by examining the breeding and
branding effects that result from manufacturers’ participation, investments, and successes in sport competitions as gear contestants.

**Conceptual Framework**

Figure 1 graphically summarizes our conceptual framework and shows the relation between a gear manufacturer contesting in a sport competition and the gear manufacturer’s innovation and sales performance, i.e., the breeding and branding effects respectively. We operationalize contesting in three ways viz., participation, spending, and performance in the sport competition. Participation denotes that the manufacturer is one of the contestants. Contingent on participation, we investigate the influence of the amount manufacturers spend on contesting in the sport competition (spending) as well as of the level of success in contesting in the sport competition (performance), as different levels of spending and performance may affect the breeding and branding returns.

The theoretical base of our conceptual framework relies on the Resource Based View (RBV) of the firm, which states that a firm’s resources and capabilities, i.e., a firm’s capacity to deploy these resources, help firms to enjoy a sustained competitive advantage (Wernerfelt 1984). We posit that the manufacturer’s team is a resource and contesting in a sport competition can be seen as a capability to leverage the manufacturer’s asset of having its own team. The manufacturer’s team is a resource that either singly, or in combination with other resources of the manufacturer, such as R&D and advertising spending, can be the basis for a sustained competitive advantage in terms of an increase in the manufacturer’s innovation performance as well as the brands’ sales performance. Specifically, we hypothesize that R&D spending moderates the relationship between contesting in a sport competition by a gear manufacturer and that gear manufacturer’s innovation performance since R&D is the most fundamental resource available to firms to produce technological know-how and to generate
innovations (Erickson and Jacobson 1992; Wuyts, Dutta, and Stremersch 2004). In a similar vein, we hypothesize that advertising spending moderates the relation between contesting in a sport competition by a gear manufacturer and the sales performance of that gear manufacturer’s brand(s) since advertising is generally an important source to increase a brand’s sales performance (e.g., Terui, Ban, and Allenby 2011).

[Insert Figure 1 about here]

**Breeding Effect**

We define the *breeding effect* as the effect of contesting in a sport competition by a gear manufacturer on that gear manufacturer’s innovation performance, which refers to the manufacturer’s innovation outputs such as, for example, patents (Ahuja and Katila 2001). Atomic, for example, developed the doubledeck technology in its skis first for use by professional athletes in the Atomic ski team that competes in the FIS World Cup, and after proven successful, transferred this technology to its commercial skis.

*Main breeding effect of contesting by a gear manufacturer.* Contesting in sport competitions is valuable to a gear manufacturer since it offers the manufacturer the opportunity to develop and test new technologies under the most demanding circumstances. Contesting generates valuable resources and competencies for converting new product ideas into innovations, increasing a manufacturer’s innovation performance (Chandy et al. 2006). The breeding effect of a gear manufacturer contesting in a sport competition on the gear manufacturer’s innovation performance can be explained as follows. First, contesting in sport competitions by gear manufacturers creates a parallel path of R&D activities in addition to the gear manufacturer’s regular R&D processes. Since sport competitions are characterized as highly demanding in terms of both speed and accuracy, contesting gear manufacturers develop and test new technologies specific for the sport competitions. Such parallel path of R&D activities, along the technical frontier, can improve a firm’s overall innovation performance
(Abernathy and Rosenbloom 1969; Dahan and Mendelson 2001). Second, the immediate performance feedback from contesting in a sport competition allows and stimulates learning by trial-and-error experiences. When experimenting with new technologies, the performance feedback provides insights into these technologies’ usefulness and quality. Such feedback facilitates the development of tacit knowledge, and the discovery of otherwise unnoticed opportunities, which may increase the gear manufacturer’s innovation performance (Börjesson, Dahlsten, and Willander 2006; Boudreau, Lacetera, and Lakhani 2011).

In sum, we expect that contesting in a sport competition by a gear manufacturer improves the gear manufacturer’s innovation performance, leading to the following hypothesis:

**H1: Contesting in a sport competition by a gear manufacturer is positively related to the gear manufacturer’s innovation performance.**

**Moderating role of R&D spending on the breeding effect.** We expect both a direct relation between R&D spending and innovation performance, as well as a positive moderating effect of R&D spending on the positive relation between contesting in a sport competition by a gear manufacturer and that gear manufacturer’s innovation performance. R&D expenditures are used to create internal knowledge and to evaluate the potential outcomes of the created knowledge (Rosenberg 1990). Prior literature (Artz et al. 2010; Somaya, Williamson, and Zhang 2007) has shown that a higher level of R&D spending entails a higher likelihood of patents being granted and/or the granted patents being intellectually valuable in terms of citations, pointing at a direct effect of R&D spending on a firm’s innovation performance.

Besides this direct effect, there are two reasons to expect a complementary effect between gear manufacturers contesting with a team in sport competitions and these gear manufacturers’ R&D spending. First, RBV theory emphasizes the role of firm-specific capabilities and competences that stretch the firm’s resources and help a firm enjoy a sustained competitive advantage (Wernerfelt 1984). Literature shows that R&D spending is
positively related to three important capabilities that may harness the innovation opportunities arising from having a team contesting in a sport competition, i.e., the absorptive capacity, product development capabilities, and patenting skills. By actively engaging in R&D in a particular field, in this case innovation development in the car industry, manufacturers increase their absorptive capacity, i.e., the capacity to acquire, assimilate, and exploit information they generate in another context, such as contesting in sport competitions (Cohen and Levinthal 1990). They may also increase their product development capabilities, i.e., the capacity to turn this information and knowledge into breakthroughs (Cohen and Levinthal, 1990; Vorhies and Morgan 2005). Finally, the higher the R&D spending, the higher a firm’s patenting skills, which may help in patenting the breakthrough innovations, resulting from technology testing by the manufacturer teams in the sport competitions (Somaya, Williamson, and Zhang 2007).

Second, higher R&D spending is an important resource for the generation of creative innovation ideas (Boudreau, Lacetera, and Lakhani 2011). The new ideas from the regular R&D process may find their way into the equipment used by the manufacturers’ teams, and contesting by these teams in the sport competitions may then provide valuable testing ground.

In line with the above arguments, we expect that R&D spending strengthens the positive effect of a gear manufacturer contesting in a sport competition on that gear manufacturer’s innovation performance, leading to the following hypothesis:

**H2: The relationship between contesting in a sport competition by a gear manufacturer and that gear manufacturer’s innovation performance is positively moderated by the gear manufacturer’s R&D spending.**

**Branding Effect**

We define the *branding effect* as the effect of contesting in a sport competition by a gear manufacturer on the sales performance of that gear manufacturer’s brands. For example,
Renault’s Formula One title in 2006 entailed a direct increase in its car sales (European Communities 2006).

**Main branding effect of contesting by a gear manufacturer.** Contesting in a sport competition may positively influence a gear manufacturer’s most important intangible resources, i.e., the brands’ awareness, image and reputation, thereby creating a sustainable competitive advantage and eventually higher sales (Aaker and Biel 1993; Conner 1991; Keller 2003). Contesting in a sport competition by a gear manufacturer may generate branding returns for the respective manufacturer for two main reasons. First, by contesting in sport competitions, gear manufacturers gain increased brand exposure since sport competitions have large viewership (e.g., 352.3 million people viewed the F1 championship globally in 2017 [Sylt 2018b]). The brand’s exposure increases with the brand’s performance in the sport competition since the better performing brands will receive more media attention than those at the back of the pack (Jensen and Cobbs 2014). Literature on the mere-exposure effect suggests that repeated exposure to a brand’s stimuli, such as words, pictures, logos, and brands will entail an affective response towards these stimuli, leading to higher brand preferences and higher brand equity, which subsequently leads to higher sales performance (Aaker 1996; Janiszewski 1993; Olson and Thjømøe 2009; Zajonc 1968).

