Firms' Strategic Leverage of Unplanned Exposure and Planned Advertising: An Analysis in the Context of Celebrity Endorsements

Timothy P. Derdenger, Hui Li and Kannan Srinivasan*

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Abstract

Using data on advertising and sales of an innovative piece of golf equipment and the performance of its celebrity endorsers, we build a discrete choice model that incorporates consumer awareness and preferences. We empirically investigate how celebrity endorsements affect consumer choices during new product introductions, the roles of planned advertising and unplanned media exposure, and how firms can strategically leverage the unplanned component. Model estimates reveal that wins in professional golf tournaments, which proxy for unplanned television exposure during weekly PGA golf tournaments, affect awareness, and that paid planned advertising impacts awareness and preferences. Focusing on Titleist equipment, counterfactual analysis demonstrates that the unplanned media exposure and planned advertising accounts for 22% and 24% of sales, respectively. The results also suggest that firms would benefit from coordinating the two. The planned portion should serve as a "substitute" for unplanned media exposure in the early stage and a "complement" as products age.

Keywords: Advertising, Awareness, Celebrity Endorsements, Golf

*Tim Derdenger is Assistant Professor in Marketing & Strategy, Tepper School of Business, Carnegie Mellon University.
e-mail: derdenge@andrew.cmu.edu.
Hui Li is Assistant Professor in Marketing, Tepper School of Business, Carnegie Mellon University.
e-mail: huil1@andrew.cmu.edu
Kannan Srinivasan is the H.J. Heinz II Professor of Management, Marketing and Information Systems, Tepper School of Business, Carnegie Mellon University.
e-mail: kannans@andrew.cmu.edu.

1 Introduction

Celebrity endorsements are continuously gaining momentum as a major activity across a number of sports: soccer, football, basketball, baseball, cricket, and tennis. Tens of millions of dollar contracts are becoming the norm rather than the exception, and 100 million dollar contracts do not attract the kind of media attention they once did. When the celebrity endorsing a brand performs exceptionally well in a given time or over an extended period, substantial additional publicity surrounds the athlete and provides significant additional exposure for the brand endorsed. In sports such as cricket, baseball (pitcher), and golf, the focal attention and hype can last for hours. This fanfare happens in all the sports, to varying degrees, but in a highly impactful manner. For instance, 14.6 million people watched CBS's coverage of the 2005 Masters golf tournament and saw Tiger Woods hole out an improbable shot from off the green on the 16th hole of the final round of the tournament to overtake Chris DiMarco as the leader and win two holes later. This shot–in which the golf ball teetered on the hole's edge for a full two seconds, Nike logo visible and all, before toppling into the cup–was so monumental that the television coverage was turned into a commercial by Nike for its Nike One golf ball a few weeks later.[1] Likewise, even in a 100-meter dash that lasted a mere ten seconds, Usain Bolt's spectacular performance in the 2012 Olympics was replayed numerous times across prime time television around the globe, with over 20 million views of the event on YouTube. In fact, the success of Usain Bolt has been completely integrated in a global advertising campaign by Nissan.[2]

When such an unplanned surge in media exposure happens for an athlete and hence the brand that is endorsed, how should the brand strategically react? Should the firm decrease planned advertising given this windfall of free media exposure? Should it leverage the hype further and utilize traditional television advertising even more? Do the strategies differ if the firm is introducing a product that is new or has been around for a while? These are the core research issues examined in this paper. We should note that such research questions are particularly important for extraordinary celebrity athletes (e.g., Michael Jordan (basketball), Stephan Curry (basketball), Tiger Woods (golf), Roger Federer (tennis), and Virat Kholi (cricket)), as their endorsements are often the most influential to consumers and the most expensive to firms.

[1] http://adland.television/commercials/nike-golf-one-tiger-woods-masters-2005-030-usa

[2] See https://www.youtube.com/watch?v=6G9Kd-9cCT0.

Previous studies have shown that celebrity endorsements can and do increase firm value via sales or stock prices (e.g., Agarwal and Kamakura [1995], Elberse and Verleun [2012] and Chung et al. [2013]). Survey results also suggest that celebrity endorsements seem to raise brand awareness.[3] Yet, there is no research that highlights the unique nature of planned advertising and unplanned media exposure and how firms should possibility coordinate the two. There is also no empirical research, to the best of our knowledge, that studies the impact of celebrity endorsement on both awareness through consideration set formation and preference through choices. This paper aims to fill this gap and provide a better understanding of celebrity endorsements.

To do so, we empirically investigate the planned and the unplanned nature of celebrity endorsement as an advertising tool in the context of the golf industry. We aim to address three questions: First, how does a celebrity endorsement affect consumer choice? Is it through raising awareness, preferences, or both? Second, how much do the planned and unplanned components contribute to the overall impact on sales? Third, how should firms manage and coordinate the planned exposure alongside the unplanned?

We focus on the golf industry and specifically the Titanium driver equipment market. We employ 36 months of aggregate sales data for two retail channels to determine celebrities' impact on consumer awareness and preference and study how firms should manage planned and unplanned brand exposure. The golf industry is a particularly suitable setting for studying celebrities' impact. Professional golfers are highly credible endorsers of golf related equipment, as they use the endorsed equipment in tournaments to earn prize money. Further, we expect their impact to be salient in this setting because their credibility would be particularly helpful in settings where consumers face more uncertainty about the product (i.e., during new product introduction). Additionally, a natural measure of celebrity attractiveness exists with the Official World Golf Rankings (OWGR), as the two most important aspects in selecting a celebrity endorser are attractiveness/quality and credibility.

We center on golfers who are ranked in the Top Ten in the world golf rankings in the last data

[3] An Attitudes and Usage Survey conducted by Golf Datatech, a marketing research firm which focuses on the golf industry, identifies several factors that lead to effective advertising: frequency of ads, ad creative, and the use of celebrity endorsements. Moreover, looking specifically at consumers who said Nike was the most effective advertiser in 2009, 40% of these consumers believe the use of Tiger Woods as a celebrity endorser made Nike ads the most effective. Support for such a finding is also found in the survey where in 2000, prior to Tiger Woods endorsing Nike equipment, Nike's unaided awareness was at 5% but in 2002, 18 months after Tiger Woods had endorsed Nike, it had increased to 25% (not proven to be a causal effect).

period, December 1999, and determine the brands they endorsed based on the brand of equipment they played. To model consumers' consideration set formation and choice decisions, we employ television and magazine advertising expenditure data, which proxies for exposure, (i.e., the planned part) for each brand in the market to allow different advertising media to impact brand awareness differently. We also allow advertising to impact consumer preferences, which is consistent with Becker and Murphy [1993]. In addition to planned advertising entering consumer preferences, a professional's official world golf ranking also impacts preferences as it captures consumer prestige. The Official World Golf Ranking is a long-term performance measure that proxies for player quality. Higher player quality increases consumer preferences for the endorsed brand because consumers want to associate themselves with the celebrity endorser. For the unplanned aspect, we use a measure of player performance that is based on a win or second place finish in a golf tournament to proxy for television exposure during weekly PGA golf tournaments. Each weekly golf tournament is typically televised on a network (ABC, NBC, CBS). A first or second place finish usually results in the player having a high level of television exposure because the networks choose to follow players who have a high likelihood of winning [Jensen, 2012]. To further support this idea of a win providing valuable brand exposure, a recent Forbes.com article highlighted that the new (current) golf club brand PXG received over $2.4 million in free television exposure due to one of its celebrity endorsers, Billy Horschel, winning the AT&T Byron Nelson tournament.[4] We believe this type of exposure can affect consumer awareness as well as consumers' preferences, as consumers may want to associate themselves with a winner, leading to an increase in product utility, which again is consistent with Becker and Murphy's theory of complementary effects of advertising.

The estimation of our model indicates that celebrity endorsements do impact both consumer awareness and preference through three channels. First, the long-term celebrity performance has a prestige effect on preference. Second, tournament television exposure, via weekly tournament wins affects awareness and is dynamic–where the effect of a win persists over time, but does not impact consumer preferences. Third, the use of celebrities in television ads raises awareness as well as shifts consumer preferences. This effect, however, is only through greater expenditures and not from a difference in marginal effects between brands with and without celebrities in the Top Ten in the

[4]https://www.forbes.com/sites/erikmatuszewski/2017/05/22/pxg-snagged-2-4-million-in-brand-exposure-with-billy-horschels-pga-tour-win/#5cfa2fff1e58

OWGR.