Second, in the context of contesting by gear manufacturers, signaling is an important additional logic beyond mere exposure for explaining the effect of contesting on the sales performance of the gear manufacturer’s brand(s). Signaling refers to the action a seller takes to convey information about the unobservable product quality to the buyer (Rao, Qu, and Ruekert 1999). Previous studies on signaling have focused on the transmission of quality signals in different forms, including brands (Erdem, Swait, and Valenzuela 2006), brand alliances (Rao, Qu, and Ruekert 1999), prices (Schmidbauer and Stock 2018), advertising expenditures (Erdem, Keane, and Sun 2008), and warranties (Boulding and Kirmani 1993).
We argue that contesting in sport competitions, under the extreme conditions these competitions entail and directly in comparison with competitors’ products, enables the respective firm to demonstrate the performance and quality of their products and brands. A new technology that a contesting firm introduces in such competitions may yield strong reputational and quality returns to the main market. Thus, contesting in a sport competition by a gear manufacturer acts as a positive signal on quality of the gear manufacturer’s brand(s), which may result in higher sales, as perceived quality has been shown to be one of the most important universal brand benefits influencing a consumer’s brand purchase intention and brand choice (Erdem, Keane, and Sun 2008; Van der Lans, Van Everdingen, and Melnyk 2016).

Following these arguments, we develop the following hypothesis:

**H3: Contesting in a sport competition by a gear manufacturer is positively related to the gear manufacturer’s sales performance.**

**Moderating role of advertising spending on the branding effect.** We postulate that advertising spending will moderate the relationship between contesting in a sport competition by a gear manufacturer and the sales performance of the brand(s) of this gear manufacturer, for two main reasons. A first argument for a negative interaction effect of contesting in sport competitions by a gear manufacturer and that gear manufacturer’s advertising spending is the saturation effect. Since gear manufacturers repeatedly show their brands during sport competitions, simultaneously increasing advertising spending will lead to saturation resulting from an increased number of brand exposures (Campbell and Keller 2003; Schmidt and Eisend 2015; Vakratas and Ambler 1999). This effect will be even more pronounced for brands with higher spending in sport competitions since higher spending leads to a more prominent display of the brand names, and logos. Similarly, the saturation effect will be higher for brands that perform well in the competition since better performing brands receive
more media attention and thus more brand exposures, as compared to brands that do not perform well (Chung, Derdenger, and Srinivasan 2013).

Second, according to Kirmani and Rao (2000), there is a negative interaction effect between two market signals that are similar in nature, due to the reduced effectiveness of one signal in the presence of another signal of similar type. Since both contesting in sport competitions and advertising involve upfront expenditures, they are similar in nature. I.e., both advertising spending and contesting in sport competitions can be seen as (substitute) signals of high product quality, compared to rivals. Therefore, we expect a negative interaction effect between them.

In line with the above arguments, we develop the following hypothesis:

\[ H4: \text{The relationship between contesting in a sport competition by a gear manufacturer and the sales performance of that gear manufacturer’s brand(s) is negatively moderated by the gear manufacturer’s advertising spending.} \]

**Data**

**Empirical Context**

The empirical context of our study is the Formula One (F1) championship, which is the leading sport championship in single-seat auto racing, established by the Fédération Internationale de l’Automobile (FIA) in 1945. The F1 season runs from March to November and consists of a series of 19 Grand Prix races across different countries worldwide. Yet, F1 has a strong heritage in Europe, where still about 50% of the races take place. Recent F1 race seasons have seen an average of 11 teams participating with two cars, and every team enrolled

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2 Note that this expectation is solely based on the magnitude of advertising spending as a signal (i.e., the more a brand spends on advertising the more it signals high quality) and not on advertising content that may be either aligned with or not aligned with contesting in sport competitions. We regard advertising content as outside the scope of the paper and formulate this hypothesis “ceteris paribus” (thus, including independent of variation in advertising content). We return to this issue in the discussion section.
in a F1 season competes in all the races of the year. At the end of the season, a world
championship is awarded to one driver as well as one team with the highest total points earned
during the races.

F1 constitutes a perfect environment for testing our breeding and branding effects
hypotheses. In terms of breeding potential, F1 teams, in which the car manufacturer’s R&D
personnel closely collaborate with the drivers and technical engineers, come up with hundreds
of ideas a year to improve automobile performance, such as aerodynamics, suspension set-up,
weight distribution, fuel efficiency. Since races are typically every two weeks, there is a fast
cycle of developing new ideas, testing them, and analyzing if the modifications improve the
race performance. F1 is also an interesting area to investigate branding effects, as participating
car brands gain a lot of brand exposure primarily due to TV viewership of F1 races (Jensen
and Cobbs 2014).

Data Collection Procedure

Level of data collection. We collected data at the manufacturer-global-year level for the
breeding analysis and at the brand-country-month level for the branding analysis. Patent data,
which we use to measure innovation performance, is only unambiguously available at the
manufacturer-global level, while data on car registrations, our measure of sales performance,
is available at the brand-country level. Moreover, data for variables in the breeding part of the
conceptual framework, such as R&D spending, are available only at the manufacturer-global-
year level, whereas data for the variables in the branding part of the conceptual framework,
such as advertising spending, are available at the brand-country-month level.

Sample of countries, brands and manufacturers. We decided to focus on Europe since F1
has its heritage in Europe, still is strongly European oriented with many F1 drivers being of
European origin, and around half of the races every year taking place in Europe. Within
Europe, we selected five countries – France, Germany, Italy, Spain, and the U.K. – based on
data availability on brands’ monthly sales performance and the highest percentage of F1 TV viewership. Specifically, the percentage of the population within a country that has seen 15 or more minutes of at least one race during the 2010 F1 season was 52% for France, 51% for Germany, 60% for Italy, 71% for Spain, and 56% for the U.K. (Formula One Global Broadcast Report 2010). Moreover, many drivers participating in F1 between 2000 and 2015 have their origin in one of these countries (11 drivers of German origin, 11 drivers of U.K. origin, eight drivers of French origin, six drivers of Italian origin, and six drivers of Spanish origin), and these countries brought forth highly successful drivers, such as Schumacher, Vettel, Rosberg, Fisichella, Alonso, Coulthard, Button and Hamilton. We are aware that our sample of countries loads the dice in favor of finding a branding effect. The branding effect we identify may thus be lower in countries with less heritage in F1, smaller F1 viewership or in which no races take place.

Table 1 lists the brands chosen in our sample countries for the branding analyses, the corresponding car manufacturers used in the breeding analyses, and the manufacturers’ car brands that participated in F1 during 2000-2015, including the years in which they participated.

[Insert Table 1 about here]

We selected the 30 car brands (see Table 1, second column) based on the following three criteria. First, we selected the top 20 brands in terms of vehicle registrations in our five sample countries. Second, we identified the brands that contested in F1 during our sample period. Among the top 20 brands, seven brands contested in F1 during 2000-2015. We added Ferrari, Jaguar and Lotus that were not in the top 20 brands in terms of registrations, but also contested in F1 between 2000 and 2015. Third, we added seven niche brands that did not

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3 The key findings of our study are not sensitive to the exclusion of these three brands from our sample. See robustness checks.
contest in F1 but are comparable to Jaguar, Ferrari and Lotus in terms of the segments they operate in: Aston Martin, Bentley, Lexus, Lamborghini, Maserati, Porsche, and Volvo. Our sample of 30 car brands accounts for more than 90% of passenger vehicle registrations in the five selected European countries. These 30 brands mapped into 16 car manufacturers (see Table 1, first column), among which ten brands from nine manufacturers contested in F1 at some point during our sample period (see Table 1, third column).  

**Measurement of Variables**

*Operationalization of variables for the breeding model.* The dependent variable in the breeding model is a manufacturer’s *innovation performance*, which we measured as the total number of citations obtained by the manufacturer’s patents that were granted during a given year. This method to measure innovation performance has been used in prior studies (e.g., Hall, Jaffe, and Trajtenberg 2005; Wuyts, Dutta, and Stremersch 2004). There were, however, two issues in measuring the number of citations. First, for each patent, we only observed a portion of the period over which it could be cited. Specifically, it takes several years to realize patents’ full citation potential. Second, the length of this observed citation period varied depending on when the patent was applied for. For example, 13 years of citation data was available for patents applied in 2001 (i.e., from 2001 to 2013), whereas only 3 years of citation data was available for patents applied in 2011 (i.e., from 2011 to 2013). We addressed this problem as follows. We first estimated the shape of the citation-lag distribution for each manufacturer using data on patents granted during 1986-1999. This distribution provides the

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4 In some cases (BMW in 2010, Jaguar during 2003-2004, and Lotus during 2010-2015), although the brand name appeared in the team’s name, the manufacturer did not supply the engine used in the races. Therefore, we do not expect breeding effects to be present for these cases. However, since the brand name appeared on the team’s name, branding effects may still be present. Nevertheless, we show that the results of our breeding analyses are robust when we exclude these observations from our data set. See robustness checks.

5 Patent information is based on the priority year and is made available after the date of publication of the application. There is a time lag of up to 30 months between the application of the patent and the availability of the information in the PATSTAT database (Eurostat Metadata 2016). Therefore, we use information on patents until December 2013.
fraction of citations that a manufacturer’s patent obtains every year after the patent is granted. We used this distribution to calculate the total number of citations for patents granted in a particular year as follows. We first observed the total number of citations between the year in which the patent was granted until 2013 (e.g., three years for patents filed in 2011), and then divided this value by the fraction of the citation-lag distribution that lies in this time interval (Hall, Jaffe, and Trajtenberg 2005).

We measured the moderator variable, i.e., manufacturer’s R&D spending, as the ratio of yearly spending in R&D in euros to the number of employees within the organization in order to control for different sizes of manufacturers. Prior studies (e.g., Scherer 1986) have found R&D spending per employee to be less sensitive to the spurious effects of business cycles, accounting manipulations, and asset sales than R&D spending as a proportion of sales.

We operationalize the independent variable, i.e., contesting by a gear manufacturer in three ways - F1 participation, F1 spending and F1 performance. F1 participation is a dummy variable that takes a value of one during the years in which a manufacturer participated in F1 as a gear contestant, and zero otherwise. We operationalize F1 spending as the yearly spending of the gear manufacturer on its F1 team in euros. Such spending may cover out-of-pocket expenses, such as materials, contracts with first-tier suppliers on components or employees on the manufacturer’s payroll dedicated to the participating team. We measure F1 performance as the number of points the manufacturer’s team accumulated during the entire F1 season. We distinguish between F1 participation and F1 spending because some manufacturers participate in Formula One without any spending. For instance, the manufacturer Proton Holdings Berhad participated between 2010 and 2015 using the Lotus brand name. However, the manufacturer neither spent any money on the team nor managed the team. Similarly, Ferrari did not make any direct financial contribution to its team's budget between 2013 and 2015. This is because the payments that Ferrari received from the Formula
One Group have increased in recent years. Therefore, it was no longer necessary for the manufacturer to give financial backing to the team. In these two cases, we treat the manufacturers (and the corresponding brands) as participants whereas we treat their spending as zero.

*Operationalization of variables for the branding model.* One of the dependent variables in the branding analyses is the brand’s sales performance, which we measured as the total vehicle registrations of the brand across all its models in a given country during a particular month. We measured advertising spending, which is both a dependent and a moderating variable in the branding analyses, as the total advertising spending of a brand in a country in euros across all media types in a given month.

A brand as gear contestant in F1 is the independent variable in the branding model, which we also expressed in three levels - F1 participation, F1 spending, and F1 performance. F1 participation is a dummy variable that takes a value of one during months in which a brand participated in at least one F1 Grand Prix race, and zero otherwise. We measured the monthly F1 spending by multiplying the brand’s annual F1 spending with the proportion of races in a year that took place in the particular month. All manufacturers except Ford participated with a single brand during our sample period. Therefore, we considered the manufacturer’s F1 spending to be equal to the brand’s F1 spending. Ford participated with the Jaguar brand name in 2000, 2001 and 2002, and with both the Ford and Jaguar brand names in 2003 and 2004. We allocated Ford’s (manufacturer) F1 spending to its individual brands as follows. We allocated the entire manufacturer’s F1 spending to the Jaguar brand for 2000-2002 and split the manufacturer’s F1 spending between the Ford and Jaguar brands during 2003 and 2004. We assume that the manufacturer spent the same amount of money to the Ford brand in 2003 and 2004, as it did prior to 2000 when participating only with the Ford brand, and the rest of the manufacturer’s spending to the Jaguar brand. Such allocation is also in line with publicly
available information (e.g., GPUpdate 2003). We note, however, that our findings of the
branding analyses are not sensitive to alternate allocations of F1 spending to the Ford and
Jaguar brands (see robustness checks later). We measured a brand’s monthly F1 performance
as the number of points accumulated by that brand during a particular month. Note that for F1
participation, F1 spending and F1 performance we assigned the same value for all countries.

We included four control variables in the branding model. First, since different countries
may have varying levels of exposure to the brands during different racing months, we
controlled for country-specific monthly exposure of participating brands by including the
monthly number of viewers that watched the live F1 races on TV in the particular country.
Second, we included the number of new product introductions of each brand in a particular
month as a control variable since we expected it to influence sales performance. We defined
this variable as the number of new products, denoted as a unique combination of brand,
segment, model, body group, and generation year, introduced by the brand during that month.
Third, we included the effects of lagged advertising spending and lagged sales performance
on current advertising spending to capture carryover effects and state dependence (Dekimpe
and Hanssens 1999). Finally, we included competitors’ sales performance and competitors’
advertising spending, and measured them as the total number of new vehicle registrations and
total advertising spending of all other brands in that country during the particular month,
respectively.

**Data Sources**

For the breeding analysis, we collected data on innovation performance, R&D spending and
F1 contesting, in terms of participation, spending, performance, for the 16 manufacturers. We
obtained data on innovation performance in terms of yearly patent applications and their
corresponding citations from the Worldwide Patent Statistical Database (PATSTAT) of the
European Patent Office from 2000 to 2013, a period of 14 years. We obtained data on yearly
R&D spending (2000-2013) from the car manufacturers’ annual reports.⁶ We converted all R&D spending figures reported in other currencies to euros using historical exchange rates. For most firms, the fiscal year matched the calendar year (January to December). We adjusted the R&D spending of other firms with a different fiscal year so that it matches with the calendar year. Finally, we gathered information on car manufacturers’ yearly participation and performance in F1 from ESPN (www.espn.co.uk/f1/), while we obtained yearly spending in U.S. dollars for all car manufacturers that participated in F1 between 2000 and 2015 from Formula Money. We used historical exchange rates to convert U.S. dollars to euros.