We further measure the overall impact of celebrity endorsements and decompose the impact into planned advertising and unplanned using counterfactuals. We "turn off" the different channels and simulate sales and profits without the planned and unplanned components. In particular, planned advertising corresponds to the difference of television ad effectiveness with and without celebrities.[5] The unplanned component, which includes short-term performance as a proxy for television exposure during weekly golf tournaments, corresponds to the effect of wins or second place finishes on awareness and preferences. The results indicate that the unplanned and planned aspects for Titleist accounts for 22% and 24% of sales over the three year data period, respectively.[6] We also determine that the impact of celebrities on the choice set is measurable, with roughly a 1 to 12 percentage point impact on brand awareness, and declines with time.

In the second counterfactual, we analyze the relationship between planned and unplanned media exposure and whether the planned component should be negatively or positively coordinated with the unplanned component or independently allocated, as it is in practice. In other words, should firms have a larger television expenditure to increase exposure right after a player wins, to reinforce the benefit associated with the unplanned exposure, or should they wait until the benefits have worn off to advertise? We also explore how time moderates the relationship, e.g., how the relationship changes as products get older and consumers become more informed. Focusing on one of the brands, Titleist, we determine that planned brand exposures should be "substitutes" for unplanned exposure at the start of the product life-cycle to help keep advertisement at a high level and smooth over a duration of time. After the new product has matured–in our case, after the first year– the relationship migrates to a complementary relationship, as the marginal return of a win decreases as the product ages.

Although we focus on the celebrity aspect of unplanned media exposure, it is inherently more broad. For instance, advertising (without celebrities) can go viral, or a public relations event may cause a windfall of exposure. Given that these unplanned events, outside the context of celebrity endorsements, lead to an increase in exposure, the above questions we address are also relevant. How

[5] In our counterfactual simulations we focus on Titleist and lower its television advertising revenue to the mean level associated with brands without celebrities in the Top Ten.

[6] These results do not include the impact of player prestige. All simulations hold player quality (OWGR) to what is observed in the data.

should the brand strategically react? Should the firm decrease advertising, given this windfall of free exposure? Should it leverage the hype further and utilize traditional television advertising even more? Do the strategies differ if the firm is introducing a product that is new or has been around for a while? Our results, in the context of celebrity endorsements, may therefore shred insight into the broader domain of the effects and coordination of planned advertising and unplanned media exposure.

2 Literature Review

Research has shown that advertising does impact sales and that there exist theories that illustrate how advertising helps inform consumers about a new product, and persuades them to purchase and recall an existing product. Moreover, numerous papers look at the interaction of multiple advertising tools. We add to this literature. There have been studies on the relative effectiveness of multimedia advertising activities (e.g., Montgomery and Silk [1972]) and the synergy among them (e.g., Jagpal [1981], Naik and Peters [2009]). Naik and Raman [2003] empirically study the synergy between television and magazine advertisements in a dynamic setting and derive theoretical propositions on the implications for media budget allocation. We study the effect of celebrities in television commercials and its synergy with celebrity performance. We further show the implications on the allocations of advertising expenditure.

In addition to empirically studying the effectiveness of television and magazine advertising, the paper also contributes to the literature on new and traditional media marketing channels. New media such as Internet advertising have expanded the set of tools that firms can use to influence consumers (Winer [2009]). Studies have documented the effectiveness of new media in promoting product adoption and driving sales (e.g., Trusov et al. [2009]; Tucker [2014]). An important feature of the effect of new media is the "uncontrolled" nature. For instance, firms do not have full control over "buzz" or viral marketing through social media websites. We find that the effect of a celebrity endorsement has a similar "uncontrolled" element, which occurs indirectly through the athlete's performance. The difference is that firms can attempt to influence "buzz" or viral marketing by actively participating in social media (e.g., Aral and Walker [2011], Dellarocas [2006]), whereas firms do not have any influence over celebrity performance. We argue that firms should coordinate

the controlled part (i.e., television and magazine advertising expenditure) and the uncontrolled part (i.e., celebrity performance) by adjusting advertising expenditure in response to the celebrity's performance.

The paper also adds to the literature on techniques to empirically distinguish different effects of brand advertising. For instance, Ackerberg [2003] analyzes whether advertising in the yogurt market possesses informative and prestige effects and finds that the primary effect of advertising is informative. Ching and Ishihara [2012] study the informative and persuasive roles of advertising but focus their attention on detailing in the prescription drug industry. They determine that there are both informative and persuasive effects of detailing. Honka et al. [2015] also include the impact of advertising into a model of awareness and choice behavior. Their model is specific to the banking industry, though, and does not incorporate any unplanned media exposure.

This paper also joins a growing body of literature in sports marketing that employs structural models and sophisticated empirical techniques. A recent paper by Chung [2013] studies the dynamic advertising effects of college athletics. He specifically measures "the spillover effect of intercollegiate athletics on the quantity and quality of applicants to institutions of higher education in the United States" using a static structural demand model. This spillover is popularly known as the "Flutie Effect." Chung [2013] determines that the "goodwill created by intercollegiate athletics resides more extensively with low-ability students than with their high-ability counterparts. But, surprisingly, athletic success impacts applications even among academically stronger students." Yang et al. [2009] study the impact of brand alliances on brand equities. Their paper takes a novel view of brand alliances and "examine[s] the alliances between professional athletes (athlete brands) and sports teams (team brands) in the National Basketball Association (NBA)." They determine "that top brands are not necessarily best off matching with other top brands." Finally, a working paper by Liu et al. [2014] studies the role branding plays in attracting corporate sponsorship and raising revenue for the multi-billion dollar business of college sports. Specifically, they study the "peer effects of brand performance in the dynamic revenue evolution of major college sports teams that play in the National Collegiate Athletic Association conferences." Their analysis illustrates sizeable peer effects in the four major conferences, indicating that teams benefit from playing in a conference with teams of strong brands.

Finally, we relate our paper to the literature on how advertising affects awareness through

consideration set formation (Sovinsky [2008], Mehta et al. [2003]; Draganska and Klapper [2011]; Barroso and Llobet [2012]). Our paper is most closely related to Sovinsky [2008], in that we use a similar estimation procedure to estimate how consumers' form consideration sets when such information is unobserved to the researcher. In a similar vein, we adopt numerous functional forms specifications for variables of interest from Chung et al. [2013] in order to capture how endorsements and exposure impact consumer awareness and preferences. We move beyond Chung et al. [2013]'s model and findings that celebrity endorsements impact consumer preferences by also modeling consumer consideration set formation and analyzing how celebrity endorsements impact consumer awareness. Finally, we also move the literature forward by analyzing how firms should manage planned and unplanned exposure over a product's life-cycle.

3 The Golf Industry

The golf industry in the United State is a very lucrative and highly innovative. On average, the research and development budgets of the leading manufacturers averages 30 million dollars per year leading to over 100 million dollars spent on R&D industry-wide. Surveys (e.g., Golf Datatech) show that innovations in equipment is important for consumers.

We focus on the category of Titanium drivers (Figure 1). The inclusion of titanium in the club heads of drivers was a substantial innovation over existing products.[7] In fact, after the incorporation of titanium into drivers, driving distance on the PGA tour increased from 266 yards in 1996 to 272.5 yards in 1999.[8] Furthermore, driving accuracy (the ability to hit the fairway off the tee) increased from 68% to 69.5% during the same time frame.