For the branding analysis, we collected monthly data on sales performance and advertising spending of the selected 30 brands across the five countries between January 2000 and December 2015 (192 months).⁷ We obtained data on sales performance in terms of monthly new passenger vehicle registration for each car brand-model, in every segment, body group, and generation year across the five European countries from R.L. Polk & Co. We obtained data on country-specific brand level monthly advertising spending for all car brands from Nielsen Company. Advertising spending figures in France, Germany, Italy, and Spain are expressed in euros and those in the U.K. are expressed in British pounds. We converted pounds to euros using historical exchange rates. We use the same sources mentioned earlier to obtain information on the brands’ F1 participation, spending and performance. Finally, we obtained information on the monthly number of television viewers that watched the live F1 races in every country of our sample from Eurodata TV Worldwide.⁸

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⁶ Porsche’s annual reports were not available prior to 2004. For these early years we assumed Porsche’s R&D spending to be 8% of its owner Volkswagen Group’s R&D spending, which was the case during the fiscal year 2005-2006.

⁷ Registration data is available in Germany until September 2015 and in France until August 2013.

⁸ For Spain, reliable viewership data is available only from 2004. Therefore, we drop the observations prior to 2004 for Spain from our branding analysis.
**Descriptive Statistics**

Tables 2 and 3 provide means, standard deviations, and correlations among different variables we used in the breeding and branding analyses, respectively. Patent citations (innovation performance) is positively correlated with a manufacturer’s F1 participation ($r = .252$), F1 spending ($r = .479$), and R&D spending ($r = .094$), but negatively with a manufacturer’s F1 performance ($r = -.111$). A brand’s new vehicle registrations (sales performance) is positively correlated with a brand’s F1 participation ($r = .079$), F1 spending ($r = .113$), F1 performance ($r = .048$), and advertising spending ($r = .495$).

[Insert Tables 2 and 3 about here]

**Empirical Analysis**

**Breeding Analysis**

*Model specification.* In line with prior studies (e.g., Artz et al. 2010; Ernst 2001), we used a one-year lag between R&D spending and patent citations. Since we consider a gear manufacturer contesting in a sport competition as a resource that creates a parallel path of R&D, we consider a one-year lag also for the effect of a gear manufacturer contesting in F1 on patent citations. Specifically, we modeled innovation performance, measured as the number of patent citations ($\text{InnPerf}_{my}$), of manufacturer m in year y as follows:

\[
\ln(\text{InnPerf}_{my}) = \mu_m + \theta_1 F1_{my-1} + \theta_2 \ln(\text{R&D}_{my-1}) + \theta_3 \left( F1_{my-1} \times \ln(\text{R&D}_{my-1}) \right) + \epsilon_{my},
\]

where $\mu_m$ denotes a manufacturer-specific fixed effect, $F1_{my-1}$ denotes manufacturer m as a gear contestant in F1 in year y-1, expressed in terms of F1 participation ($F1\text{part}_{my-1}$), log of F1 spending ($\ln(F1\text{spend}_{my-1})$) or log of F1 performance ($\ln(F1\text{perf}_{my-1})$), $\text{R&D}_{my-1}$ denotes the manufacturer m’s R&D spending in year y-1. We log-transform F1 spending, F1
performance and R&D spending to allow for their decreasing marginal returns on the manufacturer’s innovation performance. As we operationalized being a F1 contestant in three different ways, we estimated Equation (1) three times, each time with another operationalization of the F1 variable (participation, spending or performance). Since we mean-centered R&D spending for ease of interpretation, $\theta_1$ captures the effect of F1 participation, spending or performance for a manufacturer with mean level of R&D spending, $\theta_2$ captures the simple effect of R&D spending, $\theta_3$ captures the interaction between F1 participation, spending, or performance and R&D spending, and $\epsilon \sim N(0, \sigma^2_\epsilon)$ is the error term. We estimate the model in Equation (1) using ordinary least square regression.

*Estimation results.* Table 4 reports the parameter estimates of the breeding model. Columns 3, 5, and 7 contain the parameter estimates of the model that includes only the main effects of contesting in F1 and R&D spending, but not the interaction between the two, when the F1 variable is measured as F1 participation, F1 spending, and F1 performance, respectively. It shows that the main effect of contesting in F1, i.e., the effect of contesting independent of the R&D level, on innovation performance is significant when contesting in F1 is operationalized as F1 participation or F1 spending, but not when it is operationalized as F1 performance. Therefore, we can confirm H1, except when we operationalize contesting by performance.

[Insert Table 4 about here]

Columns 4, 6 and 8 of Table 4 contain the parameter estimates of the full model that includes the simple effects of contesting in F1 ($\theta_1$) and R&D spending ($\theta_2$) as well as the interaction effect between them ($\theta_3$) when the F1 variable is measured as F1 participation, F1 spending, and F1 performance, respectively. Note that one cannot interpret these simple effects as main or marginal effects of F1 involvement, in the presence of the interaction
effects between F1 and R&D spending (i.e., they cannot be used to test H1). We find that the interaction effect ($\theta_3$) is positive and significant at the .01 level in all three models.

To interpret these findings, we plotted the effects of a car manufacturer contesting in F1 on its innovation performance for the 5th percentile (€5,567) to the 95th percentile (€35,989) of annual R&D spending per employee in our data set (mean R&D spending per employee = €18,177). Figure 2A shows the effect of manufacturers’ participation on innovation performance across different levels of R&D spending. We obtained the mean effects (see the solid line) and the 95% confidence intervals (see the dotted lines). Similarly, Figures 2B and 2C respectively plot the effect of 1% increase in F1 spending and the effect of 1% increase in F1 points on innovation performance across different levels of R&D spending. The breeding effect is significant at the 5% level when both the dotted lines indicating the 95% confidence interval are above or below the x-axis. All three figures show that there is a synergistic effect of car manufacturers contesting in F1 and R&D spending. Combining the simple effect of F1 and the interaction effect between F1 and R&D spending, we find a significant, positive effect of F1 participation, spending and performance on innovation performance for manufacturers with high, above mean levels of R&D spending (specifically, greater than €18,200, €17,800, and €23,500 annual R&D spending per employee or €3 billion, €2.9 billion and €3.8 billion annual R&D spending for F1 participation, F1 spending, and F1 performance respectively). This supports Hypothesis 2.

[Insert Figures 2A, 2B, and 2C about here]

**Branding Analysis**

**Model specification.** We modeled sales performance, measured as the number of new passenger vehicle registrations, ($SalesPerf_{ijt}$) for brand $i$ in country $j$ at month $t$ as follows:

\[
\ln(SalesPerf_{ijt}) = \alpha_{ij} + \beta_1 F1_{it} + \beta_2 AdGW_{ijt} + \beta_3 (F1_{it} \times AdGW_{ijt}) +
\]
\[
\beta_4 \left( F_{1it} \times \ln(\text{Viewers}_{jt}) \right) + \beta_5 \sum_{k=0}^{12} \text{NPI}_{ijt-k} +
\]
\[
\beta_6 \ln(\text{CompSalesPerf}_{ijt}) + \epsilon_{ijt},
\]
where \( \alpha_{ij} \) denotes the brand-country fixed effect, which captures time-invariant brand-specific and country-specific effects.\(^9\) Incorporating such fixed effects alleviates the risk of endogeneity arising from idiosyncratic variations in brands (e.g., mainstream versus niche brands) and countries (Papies, Ebbes and Van Heerde 2017; pg. 602). \( F_{1it} \) denotes the brand’s manufacturer being a gear contestant in F1, which we operationalize as either F1 participation (\( F_{1\text{part},it} \)), log of F1 spending (\( \ln(F_{1\text{spend},it}) \)) or log of F1 performance (\( \ln(F_{1\text{perf},it}) \)) of brand \( i \) in a particular month \( t \), and \( \text{AdGW}_{ijt} \) is the advertising goodwill of brand \( i \) in country \( j \) in month \( t \). We employ the standard Nerlove-Arrow (1962) exponential decay goodwill model for each country-brand combination. Specifically, we model the goodwill as \( \text{AdGW}_{ijt} = \rho \text{AdGW}_{ijt-1} + \sqrt{\text{Ad}_{ijt}} \), where \( \text{Ad}_{ijt} \) is the advertising spending of brand \( i \) in country \( j \) at month \( t \), and \( \rho \) is the carryover parameter, which we find using a grid search (Narayanan, Desiraju, and Chintagunta 2004).\(^10\) The squared-root term accounts for the decreasing marginal returns from advertising spending. \( \text{Viewers}_{jt} \) denotes the number of people watching the live F1 races in country \( j \) in month \( t \). We interact \( \text{Viewers}_{jt} \) with \( F_{1it} \) because we expect the effect of F1 TV viewership on sales performance to depend on the extent to which the brand contest in F1 (e.g., if it participates, spends a certain amount, and has won a certain number of points). \( \text{NPI}_{ijt} \) denotes the number of new products introduced by brand \( i \) in country \( j \) during the month. We model the effect on sales performance of new products introduced by the brand

\(^9\) We regret not to have information on monthly prices of passenger vehicles. Since there is very little variation in prices at the brand level (most price variation occurs at the model level or due to customizations), we believe that the effect of the price level on sales performance is captured by the fixed-effect in Equation (2).

\(^10\) We estimated the model with different values of the carryover parameter and chose the model with the highest \( R^2 \). We obtained the highest model fit when the carryover parameter was set to 86%.
during the last 12 months (i.e., $\sum_{k=0}^{12} NPI_{ijt-k}$). $\text{CompSalesPerf}_{ijt}$ denotes the number of registrations of all other brands in the country.

$\beta_1$ captures the main/simple effect of the brand contesting in F1 on sales performance, $\beta_2$ denotes the main/simple effect of advertising goodwill on sales performance, and $\beta_3$ denotes the interaction effect between the brand contesting in F1 and advertising goodwill. Since we mean-center $\ln(\text{Viewers}_{ijt})$, $\beta_1$ and $\beta_3$ capture the simple effect of the brand’s contesting in F1 and interaction effect between the brand’s contesting in F1 and advertising goodwill respectively for an average level of F1 TV viewership. Moreover, $\beta_4$ captures the effect of the number of viewers for gear contestants depending on the level of the brand’s contesting in F1, $\beta_5$ denotes the effect of new product introductions during the past 12 months, $\beta_6$ denotes the effect of competitors’ sales performance, and $\epsilon_{ijt}$ is the error term.

In Equation (2), advertising spending may be endogenous to sales performance because the unobservable monthly shocks in car registrations may be correlated with those affecting advertising spending (e.g., an important sales exhibition may occur in a given month in a given country). We model such endogeneity by including an instrumental variable and by modeling the error terms of the sales performance (Equation (2)) and advertising spending equations (see Equation (3) below) to be correlated with each other. We use the brand’s monthly advertising spending in the other four countries as the instrumental variable. The brand’s advertising spending in other countries is likely to be related to the brand’s advertising spending in the focal country since manufacturers allocate advertising budgets across countries (Bigné 1995; Fisher et al. 2011). However, we expect the advertising spending in other countries to be exogenous to sales performance in the focal country. The advertisements in each of the five countries in our analysis were most likely in different languages, i.e., French in France, German in Germany, Italian in Italy, Spanish in Spain and
English in the U.K. Moreover, manufacturers customize advertising content to local markets (e.g., Sandler and Shani 1992). To check whether the advertising spending in other countries is a reasonable instrument for advertising spending, we carried out an auxiliary regression in which we used the log of advertising spending as the dependent variable and the log of the total advertising spending in the other four countries as the independent variable. The $R^2$ of this regression is .590, indicating that using advertising spending in other countries to account for advertising endogeneity is a reasonable instrument (Stock and Watson 2015).

In addition to accounting for the endogeneity of advertising spending, we are interested in examining how the brand’s contesting in F1 affects advertising spending (see Figure 1). In line with this, we modeled the advertising spending for brand $i$ in country $j$ in month $t$ ($\text{Ad}_{ijt}$) (in logarithmic units) as follows:

$$
\ln(\text{Ad}_{ijt}) = \gamma_{ij} + \delta_1 \text{F1}_{it} + \delta_2 \left( \text{F1}_{it} \times \ln(\text{Viewers}_{jt}) \right) + \delta_3 \text{NPI}_{ijt} + \delta_4 \ln(\text{Ad}_{ijt-1}) \\
+ \delta_5 \ln(\text{SalesPerf}_{ijt-1}) + \delta_6 \ln(\text{CompAd}_{ijt}) + \delta_7 \sum_{j' \neq j} \text{Ad}_{ij't} + \xi_{ijt},
$$

where $\gamma_{ij}$ denotes country-brand specific fixed effect to account for time-invariant brand-specific and country-specific advertising level, $\text{Ad}_{ijt-1}$ denotes lagged advertising spending, $\text{SalesPerf}_{ijt-1}$ denotes lagged sales performance, $\text{CompAd}_{ijt}$ denotes advertising spending of all other brands in the country during a particular month in order to account for competitive pressure in advertising spending or a common trend in advertising patterns, and $\text{Ad}_{ij't}$ denotes the advertising spending for brand $i$ in country $j'$ in month $t$, which is the instrumental variable for advertising. We model the error terms of Equations (2) and (3) to be jointly distributed as $[\varepsilon_{ijt} \quad \xi_{ijt}]' \sim \mathcal{N}(0, \Sigma)$. We estimate these equations using seemingly unrelated regression technique as suggested by Papies, Ebbes, and Van Heerde (2017; pg. 591). Similar to the breeding analysis, we estimated the branding model three times, each time with another operationalization of the F1 variable (F1 participation, F1 spending, or F1 performance).
Estimation results. Table 5 reports the parameter estimates of the branding model. Columns 4, 6 and 8 contain the estimates of the model excluding the interaction effect between contesting in F1 and advertising goodwill. Examining the parameter estimates of the sales performance equation (see upper part in Table 5), we find for the main effects only model that the main effect of contesting in F1, i.e., the effect of contesting independent of the level of advertising goodwill, is significant if we operationalize contesting as participation and spending, but not in case of performance. Therefore, we confirm H3, except if we operationalize contesting as performance.

[Insert Table 5 about here]

In the full model (see columns 5, 7 and 9 of Table 5), the simple effects of being a gear contestant ($\beta_1$) and advertising goodwill ($\beta_2$) are positive and significant at the .01 level in all three models. The size of the simple effects is calculated taking into account the level of the other independent variable. Since the models include an interaction effect between contesting in F1 and advertising goodwill, we cannot separately interpret the simple effects (i.e., the simple effects do not offer an appropriate test of H3). The interaction effect between contesting in F1 and advertising goodwill ($\beta_3$) is negative and significant at the .01 level in all three models, confirming H4.