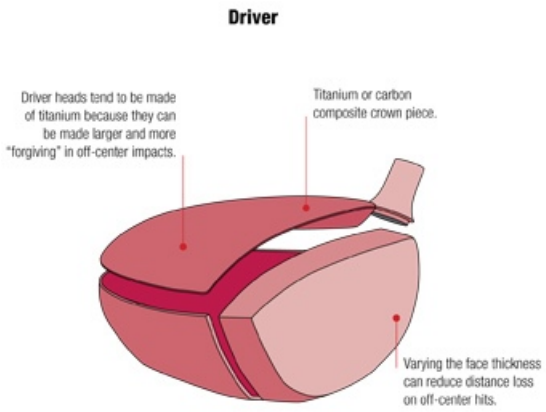
[7]This change was a major step forward in the science and technology of golf club design. Titanium is lighter, stronger, and more elastic than other metals. Titanium is used in the club heads of drivers because it allows manufacturers to increase the overall size and the sweet spot without increasing the overall weight. Drivers with titanium club heads and graphite shafts weigh less than stainless steel club heads and shafts, which enables players to increase club head speed and hit the ball farther. In addition, the larger sweet spot means mishits are likely to travel farther and straighter. Since titanium is more elastic and stronger than steel, a thin titanium club face is said to increase the trampoline effect of the ball springing off the club face, although the USGA says this effect is limited to pro-level players who generate very high club head speed. (http://golftips.golfsmith.com/golf-clubs-made-titanium-20483.html)

[8]https://www.amstat.org/newsroom/pdfs/198.feature.pdf

Figure 1: Golf Clubs

(a) Woods

(b) Driver Technology



3.1 Celebrity Endorsements in the Golf Industry

In the golf industry, celebrity endorsements are an important marketing tool as many brands employ PGA tour players as celebrity endorsers. Endorsement contracts between player and brand are for an agreed duration of time and for specific service–the most important in the golf context is which brand of equipment and apparel will the player play with or wear during televised golf tournaments. Players are also typically required to be featured in television commercials and print advertisements. A prominent example of a endorsement contract is the one Tiger Woods signed in June of 2000 (and again in 2005) with Nike Golf. The contract was a five-year deal worth $100 million and specified that Tiger Woods use Nike golf balls and clubs and wear Nike apparel during tournament rounds. $100 million for five years of endorsement services was and remains an anomaly for PGA tour players. Compensation is a function of many factors, but two of the most important are the scope of services required by the player and the quality of the golfer as measured by the Official World Golf Ranking. Woods was able to command $20 million per year from Nike because of his OWRG, whereas a typical PGA tour player ranked outside the top 50 earns roughly $100,000 to $500,000 per year from an endorsement deal.

3.2 Planned and Unplanned Media Exposure in the Golf Industry

Advertising in the golf industry is an important marketing tactic, as it can change consumer preferences as well as awareness of a given product.[9] Firms can advertise through traditional channels such as television, magazine and through celebrity endorsements. Those firms that also have celebrity endorsers leverage such assets by placing endorsers in television advertising creatives. As we will discuss below, we are in possession of television and magazine advertising expenditure data for each brand of titanium driver. Television advertisements are assumed to include celebrities, whereas magazine creatives do not. This data assists in measuring reach or exposure of a brand by assuming that expenditures are a proxy for exposure–given that the message the firm or brand presents to consumers is set. Firms also usually set magazine and television expenditure levels at least 6 months before the official start of the golf season (March) without regard to how their set of celebrity endorsers finishes golf tournaments (the unplanned component). Once budgets are set, firms go to the advertising marketplace to purchase spots for television and magazine–in many instances, annual or long-term contracts are used to lower costs in a particular market. Nonetheless, the advance purchase of advertising does not restrict the firm or marketing manager from going back to the ad market to increase its spend in order to coordinate with a win of a golf tournament by one of its celebrities. However, we find that such an event does not occur in practice.

In contrast to paid advertising, unplanned media does not require an outlay of expenditures. In our context, unplanned media refers to television exposure the brand receives during weekly golf tournaments. This free television exposure happens because weekly golf tournaments are televised on network stations, with the winner and runner-up, on average, receiving 55% of the televised tournament air time [Jensen, 2012].[10] This type of advertising is inherently volatile, as it depends upon the performance of the athletes each week who endorse a brand.

[9] We thank a referee for pushing us to discuss further what exactly is advertising and how firms partake in the marketplace.

[10] Furthermore, this variable would also proxy and capture for any increased news regarding the celebrity from winning or finishing second such as weekend sports highlights or Monday newspaper articles.

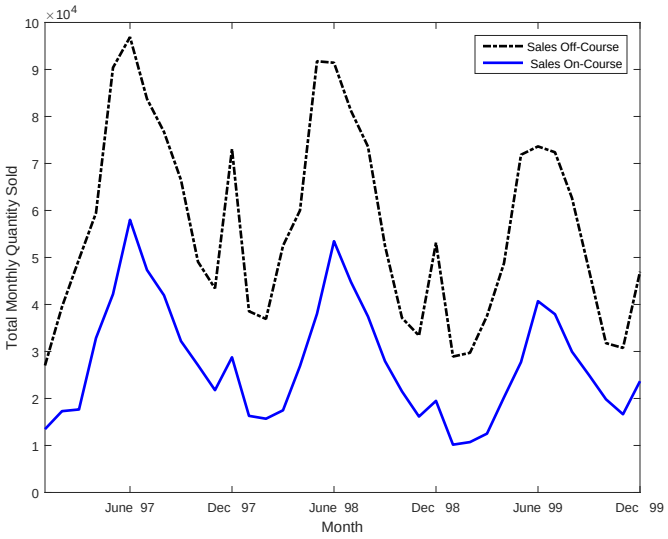
4 Data

We use aggregated U.S. monthly sales for each product in the titanium driver market collected by Golf Datatech. The time period encompasses January 1997 to December 1999. This data represents the total sales for on-course (green grass) and off-course golf specialty stores. The sales figures originate from over 550 on-course shops, and over 250 off-course shops, which are then extrapolated to an aggregate U.S. level.[11]

4.1 Sales, Pricing, and Entry

Below we present plots of sales for titanium drivers over time and summary statistics for the titanium driver market.

Figure 2: Titanium Driver Sales: 1997-1999



The sales of titanium drivers are highly seasonal, as shown in Figure 2, and also decline with time. This decline is not specific to this category of goods, but is present in the general golf equipment category.[12] The titanium driver market was also relatively concentrated over the data period with the top four firms holding over 90% the market share. Table 1 presents the market shares (across

[11]The golf industry consists mainly of two retail channels, on-course and off-course. On-course sales occur at golf course pro-shops around the country. These pro-shops act as retail stores for the courses where apparel and equipment are sold, in addition to where consumers register and pay to play rounds of golf. The second channel consists of sporting goods stores, such as Sports Authority and Dick's as well as specialized golf stores like the PGA Superstore and Golf Galaxy. Consumers can purchase apparel and equipment like that of on-course stores but are unable to play rounds of golf.

[12]http://www.golf2020.com/media/30717/2002golf2020economicreport.pdf

both on- and off-course channels) of all brands for the observed data period. We also include the industry Herfindahl–Hirschman Index (HHI) at the beginning and the end of the data period, January 1997 and December 1999, to further illustrate the concentration of the market. There were 14 different brands observed in the data with those 14 brands creating 22 unique products. It is important to note that not all brands and products were available in the same time period as many new brands entered the market and old products were retired. This entry of new products eliminates the concern one might have regarding advertising being used as a barrier to entry [Erdem and Keane, 1996]. In Figure 3, we present the number of unique products and brands in the marketplace in a given time period. From 1997 to the end of 1999, the number of unique products rose from 7 to 14, with brands increasing from 7 to 10. In Table 2, we also list the brands and their first product that entered after January 1997.

Table 1: Market Statistics for Titanium Drivers Brands: (1997-1999)

Brand	Share	Total Sales	# of Products	Num.of Months in Data	Average Price
ADAMS	0.49%	15,270	1	12	**$315.03** [$279.77 ; $356.14]
CALLAWAY	45.79%	1,424,530	3	36	**$348.42** [$207.75 ; $489.17]
CLEVELAND	0.44%	13,650	1	12	**$266.21** [$242.15 ; $286.44]
COBRA	11.05%	343,600	1	36	**$233.20** [$174.32 ; $284.63]
DAIWA	0.16%	5,060	1	8	**$318.87** [$276.66 ; $398.51]
LYNX	1.10%	34,210	1	24	**$233.98** [$140.95 ; $307.41]
MIZUNO	1.49%	46,280	1	28	**$294.49** [$165.85 ; $373.13]
PING	1.37%	42,660	1	18	**$376.60** [$351.83; $400.52]
TAYLORMADE	30.38%	944,990	3	36	**$275.68** [$351.83; $484.63]
TEARDROP	0.69%	21,520	2	35	**$181.12** [$141.95 ; $278.18]
TITLEIST	4.57%	142,320	3	36	**$335.53** [$147.00 ; $443.69]
TOP FLITE	1.36%	51,070	1	27	**$211.43** [$104.00 ; $331.69]
WILSON	0.43%	13,350	2	28	**$257.71** [$180.23 ; $306.64]
YONEX	0.40%	12,370	1	8	**$299.46** [$248.73 ; $342.19]
			Jan 1997	Dec. 1999	
		HHI	3343	3533	
		Four Firm	95.52	90.29	
		# of Products	7	13	

Figure 3: Product Entry

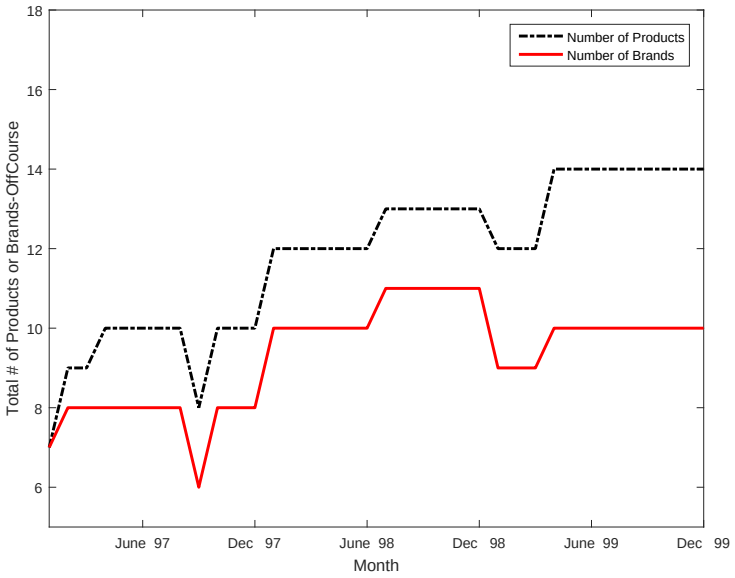


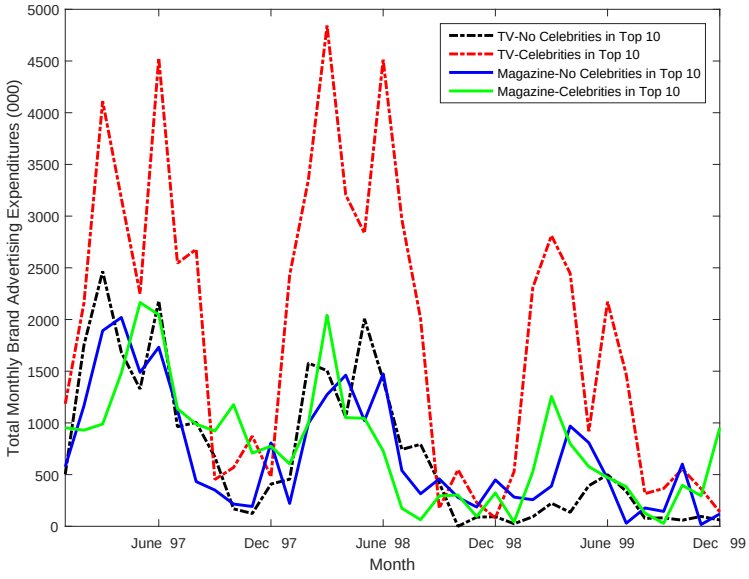
Table 2: Entrants Post January 1997

Brand	Entry Date	First Product
ADAMS	Jan-99	SC DRIVER (B)
CLEVELAND	Jan-98	T.A. TITANIUM (B)
MIZUNO	Sep-97	T-ZOID TITANIUM (B)
PING	July-98	ISI TITANIUM (B)
TEARDROP	Feb-97	TOMMY GUN (B)
TOP FLITE	Oct-97	TF INTIMIDATOR 400 (B)
WILSON	Sep-97	STAFF TITANIUM (B)

4.2 Planned Paid Media: Advertising Data

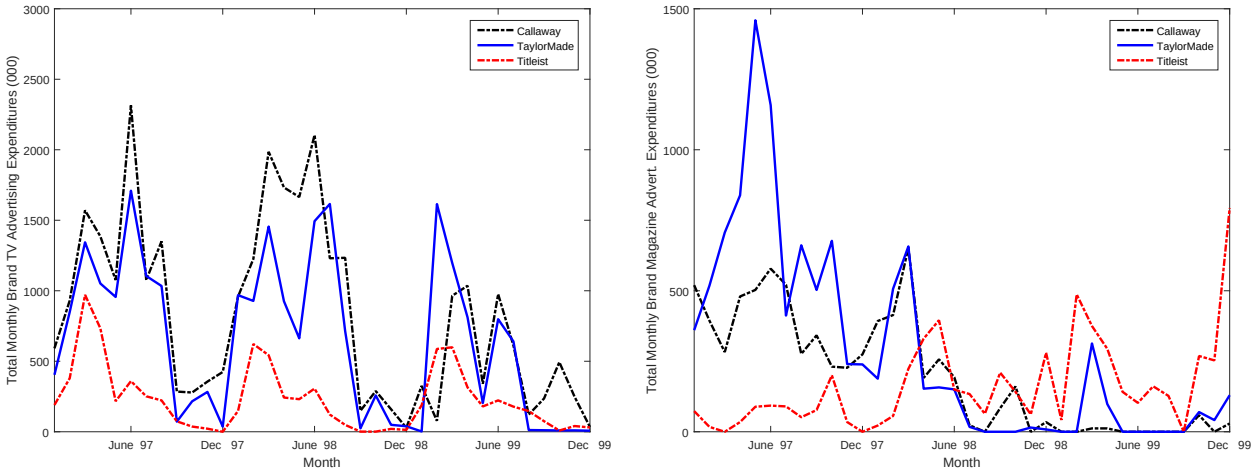
We employ data from Kantar Media that tracks the advertising expenditures for each *brand* within television and magazines as a proxy for advertising exposure. Figures 4 and 5 present plots of magazine and television advertising expenditures for brands with celebrities in the Top Ten in the OWGR and those without, as well as at the brand level for the three of the largest brands (Callaway, TaylorMade, Titleist). Aggregate television and magazine ad expenditures look quite seasonal, with a spikes in March (the month the formal golf season starts), June, and in the closing month of August. In the case of magazine advertising, seasonality plays a much smaller role, but does include a similar spike in the month of March as seen in Figure 4. Moreover, brands with celebrities in the Top Ten outspend their counterparts in television adverting by the magnitude of 2.5 times. Figure 4 certainly illustrates that brands with endorsers in the Top Ten OWGR attempt to leverage their celebrities with increased television expenditures. Magazine advertisements, however, do not illustrate a similar separation. As a result, we assume that magazine ads do not include celebrity endorsers.[13] Thus, any empirical work that includes magazine ads will assume the marginal effect of utility or awareness from such is the same for brands with endorsers in the Top Ten and for those without.[14]

Figure 4: Industry Monthly Brand Advertising



[13] We also do so given the difficult nature of determining whether celebrities are present in the ad creatives.
[14] A simple image search of golf driver magazine ads reveals many ads without celebrities.

Figure 5: Monthly Brand Advertising



(a) Television Advertising

(b) Magazine Advertising

4.3 Unplanned Weekly Television Exposure: Winning and Second Place Data

In addition to planned paid advertising over 100 tour golfers play in PGA golf tournaments each week, competing for an average prize purse worth over $3 million. At the start of each four day tournament, any player in the field has a chance to win–the player with the lowest four day total. Almost all golf tournaments are televised, with the two weekend rounds being televised on one of the major network channels (i.e., NBC, ABC, or CBS) and the first two days on a cable channel such as the golf channel. Typically, the players that are on top of the leaderboard are those who receive the most television coverage, regardless of their world ranking. Jensen [2012] specifically analyzes the drivers of television exposure in televised sports events. He looks at the relationship between a golfer's performance and sponsor exposure during televised golf events. He determines that a player's finish in a tournament is an extremely important driver of his television exposure. As the golfer's finishing position becomes worse, the amount of exposure falls. The author also presents statistics from six major golf tournaments from July 2006 through August 2007 and determines that the golfers who finished in the top two positions received no less than 38% of the television coverage and averaged over 55%. Likewise, Grange (1999) reports that when Tiger Woods won the Masters Tournament in April 2000 he was on-screen for 32% of the broadcast time, whereas the rest of the field was on-screen for 36% of the time.