To interpret these findings, we plotted the effect of contesting in F1 on sales performance for the 5th percentile (€0)\textsuperscript{11} to the 95th percentile (€21.8 million) of monthly advertising spending in our data set (assuming equal values of past advertising goodwill). In Figure 3A, we show the effect of a brand’s participation in F1 on sales performance across different levels of monthly advertising spending. Similarly, in Figures 3B and 3C, we plot the effect of a 1% increase in F1 spending and the effect of a 1% increase in F1 points on sales.

\textsuperscript{11}This indicates that 5% of our observations have zero advertising spending. This is not uncommon given that we measure advertising spending at the monthly level.
performance, respectively, across different levels of monthly advertising spending. We obtained the mean effects (solid lines) and the 95% confidence intervals (dotted lines). The branding effect is significant when both the dotted lines indicating the 95% confidence interval are above or below the x-axis. These findings indicate that higher advertising spending lowers the effect of the brand’s contesting in F1, thus supporting Hypothesis 4. This points at a substituting effect between contesting in F1 and advertising spending. Nevertheless, all brands have a positive branding effect from F1 participation and F1 spending and brands that spend less than €10.6 million on monthly advertising also have a positive branding effect from F1 performance.

[Insert Figures 3A, 3B, and 3C about here]

In addition to the effects of F1 and advertising, we find that $\beta_4$ is positive and significant at the .01 level, indicating that an increase in the number of F1 TV viewers strengthens the positive effect of the brand’s contesting in F1 on sales performance. $\beta_5$ is positive and significant at the .01 level in all three models. This indicates that sales performance has a positive relationship with the number of new products introduced during the last 12 months. Competitors’ sales performance ($\beta_6$) is positively related to the sales performance of the focal brand and is significant at the .01 level for all three models. This could capture the trend in automobile registrations for all brands in the country.

The lower part of Table 5 presents the parameter estimates of the advertising equation, i.e., Equation (3). We find that $\delta_1$ is positive and significant at the .01 level for the model in which F1 contesting is measured as F1 participation, positive and significant at the .10 level for the model in which F1 contesting is measured as F1 performance, and insignificant for the model in which F1 contesting is measured as F1 spending. This indicates that brands spend more on advertising when they contest in F1 or perform well in F1.
Further, regarding the control variables in the advertising equation, $\delta_2$, $\delta_3$ and $\delta_5$ are not significant. Lagged advertising spending ($\delta_4$) has a positive and significant ($p<.01$) effect on current advertising spending, for all three models. $\delta_6$ is positive and significant for all three models at the .01 level. This denotes that an increase in advertising spending of other brands in the country leads to an increase in the focal brand’s advertising. This may capture either a competitive response or a trend in advertising spending among all brands within a country. Finally, we find that the instrumental variable ($\delta_7$) is positive ($p<.01$) and significant for all three models, denoting that advertising spending in other countries has a significant effect on the brand’s advertising spending in the focal country.

**Robustness Checks**

We checked the robustness of our results in four ways. First, we excluded data points from the breeding analysis in which the manufacturer outsourced the gear (engine) used during a racing season (see Table A1 in the Web Appendix). Specifically, although BMW withdrew from racing in 2010, the BMW Sauber F1 team competed using Ferrari engines (Noble and Beer 2009). Similarly, Jaguar used Cosworth engines and Lotus used Cosworth, Renault and Mercedes engines during the years they contested. Second, we allocated an equal amount of F1 spending to Ford and Jaguar during 2003 and 2004, when both the manufacturer’s brands participated in F1, and re-estimated the branding model with F1 spending (see Table A2 in the Web Appendix). Third, we excluded the contesting niche brands (Ferrari, Jaguar, and Lotus) from our branding analyses to examine whether we observe the negative moderation effect between a manufacturer being a gear contestant and its advertising spending due to the differences between large and small brands in our sample (see Table A3 in the Web Appendix). Finally, although we treat breeding and branding analyses to be different, we checked for the robustness of the inclusion of innovation performance and R&D spending in the branding analysis. Following Artz et al. (2010), we employed a three-year lag for the
effect of R&D spending and a two-year lag for the effect of innovation performance (see Table A4 in the Web Appendix). We note that our findings are robust to all the aforementioned changes. The results of these analyses reaffirm our main findings that the manufacturer’s R&D spending and contesting in F1 are complementary of each other whereas the brand’s advertising spending and contesting in F1 are substitutes.

Discussion

Managerial Implications

We provide useful insights for managers and analysts, specifically in the automotive industry, including tier 1 suppliers in that industry, and more generally to those in sports gear industries, for which being involved as a gear contestant in sport competitions is a relevant consideration. First, we show that manufacturers with higher R&D spending stand to gain more from the breeding consequences of investments in sport competitions. For example, we show in Figure 2A that car manufacturers that spend at least €3 billion on R&D (e.g., BMW, Honda) benefit from contesting in F1, while manufacturers that spend less than that (e.g., Fiat, Renault) do not. Thus, if manufacturers decide to invest in F1 to enhance their patent base, they have to complement it with a high R&D budget to fully exploit the innovation potential that F1 offers.

Second, we show that a gear manufacturer’s brand contesting in sport competitions and the gear manufacturer’s advertising spending for that brand are substitutes in inducing an increase in sales performance of that manufacturer’s brand(s). The branding returns are the largest among brands that have the lowest advertising (e.g., Ferrari, Jaguar, Lotus). Contesting in a sport competition clearly helps the gear manufacturer in building its brand by showing its products and brand(s) in a relevant context. Therefore, manufacturers do not have to complement contesting in sport competitions with a large advertising budget.
In sum, our findings may guide manufacturers in budget allocation decisions on sport competitions, R&D and advertising. Our two main findings imply that firms that spend a lot on advertising already and spend relatively little on R&D have much less to gain from being a gear contestant in sport competitions as compared to firms that spend little on advertising and spend a lot on R&D. Thus, research-intense firms have more to gain from investing heavily in sport competitions as a gear contestant, as compared to advertising-intense firms. This study gives primary evidence from the automotive industry, but is generalizable in logic to other industries. Both skiing and cycling, for example, have prime competitions of similar status as F1 in automotive to which our conceptual framework would generalize.

**Theoretical Implications**

Our study adds to the literature on investments in sport competitions as follows. First, it shows firms may obtain breeding and/or branding returns from contesting in sport competitions, while the past literature only examined branding returns from sponsoring and, thus, offers only a partial view, at best. Second, it conceptualizes contesting by a firm in a sport competition as inherently different from merely sport sponsoring. It also provides an analytical framework for estimating the returns for contesting firms and provides the first estimates of such returns ever reported in the scholarly literature. Third, our findings also add to the RBV theory, as we show a new type of resource (i.e., owning a manufacturer team) as well as new type of capability (i.e., contesting in sport competitions), that together may lead to a competitive advantage, i.e., breeding and branding effects. Fourth, our evidence of significant interaction effects between different manufacturer resources suggests that the returns to a manufacturer’s resource should not be studied in isolation but in combination with other resources that could be exploited to achieve the same outcome, which is in line with the RBV. Specifically, we report that a gear manufacturer’s R&D spending strengthens the effect of the relation between contesting in sport competitions and its innovation performance, while
a gear manufacturer’s advertising spending for a contesting brand weakens the effect of the relation between contesting and the brand’s sales performance. Contesting in F1 and advertise heavily at the same time is less effective. We are the first to empirically demonstrate saturation effects to occur even across greatly dissimilar exposure vehicles (in our case, car advertising and F1 contesting). This complements prior literature that has demonstrated such saturation effects only among fairly similar exposure vehicles (e.g., Vakrata and Ambler 1999). It may also contradict managerial practice to leverage sport investments with greater advertising spending.

**Research Agenda for Investigating Outcomes of Investments in Sport Competitions**

Like with any first exploration of a new phenomenon, several interesting future research directions remain, for studies focusing on contesting as well as sponsoring in sport competitions. First, one could test the conceptual framework used in this paper in another context, such as the Tour the France, or in other markets (e.g., emerging countries), to show the generalizability of the breeding and branding effects of contesting by gear manufacturers in sport competitions.

Second, an interesting extension of the current study would be to examine and compare branding effects (e.g., brand’s sales performance) between contesting in and sponsoring of a sport competition. So far, studies have investigated the branding effects for gear and non-gear sponsors separately, while our study focuses on the branding effects of gear contestants only. A comparison of the branding effects, and the underlying theories that drive potential differences in consumer responses to sponsoring and contesting might provide valuable new insights.

Another interesting research topic related to the branding effects might be to what extent a specific link in manufacturers’ advertisements to the investments in the sport competitions (e.g., “We sell on Monday what we race on Sunday,” or in relation to success “If we can do it
there, we can do it everywhere”) would positively elevate the branding effects. A related issue is to investigate the mediating effect of advertising spending on the relationship between contesting in sport competitions and sales performance, especially when the relationships between the variables are non-linear in nature.

A fourth interesting avenue for further research is to investigate to what extent being a gear sponsor, rather than a gear contestant, would also lead to breeding effects in terms of a better innovation performance, and if so, if these breeding effects are comparable to, or stronger or weaker than the breeding effects of gear contestants. So far, studies on gear sponsors only provide evidence for a positive branding effect (e.g., Chung, Derdenger, and Srinivasan 2013), while breeding effects of being a gear sponsor have been totally neglected. However, as gear sponsors do collaborate with athletes to develop new products (e.g., Wilson collaborated with Roger Federer to develop new tennis rackets [Amer Sports 2018]), it is relevant to investigate if, and to what extent these collaborations between the gear sponsor and the sponsored athletes entails breeding effects (e.g., patents or patent citations) for the sponsoring manufacturer. And related to this, what role does the strength of the linkage between the manufacturer’s R&D and the sponsored or contesting team’s R&D play in developing impactful corporate patents.

To conclude, as many manufacturers have increasingly been involved in sport competitions over the past few centuries, either as a contestant or a sponsor, the return on these investments has clearly become an important management priority. Although academic research has covered a number of relevant branding issues related to manufacturers being a sponsor, the above discussed research areas suggest that the outcomes of manufacturers’ investments in sport competitions would still be an important research area for the years to come.
References


European Communities (2006), Regulation (EC), No 139/2004 - Case No COMP/M.4066 - CVC / SLEC.


Foster, George, and David Hoyt (2007), *Red Bull and Auto Racing: Sponsor or Own a Formula One Team?* Stanford Graduate Business School, Case SPM-35.


Keller, Kevin Lane (2003), *Strategic brand management: building, measuring, and managing brand equity*, Prentice Hall.


Stock, James, and Mark Watson (2015), Introduction to Econometrics, Pearson.


TABLE 1: SELECTED MANUFACTURERS AND BRANDS.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Selected brand(s)</th>
<th>Contesting brand(s) and years during which they contested</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW AG</td>
<td>BMW</td>
<td>BMW (2000-2010)†</td>
</tr>
<tr>
<td>General Motors Company</td>
<td>Opel (Vauxhall in the U.K.)</td>
<td>Did not participate</td>
</tr>
<tr>
<td>Groupe PSA</td>
<td>Citroen, Peugeot</td>
<td>Peugeot (2000)</td>
</tr>
<tr>
<td>Hyundai Motor Company</td>
<td>Hyundai</td>
<td>Did not participate</td>
</tr>
<tr>
<td>Kia Motor Corporation</td>
<td>Kia</td>
<td>Did not participate</td>
</tr>
<tr>
<td>Mazda Motor Corporation</td>
<td>Mazda</td>
<td>Did not participate</td>
</tr>
<tr>
<td>Nissan Motor Company Ltd</td>
<td>Nissan</td>
<td>Did not participate</td>
</tr>
<tr>
<td>Porsche AG†</td>
<td>Porsche</td>
<td>Did not participate</td>
</tr>
<tr>
<td>Proton Holdings Berhad</td>
<td>Lotus</td>
<td>Lotus (2010-2015)‡</td>
</tr>
<tr>
<td>Toyota Motor Corporation</td>
<td>Lexus, Toyota</td>
<td>Toyota (2002-2009)</td>
</tr>
<tr>
<td>Volkswagen Group</td>
<td>Audi, Bentley, Lamborghini, Seat, Skoda, Volkswagen</td>
<td>Did not participate</td>
</tr>
</tbody>
</table>