In our empirical model below, we proxy for this unplanned weekly television exposure by em-

ploying whether a golfer wins or finishes second in each weekly golf tournament. This measure can impact a consumer's awareness of a particular brand as well as shift consumer preferences.[15] Awareness increases because a player who wins or finishes second can receive a large amount of television exposure, whereas preferences increase because consumers want to associate themselves with a winning brand, which is consistent with Becker and Murphy's theory of complementary advertising.[16]

In order to formulate our tournament exposure proxy variable, we specifically sum the number of golf tournament wins and runner-up finishes by top golfers who endorse brand b in a given month.[17] Each new variable is at the brand level. We define the winning and second place brand exposure variables as $wins_{b,t} = \sum_{g=1}^{G} PlayerWins_{g,b,t}$ and $seconds_{b,t} = \sum_{g=1}^{G} PlayerSeconds_{g,b,t}$ where

$$PlayerWins_{g,b,t} = \begin{cases} 4 * MWin_{g,t} + win_{g,t} & \text{if } \mathcal{I}_{g,b,t} = 1 \\ 0 & \text{if } \mathcal{I}_{g,b,t} = 0. \end{cases}$$

$$PlayerSeconds_{g,b,t} = \begin{cases} 4 * MSecond_{g,t} + second_{g,t} & \text{if } \mathcal{I}_{g,b,t} = 1 \\ 0 & \text{if } \mathcal{I}_{g,b,t} = 0. \end{cases}$$

Here, the variable $win(second)_{g,t}$ is an indicator variable that is 1 if player g at time t wins (finishes second in) the tournament.[18] $\mathcal{I}_{g,b,t}$ is an indicator variable equal to 1 if player g endorses brand b at time t. In order to account for one of the PGA Tour's four major tournaments we include the indicator variable $MWin_{g,t}(MSecond_{g,t})$, equal to 1 if the player who wins (finishes second) at t won (or placed second). The four major tournaments are the Masters Tournament, the U.S. Open Championship, the (British) Open Championship, and the PGA Championship. These tournaments are usually widely publicized and have typically larger audiences and longer television coverage than regular tournaments. According to Nielsen, the average number of viewers of the final round of the three U.S. major golf tournaments was approximately 12.75 million people from

[15] A win or second place finish is unplanned, in that a firm does not know which tournament the celebrity endorser will win.

[16] It is not difficult for viewers to identify the product/brand of equipment that golfers use, because the camera angle allows for an explicit view of the brands.

[17] This functional form is similar to Chung et al. [2013]

[18] We gather data to construct the above variables of interest from Yahoo! sports

1997-1999, and in 2015 it was 9.13 million.[19] In 2015, non-major tournaments reached roughly an average of 2.3 million during the final round of a each tournament, providing a ratio of 4x more viewers for majors than for non-majors in 2015. We make the assumption that the ratio of viewers in 2015 was the same for 1997-1999.[20] Therefore, in taking into account the additional exposure at these major tournaments, we assign a value of four to a major tournament and normalize the value of regular tournaments to one.[21]

In order for television exposure during golf tournaments to be random and classified as unplanned, we must show that wins/runner-ups are random (Figure 6) and that the probability of winning is low before the start of each tournament.[22] Fortunately, *The Economist* magazine has created a program called the EAGLE, the Economist Advantage in Golf Likelihood Estimator to highlight the latter concern. "EAGLE is a mathematical model of golf tournaments that estimates every player's chances of victory at every point in the event."[23] To highlight the low chance of winning in a given week, Figure 7 presents the final results and EAGLE predicted win probabilities for the 2016 British Open. An interesting finding is that the player who was predicted to win the event at the start of the tournament (the #1 ranked golfer in the world, Jason Day) did not finish in the Top Ten. Henrik Stenson, who won the tournament and who was the number 5th ranked player in the Official World Golf Ranking, had only a 3% chance to win, whereas the second best ranked player had only a 7% chance. With this evidence, we conclude that the ex-ante probability

[19] We do not include the British Open, due to the time change (6-9 hours) between the United States and the United Kingdom.

[20] http://www.sportsmediawatch.com/major-golf-ratings-historical-masters-us-open-british-pga-championship-tiger-woods/

http://www.sportsmediawatch.com/2016/10/pga-tour-ratings-wrap-2016-cbs-nbc-fox-viewership/

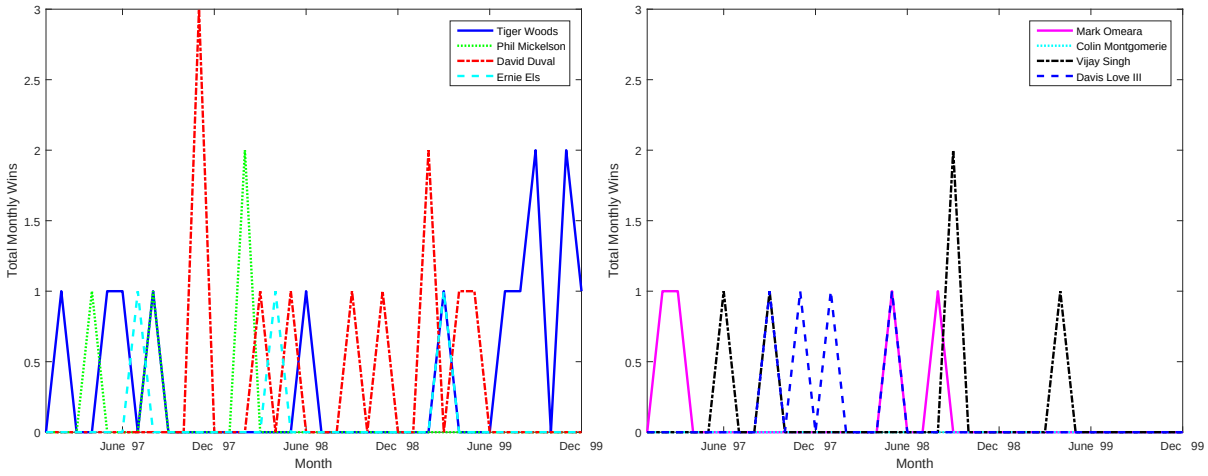
Unfortunately, were were unable to obtain data from 1999 regarding viewership of major tournaments and non majors. Nonetheless, the data found supports such an added benefit. We thank the associate editor for this recommendation.

[21] We do not estimate the above ratio given a major golf tournament is played only four times a year and in four different months. The number of total observations from major golf wins (or seconds) is 12 (4 tournaments x 3 years). 12 observations is far from the number of observations needed to identify the ratio let alone with statistical precision. Instead, we run sensitivity analysis with respect to the ratio. We specifically run analysis assuming the ratio is set at 4.5 and 3.5. The analysis is found in Appendix B and it illustrates that model parameters are not highly sensitive to different values.

[22] If the ex-ante probability of winning was large at the start of each tournament, firms could condition on this and television exposure via tournaments would be planned rather than unplanned.

[23] "[It] is based on a dataset of some 440,000 golfer-holes drawn from major tournaments during the past 15 years. Conceptually, it is quite straightforward. First, the system estimates each player's skill level on every hole they play. Next, it calculates the probability of a golfer of that ability producing each score type on every hole, ranging from an eagle (two strokes below par) to a quadruple bogey (four strokes above it), according to the hole's configuration and difficulty. Finally, it uses those probabilities to simulate every hole left to play in the event 10,000 times for each golfer, counting the number of simulations won by each participant in order to derive their chances of victory."

Figure 6: Player Wins: Short Term



of winning a tournament is very low for even the best golfers in the world and that first or second place finishes can therefore reliably be assumed as random and unplanned.

4.4 Celebrity Player Performance: Official World Golf Ranking

Long-term player performance is also an important consumer driver of demand [Chung et al., 2013] and can be employed as a measure of prestige [Becker and Murphy, 1993]. We measure player quality through a world ranking, which is based on a rolling two-year performance (Figure 8). As we will present below, this measure enters consumers' preference, as consumers might prefer celebrities with high long-term rank, because a product endorsed by a celebrity creates an image that is recognizable by others. This perception also does not drastically vary based on short-term monthly performance.