Notes:
† Lancia brand is not sold in the U.K.
‡ Despite the connection between Porsche AG and the Volkswagen Group, we treat them as two separate entities. Until 2012, Porsche AG and Volkswagen had strong ties, including equity stakes in both directions. In 2012, the two companies actually merged, but they reported separately until the end of our data period.
‡ Outsourced development of the race team: BMW (2010), Jaguar (2000-2004) and Lotus (2010-2015). Our key findings are robust when we include a dummy for these manufacturers during the years when they outsourced the development of the race team.
TABLE 2: DESCRIPTIVE STATISTICS FOR THE VARIABLES USED IN THE BREEDING ANALYSIS.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (std. dev.)</th>
<th>Innovation performance</th>
<th>F1 participation</th>
<th>F1 spending</th>
<th>F1 performance</th>
<th>R&amp;D spending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation performance (patent citations in ‘000)</td>
<td>6.943 (9.476)</td>
<td></td>
<td></td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1 participation (no/yes)</td>
<td>0.341 (0.475)</td>
<td>.252</td>
<td></td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1 spending (billion euros)</td>
<td>0.044 (0.071)</td>
<td>.479</td>
<td>.851</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1 performance (in 100s points)</td>
<td>0.643 (1.595)</td>
<td>-.111</td>
<td>.562</td>
<td>.321</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>R&amp;D spending (million euros per employee)</td>
<td>0.018 (0.012)</td>
<td>.094</td>
<td>-.110</td>
<td>-.020</td>
<td>-.154</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*Note: All variables in the breeding analysis are measured at the manufacturer-global-year level.*
### TABLE 3: DESCRIPTIVE STATISTICS FOR THE VARIABLES USED IN THE BRANDING ANALYSIS.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (std. dev.)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sales Performance – Vehicle registrations (in thousands)</td>
<td>5.699 (9.113)</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. F1 participation (no/yes)</td>
<td>0.132 (0.338)</td>
<td>.079</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. F1 spending (billion euros)</td>
<td>1.784 (5.801)</td>
<td>.113</td>
<td>.782</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. F1 performance (in 100s points)</td>
<td>0.033 (0.150)</td>
<td>.048</td>
<td>.569</td>
<td>.421</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Advertising spending (million euros)</td>
<td>5.496 (8.533)</td>
<td>.495</td>
<td>.063</td>
<td>.095</td>
<td>.067</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. New product introductions</td>
<td>0.085 (0.346)</td>
<td>.111</td>
<td>.100</td>
<td>.113</td>
<td>.088</td>
<td>.069</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. F1 TV viewers (millions)</td>
<td>0.675 (2.023)</td>
<td>.070</td>
<td>.856</td>
<td>.701</td>
<td>.467</td>
<td>.089</td>
<td>.087</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Competitors’ Sales Performance – Vehicle registrations (in millions)</td>
<td>0.178 (0.080)</td>
<td>.176</td>
<td>.054</td>
<td>.069</td>
<td>-.010</td>
<td>-.092</td>
<td>.018</td>
<td>.076</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>9. Competitors’ advertising spending (billion euros)</td>
<td>0.184 (0.142)</td>
<td>-.056</td>
<td>.003</td>
<td>-.012</td>
<td>.028</td>
<td>.431</td>
<td>-.008</td>
<td>.083</td>
<td>-.065</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*Note: All variables in the branding analysis, except F1 participation, F1 spending and F1 performance, are measured at the brand-country-month level. F1 participation is measured at the brand-global-year level and F1 spending and performance are measured at the brand-global-month level.*
TABLE 4: THE EFFECTS OF MANUFACTURERS’ F1 CONTESTING ON INNOVATION PERFORMANCE (BREEDING ANALYSIS).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Estimates for the model in which F1 contesting is measured as</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>F1 participation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Main effects only</td>
</tr>
<tr>
<td>F1 participation (H1)(^{i})</td>
<td>(\theta_1)</td>
<td>.470***</td>
</tr>
<tr>
<td>F1 spending (H1)(^{i})</td>
<td></td>
<td>N.A.</td>
</tr>
<tr>
<td>F1 performance (H1)(^{i})</td>
<td></td>
<td>N.A.</td>
</tr>
<tr>
<td>R&amp;D spending per employee</td>
<td>(\theta_2)</td>
<td>.419***</td>
</tr>
<tr>
<td>F1 participation × R&amp;D spending per employee (H2)</td>
<td>(\theta_3)</td>
<td>N.A.</td>
</tr>
<tr>
<td>F1 spending × R&amp;D spending per employee (H2)</td>
<td></td>
<td>N.A.</td>
</tr>
<tr>
<td>F1 performance × R&amp;D spending per employee (H2)</td>
<td></td>
<td>N.A.</td>
</tr>
<tr>
<td>(R^2)</td>
<td></td>
<td>.860</td>
</tr>
</tbody>
</table>

Number of observations: 205

Notes:
\* p-value < 0.10; \** p-value < 0.05; \*** p-value < 0.01.
\(^{i}\) Since R&D spending per employee is mean centered, the simple effect of F1 participation, spending or performance denote the effect for a manufacturer with mean level of R&D spending per employee.
## TABLE 5: THE EFFECTS OF BRANDS’ F1 CONTESTING ON SALES PERFORMANCE AND ADVERTISING SPENDING (BRANDING ANALYSIS).

<table>
<thead>
<tr>
<th>Dep. var</th>
<th>Independent variable</th>
<th>Parameter Estimates for the model in which F1 contesting is measured as</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>F1 participation</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Main effects only</strong></td>
</tr>
<tr>
<td>Sales perf.</td>
<td>F1 participation (H3)</td>
<td>( \beta_1 )</td>
</tr>
<tr>
<td></td>
<td>F1 spending (H3)</td>
<td>( \beta_2 )</td>
</tr>
<tr>
<td></td>
<td>F1 performance (H3)</td>
<td>( \beta_3 )</td>
</tr>
<tr>
<td></td>
<td>Advertising goodwill</td>
<td>( \beta_4 )</td>
</tr>
<tr>
<td></td>
<td>F1 participation × Advertising goodwill (H4)</td>
<td>( \beta_5 )</td>
</tr>
<tr>
<td></td>
<td>F1 spending × Advertising goodwill (H4)</td>
<td>( \beta_6 )</td>
</tr>
<tr>
<td></td>
<td>F1 performance × Advertising goodwill (H4)</td>
<td>( \beta_7 )</td>
</tr>
<tr>
<td></td>
<td>F1 participation × Number of F1 TV viewers</td>
<td>( \beta_8 )</td>
</tr>
<tr>
<td></td>
<td>F1 spending × Number of F1 TV viewers</td>
<td>( \beta_9 )</td>
</tr>
<tr>
<td></td>
<td>F1 performance × Number of F1 TV viewers</td>
<td>( \beta_{10} )</td>
</tr>
<tr>
<td></td>
<td>New products introduced in last 12 months</td>
<td>( \beta_{11} )</td>
</tr>
<tr>
<td></td>
<td>Competitors’ sales performance</td>
<td>( \beta_{12} )</td>
</tr>
<tr>
<td></td>
<td>Lagged advertising spending</td>
<td>( \delta_1 )</td>
</tr>
<tr>
<td></td>
<td>Lagged sales performance</td>
<td>( \delta_2 )</td>
</tr>
<tr>
<td></td>
<td>New product introductions</td>
<td>( \delta_3 )</td>
</tr>
<tr>
<td></td>
<td>Lagged advertising spending</td>
<td>( \delta_4 )</td>
</tr>
<tr>
<td></td>
<td>Lagged sales performance</td>
<td>( \delta_5 )</td>
</tr>
<tr>
<td></td>
<td>Competitor’s advertising spending</td>
<td>( \delta_6 )</td>
</tr>
<tr>
<td></td>
<td>Advertising spending in other 4 countries (IV)</td>
<td>( \delta_7 )</td>
</tr>
<tr>
<td></td>
<td>Number of observations</td>
<td></td>
</tr>
</tbody>
</table>

Notes: \( p \)-value < 0.10; \( ** \) \( p \)-value < 0.05; \( *** \) \( p \)-value < 0.01.
FIGURE 1
CONCEPTUAL MODEL

Contesting in a Sport Competition by a Gear Manufacturer:
• Participation
• Spending
• Performance

R&D spending

H1
Breeding effect

Innovation Performance

Advertising spending

Branding effect

Sales Performance

Control variables

Control variables

H2
FIGURE 2A
INTERACTION BETWEEN F1 PARTICIPATION AND R&D SPENDING PER EMPLOYEE ON INNOVATION PERFORMANCE

FIGURE 2B
INTERACTION BETWEEN F1 SPENDING AND R&D SPENDING PER EMPLOYEE ON INNOVATION PERFORMANCE
FIGURE 2C
INTERACTION BETWEEN F1 PERFORMANCE AND R&D SPENDING PER EMPLOYEE ON INNOVATION PERFORMANCE

FIGURE 3A
INTERACTION BETWEEN F1 PARTICIPATION AND ADVERTISING SPENDING ON SALES PERFORMANCE
FIGURE 3B
INTERACTION BETWEEN F1 SPENDING AND ADVERTISING SPENDING ON SALES PERFORMANCE

Percentage change in sales performance (vehicle registrations) if F1 spending increases by 1% of the current spending.

Monthly advertising spending (in million euros)

FIGURE 3C
INTERACTION BETWEEN F1 PERFORMANCE AND ADVERTISING SPENDING ON SALES PERFORMANCE

Percentage change in sales performance (vehicle registrations) if F1 points increase by 1% of the current points.

Monthly Advertising spending (in million euros)