The functional form we employ to model the effect of player quality on the sale of the endorsed brand b by golfer g in period t is (and follows[Chung et al., 2013]'s specification)

$$En_{g,b,t} = \begin{cases} \left(\frac{1}{rank}\right) & \text{if } D_{g,b,t} = 1, \\ 0 & \text{otherwise} \end{cases}$$

where $D_{g,b,t}$ is an indicator equaling one if player g endorses brand b and zero otherwise. By tak-

Figure 7: EAGLE Prediction

British Open 2016 leaderboard

Final results and EAGLE-predicted win probability

Ranking			Win probability, %				Score to par
Final	Predicted at start		at start	end R1	end R2	end R3	
1	5	Henrik Stenson	3.1	5.2	32.6	63.9	-20
2	17	Phil Mickelson	1.4	20.0	31.7	33.9	-17
3	24	J.B. Holmes	0.9	0.7	0.4	0.3	-6
4	77	Steve Stricker	0.3	1.4	0.0	0.0	-5
T5	57	Tyrrell Hatton	0.4	0.2	0.1	0.0	-4
T5	12	Sergio García	1.9	3.3	2.9	0.1	-4
T5	4	Rory McIlroy	4.4	4.9	1.7	0.0	-4
8	114	Andrew Johnston	0.1	0.3	0.7	0.3	-3
T9	37	Bill Haas	0.6	1.3	1.6	1.1	-2
T9	2	Dustin Johnson	7.2	3.1	2.3	0.1	-2
T9	61	Soren Kjeldsen	0.4	2.0	6.5	0.1	-2

Source: *The Economist*

ing into account the variability of skill level over time, we assume that if there exists an endorsement effect, it will be larger when a player's world ranking approaches one. In practice, we include nine of the Top Ten golfers at the end of 1999 in the analysis.[24] These golfers are Tiger Woods, Phil Mickelson, David Duval, Ernie Els, Vijay Singh, Colin Montgomerie, Mark O'Meara, Lee Westwood, and Davis Love III. Table 3 presents the respective brand each golfer endorses and their corresponding wins and runner-up finishes broken down by major and non-major tournaments. Yet, we restrict the marginal effect associated with each endorser to be identical within brands, transforming the above variable for one celebrity to $En_{b,t} = \sum_g En_{g,b,t}$ for the portfolio of celebrities endorsing brand b. We do so to remain consistent with our advertising variables, as we are unable to identify which celebrities are in which ad creative, or in what fraction of ad expenditures. Figure 8 illustrates the variation in player (inverse) ranking, which proxies for prestige effect. Further analysis also determines the correlation between player ranking and wins is -0.071 and is particularly due to one's world golf ranking depending upon how others golfers play.

[24]The 10th was Nick Price, who had an endorsement contract with Goldwin, which did not produce a Titanium driver at the time.

Figure 8: Long-Term Player Performance

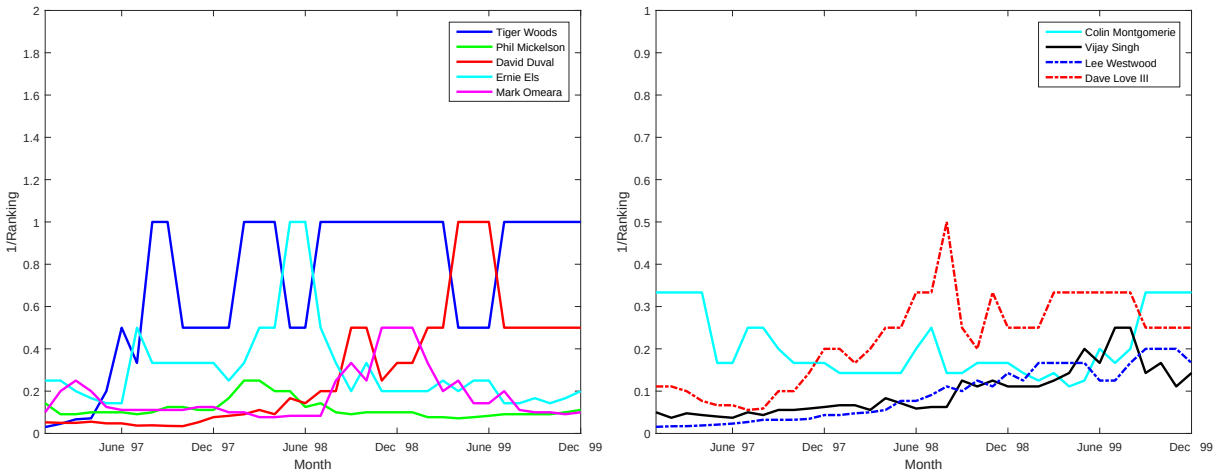


Table 3: Celebrities and their Endorsed Brands

		Wins		Second	
Celebrity	Brand	Major	Non-Major	Major	Non-Major
Tiger Woods	Titleist	2	11	0	5
Phil Mickelson	Titleist	0	4	2	2
David Duval	Titleist	0	11	0	5
Davis Love III	Titleist	1	2	1	5
Ernie Els	TaylorMade	1	2	0	4
Mark O'Meara	TaylorMade	2	2	0	2
Lee Westwood	Ping	0	1	0	0
Vijay Singh	Wilson	1	4	0	5
Colin Montgomerie	Callaway	0	0	1	1

4.5 Micro Survey Data

The next set of data we employ is micro-level survey data about the purchase behavior of consumers by skill level in January 2000. This data originates from a survey by Golf Datatech. It samples roughly 1000 users about a variety of golf related topics, including a consumer's quality level and his channel purchase behavior. This information reveals the distribution of consumer types by golf skills level (golf handicap) within channels and serves as additional aggregate moments in estimation. A golf handicap is a measure of a golfer's ability; higher measure indicating lesser ability. Thus, a player with a lower handicap is a highly skilled golfer. We break down each type of golfer into three skill levels: high (handicap 0-10), medium (10-20), and low (20+). The on-course distribution of player types is 39%, 46% and 15%, for high, medium and low skilled players respectively. Similarly, for off-course the mixture is 20% high, 58% medium, and 22% low.

5 Reduced-Form Analysis

An important question to ask before specifying our structural model is how advertising expenditure relate to market shares by brand. For instance, TaylorMade's and Titleist's market shares changed noticeably between 1997 and 1999. In January 1997 TaylorMade's and Titleist's market share were 29% and 0.66%, respectively. However by December of 1999 the market of share of TaylorMade decreased to 19% while Titleist's rose to 11%. Was this shift related to changes in advertising and/or in celebrity endorsements? Employing Figure 5 we determine that the fraction of planned TV advertising from Titleist relative to the summation of top three brands with celebrities increases each year. This same pattern also holds for magazine advertising spend leading us to believe that both advertising and celebrity endorsements may have impacted firm market share and sales as TV advertising embeds celebrities while print does not.

We next present reduced-form analysis to understand whether any of the above variables (celebrity ranking, wins, or advertising expenditures (television or magazine)) impacts sales.[25] This analysis also highlights what type of interaction exists between celebrity endorsements and advertising expenditures, if any. We present results from a linear regression model of monthly log sales. Results in Table 4 indicate that a player's world golf ranking, whether he wins, and television and magazine

[25]We thank a referee for this suggestion.

expenditures in period t all lead to an increases in sales. Yet, there appears to be no statistically significant synergy effect associated with television ads that include Top Ten celebrity endorsers, evident by the differencing of the two television advertising effects. Note, we separately estimate the effects of television expenditures for brands that have celebrity endorsers in the Top Ten and for those that do not, given that high quality celebrity endorsers who are featured in television advertising could have different effects than lower quality players. We also run a second regression that creates two new variables that interacts player ranking with wins (and second place finishes) and then aggregates across players affiliated with a brand. These two new variables capture the impact, if any, unexpected wins or runner-up finishes have on sales. We determine that there is no additional effect due to unexpectedness and is a result of the very low probability a player, even the number one player, has in winning any given tournament (as shown in the Eagle Model Results).

Table 4: Reduced-Form Regression Results

Variable	Coef.	SE	Coef.	SE
Prestige Effect: $\left(\sum_g \frac{1}{rank_{g,b}}\right)$	0.7868**	0.2012	0.8102**	0.2073
$\hat{\text{Wins}}$	0.0659**	0.0325	0.1038**	0.0480
$\hat{\text{Second}}$	0.0979**	0.0433	0.1290**	0.0657
$\hat{\text{Ad}}_b{}^{tv}$*I[Endorse]	0.0966**	0.0209	0.0998**	0.0213
$\hat{\text{Ad}}_b{}^{tv}$*(1-I[Endorse])	0.0741**	0.0212	0.0745**	0.0212
$\hat{\text{Ad}}_b{}^{mag}$	0.0477**	0.0136	0.0463**	0.0136
$\sum_g \left(\frac{1}{rank_{g,b}} \hat{\text{Wins}}_g\right)$			-0.1177	0.1074
$\sum_g \left(\frac{1}{rank_{g,b}} \hat{\text{Second}}_g\right)$			-0.1206	0.2542

Notes: price and month and product-channel FE not reported

Number of Observations=737

**indicates significant at 5%; *indicates significant at 10%;

6 The Economic Model

We now discuss the discrete choice model used to understand how consumers respond to different types of information. Specifically, we adapt the demand model of Sovinsky [2008], a limited information model with consideration set formation, in order to capture how celebrity endorsements and their success impact consumer awareness and preferences. We use a limited information model for two reasons. A survey conducted by Golf Datatech in the summer of 2008 determined unaided brand awareness was not 100% for all companies. Rather, the proportion of survey participants who

could recall Callaway was 66%, TaylorMade 59%, Titleist 36%, Nike 38%, Ping 31%, Cobra 17%, and Cleveland at 13%. Secondly, during the same period, they asked survey participants if they were planning on purchasing a driver in the next twelve months and if yes what brands were they considering. The results were Callaway at 48%, TaylorMade 59%, Titleist 18%, Nike 29%, Ping 31%, Cobra 32%, and Cleveland at 24%.[26] Both survey results clearly supports a model in which consumers do not consider or recall all brands.[27]

6.1 Consideration Set Formation

The limited information model assumes that the probability of consumer i purchasing product j in period t depends upon the probability he is aware of the product, the probability he is aware of other competing products, and the probability he would purchase product j given his choice set. We further assume that consumers are aware of the outside option of not purchasing with certainty.

A consumer's choice set formation is assumed to be impacted by factors such as the age of the product, a firm's advertising decisions for the brand, and the impact celebrity endorsers create when they win or finish second in golf tournaments, which proxies for unplanned television exposure (we also include a constant).[28] The information technology that summarizes the effectiveness of advertising at informing consumers about the product's existence for consumer i is[29]

$$\phi_{i,j,t} = \frac{exp(\gamma_{i,j,t}(\Omega_t^{Ad}))}{1 + exp(\gamma_{i,j,t}(\Omega_t^{Ad}))} \tag{1}$$

[26] We, unfortunately, do not have the survey results for the data period of our analysis.

[27] Consideration set formation modeling, in general, is motivated by the fact that consumers do not choose from the same set of all available products, but rather choose from a restricted choice set (e.g., Hoyer 1984; Mitra and Lynch 1995). This is the case even when the number of products is not very large. For instance, Mehta et al. [2003] model consumers' consideration sets for liquid detergent and ketchup, each of which consists for four national brands. They find that the average number of detergent brands in a choice set is roughly 2.33–much smaller than the number presented in Figure 3. Draganska and Klapper [2011] model consumer consideration set formation in the coffee market where there are only five major national brands. Their data provides evidence that consumers are not able to recall all brands.

[28] We further assume that the probability that a product enters into a consumer's choice set is independent of any rival advertising decisions and consumer characteristics. Therefore, informational spillovers are assumed to not exist.

[29] This setup follows that of Sovinsky [2008], Van Nierop et al. [2010], Dinerstein et al. [2015], Ching et al. [2009],Honka et al. [2015] which either implicitly assumes or explicitly states that there is a logit error in the awareness model and that these errors are independent and identically distributed across consumers and products. This assumption is standard in the consideration set literature. Van Nierop et al. [2010] found that estimates of the correlation of epsilon are very unstable and assume the correlation is 0. In addition, it is not straightforward to impose a particular correlation structure a priori" [Kawaguchi et al., 2016]

where

$$\gamma_{i,j,t}(\Omega_t^{Ad}) = \varphi_{i,0} + \varphi_1 \hat{Ad}_{b,t}^{TV} + \varphi_2 \hat{Ad}_{b,t}^{TV} * (1 - I[Endorse]) + \varphi_3 \hat{Ad}_{b,t}^{Mag} + \varphi_4 \hat{Wins}_{b,t} + \varphi_5 \hat{Second}_{b,t} + \varphi_6 Age_{j,t}$$

and $\hat{Ad}_{b,t}^{TV}$, $\hat{Ad}_{b,t}^{Mag}$, $\hat{Wins}_{b,t}$, $\hat{Second}_{b,t}$ are goodwill measures of television advertising for brand b, magazine advertising for brand b, and wins and second place finishes for brand b, respectively.[30] Also, $(1 - I[Endorse])$ is the set of brands not listed in Table 3. We allow for the consideration set formation to differ by consumers' observed skill level of playing golf. As such, each type of consumer has a differing general level of awareness of titanium drivers, $\varphi_{i,0} = \bar{\varphi}_0 + \varphi_0 I(type)$. Using data from the United States Golf Association regarding player quality, we group golfers into three distinct segments: high-, medium- and low-skilled golfers. The data provided by the USGA provides the distribution of player quality broken down by 38 discrete segments. For the purpose of initial awareness, we assume players within each skills bin (handicaps 0-10, those from 11-20, and players with 20+) all have the same initial product awareness level. Importantly, these larger groupings of consumers are not made ad hoc. Instead, they follow the same assignment as our micro-level survey data provided by Golf Datatech, regarding which channel a consumer purchases from, given his or her skill level.

We further allow for the fact that a firm's use of advertisement and the impact of a win or second place finish in a tournament by a celebrity can build upon the previous months' decisions or outcomes. Thus, the impact of advertising is modeled as a function of goodwill that augments the current period's decision, but that is allowed to decay over time. This framework is similar to the advertising-as-investment model of Nerlove and Arrow [1962] and later used in another sports context by Chung [2013].[31] We specifically model each of the goodwill measures as

$$\begin{aligned}
\hat{Ad}_{b,t}^{TV} &= ad_{b,t}^{TV} + \psi_{tv} \hat{Ad}_{b,t-1}^{TV} \\
\hat{Ad}_{b,t}^{Mag} &= ad_{b,t}^{Mag} + \psi_p \hat{Ad}_{b,t-1}^{Mag} \\
\hat{Wins}_{b,t} &= wins_{b,t} + \psi_u \hat{Wins}_{b,t-1} \\
\hat{Seconds}_{b,t} &= seconds_{b,t} + \psi_u \hat{Seconds}_{b,t-1}
\end{aligned}$$

[30] See Sovinsky [2008] as precedent for use of age in the choice set formation model.

[31] Notice that the decay parameter is identical for Wins and Second place variables. This restriction is imposed to increase the statistical power of the parameter in estimation.

where $ad_{b,t}^{TV}$, $ad_{b,t}^{Mag}$, $wins_{b,t}$, $seconds_{b,t}$ are period specific measures of log television advertising expenditures for brand b, log magazine advertising expenditures for brand b, and wins and second place finishes for brand b, respectively.

6.2 Utility

Consumer i determines in period t whether or not to purchase product j, by observing a vector of variables $\vartheta_{i,t} \in \mathbf{\Theta}$ specific to the consumer and period. Let $\vartheta_{i,t} = (\mathbf{x}_t, p_t, \xi_\mathbf{t}, \epsilon_{i,t})$, where $(\mathbf{x_t},\, \mathrm{p_t}) \in \mathbf{X}_t$ are the *observed* product characteristics, ξ_t are *unobserved* product characteristics, and $\epsilon_{i,t}$ are the individual specific idiosyncratic shocks. Denote the set of observed and unobserved product characteristics as $\Omega_t = (\mathbf{X}_t, \xi_\mathbf{t})$. Consumer i purchasing product j from channel r in period t obtains a *utility* given by:

$$u_{i,j,r}(\Omega_t, \epsilon_t) = \delta_{j,r,t} + \overbrace{\alpha_p\ p_{j,r,t}}^{\text{Price}} + \overbrace{\alpha_{p,Off}\ p_{j,r,t}(OffCourse)}^{\text{Price-OffCourse}} + \overbrace{\eta_{\tau(t)}}^{\text{Seasonal}} + \epsilon_{i,j,r,t}$$

where

$$\delta_{j,r,t}(\mathbf{x}_t, \xi_\mathbf{t}) = \overbrace{\alpha_{j,r}}^{\text{Product}} + \overbrace{\alpha_x\ x_{j,r,t}}^{\text{Observable Characteristics}} + \overbrace{\triangle\xi_{j,r,t}}^{\text{Unobservable Characteristics}} . \tag{2}$$

In the above utility specification, $\alpha_{j,r}$ is a product-channel fixed effect, which accounts for any observed or unobserved product characteristic (to the econometrician) that does not vary over time. $x_{j,r,t}$ denotes observable club (product) j characteristics in channel r and time t and includes the prestige effect $En_{b,t}$, planned media spending $\hat{Ad}_{b,t}^{Mag}$,$\hat{Ad}_{b,t}^{TV}$, $\hat{Ad}_{b,t}^{TV}(1 - Endorse)$, and unplanned exposure as a result of wins or second place finishes $(\hat{Wins}_{b,t}, \hat{Seconds}_{b,t})$ by a brand's celebrities. $\triangle\xi_{j,r,t}$ is a product-channel-time specific deviation from its unobserved mean $\bar{\xi}_{j,r,t}$, and is unobservable to the econometrician. This variable can best be thought of as the deviation from a mean aggregate measure of the bundle of product and service provided by the channel that the consumer accounts for in his purchase decision. Unobservable characteristics might, therefore, include channel-specific effects of merchandising (e.g., featuring the product prominently) that are not present in the data. The firm might be expected to set prices accounting for the value of the unobservable characteristic, making price an endogenous variable in the utility function.

6.3 Consumer's Problem

Before entering the market, a consumer considers numerous products and market characteristics that may affect his current and future purchase utilities. The sequence of events in the consumer model is consumer i considers whether or not to purchase a product from the available consideration set $\mathbf{J_t} \in \mathbb{J}_\mathrm{t}$, where $\mathbb{J}_\mathrm{t}$ is the set of all choice sets which contain product j in period t. In each period (month) $t \in \mathbf{T}$, a consumer purchases or chooses not to purchase a product.

Consumer purchases are influenced by variables Ω_t, which include price, player ranking, paid advertising, wins and second place finishes, and (unobservable) product quality. All variables in Ω_t impact product utility. Additionally, consumer purchase decisions are influenced by Ω_t^{Ad}, as these variables impact what products consumers are aware of in period t.

For a consumer in the titanium driver market and faced with Ω_t and Ω_t^{Ad} in period t, along with the assumptions that the idiosyncratic errors ϵ are distributed as Type I extreme value random variables and the outside good's utility $u_0(\Omega_t)$ is normalized to zero, the choice probability $s_j\left(\Omega_t, \Omega_t^{Ad}\right)$ of choosing each $j \in \mathbf{J}$ given $(\Omega_t, \Omega_t^{Ad})$ can then be written in closed form as:

$$s_{i,j,r,t|J_t}(\Omega_t, \Omega_t^{Ad}) = \frac{\exp\left(u_{i,j,r}(\Omega_t)\right)}{exp\left(u_0\left(\Omega_t\right)\right) + \sum_{g \in J_t \setminus \{0\}} \exp\left(u_{i,g,r}(\Omega_t)\right)}.$$

Given the fact that a consumer's choice set is unobserved to the econometrician, we must draw inferences from the unconditional probabilities that consumer i purchases product j in period t from channel r, which is

$$s_{i,j,r,t}(\Omega_t, \Omega_t^{Ad}) = \sum_{J_t \in \mathbb{J}_\mathrm{t}} s_{i,j,t|J_t}(\Omega_t, \Omega_t^{Ad}) Pr(J \mid \Omega_t^{Ad})$$
$$Pr(J \mid \Omega_t^{Ad}) = \prod_{j \in J_t} \phi_{i,j,t} \prod_{m \notin J_t} (1 - \phi_{i,m,t}).$$

The second equation calculates the probability that the consumer is faced with a given choice set. Or, more specifically, the probability of choice set J_t occurring is equal to the probability that the consumer is informed of the availability of each product in J_t and is not informed of products not in J_t.

6.3.1 Market Share

With access to only aggregate level sales data, we must aggregate the consumer level model up to the population. The above model assumes that consumers are different in terms of their general awareness factor. Let $\chi_i = (h_i)$ be the vector of observed individual characteristics. As stated above, consumers purchase only one unit per period that provides the largest utility, U, from products in their choice set. Let $Q_j \equiv \{\chi_i : U(\chi, p_{j,r,t}, x_{j,r,t}, \xi_{j,r,t}, \epsilon_{i,j,r,t}) > U(\chi, p_{g,r,t}, x_{g,r,t}, \xi_{g,r,t}, \epsilon_{i,g,r,t}) \, \forall g \neq j\}$ define the set of variables that results in the purchase of product j, given the parameters of the model. The market share of product j in period t is

$$s_{j,r,t}(\Omega_t, \Omega_t^{Ad}) = \int_{Q_j} dG(h, \epsilon) = \int_{Q_j} s_{i,j,r,t} dG_h(h),$$

where $G_h(h)$ is the distribution of consumer skill level, and $s_{i,j,r,t}$ is given above in Section 6.3. Note that if $\phi = 1$ for all j, then the generated market shares would be the "standard full information choice probabilities" [Sovinsky, 2008].

7 Estimation and Identification

7.1 Estimation

The methodology used to estimate the above model follows from the discrete choice literature employing aggregate sales data. It also employs techniques for simulating consumer choice sets from Sovinsky [2008]. In order to estimate the model parameters, we employ a GMM procedure. We specifically match two unique moments to the data. The first is the standard macro moments associated with discrete choice demand models with aggregate data where observed market shares are matched to predicted market shares.

$$S_{j,r,t}^{Obs} - s_{j,r,t}(\Omega_t, \Omega_t^{Ad}; \theta) = 0$$

The second set of moments match simulated within channel shares by skill level at the end of the data period to observed shares (a la Petrin, 2002). These moments leverage the micro-moments data presented in Section 4.5 where we specifically observe within channel share for high-, medium-,

and low-skilled consumers. Let $\mathcal{B}_{i,C}(\Omega_t, \Omega_t^{Ad}; \theta)$ be the residual difference between the simulated and observed share for consumers of skill level i for channel c. Let the moments we estimate be

$$\mathcal{B}_{i,On}(\Omega, \Omega^{Ad}; \theta) = C_{i,on}^{Obs} - c_{i,on}(\Omega, \Omega^{Ad}; \theta)$$
$$\mathcal{B}_{i,Off}(\Omega, \Omega^{Ad}; \theta) = C_{i,off}^{Obs} - c_{i,off}(\Omega, \Omega^{Ad}; \theta)$$

where $c(\Omega, \Omega^{Ad}; \theta)$ is the simulated fraction of consumers who purchase from channel r. For completeness, let $c_{i,r}(\Omega, \Omega^{Ad}; \theta)$ be

$$c_{i,r}(\Omega, \Omega^{Ad}; \theta) = \frac{\sum_{d=1}^{D} \sum_{t \in \mathbb{T}} \sum_{J_t \in \mathbb{J}_t} s_{i,d,r,t|J_t}(\Omega_t, \Omega_t^{Ad}) Pr(J \mid \Omega_t^{Ad})}{\sum_{d=1}^{D} \sum_{t \in \mathbb{T}} \sum_{i=1}^{I} \sum_{J_t \in \mathbb{J}_t} s_{i,d,r,t|J_t}(\Omega_t, \Omega_t^{Ad}) Pr(J \mid \Omega_t^{Ad})}$$

where D is the set of all drivers from all brands. Our estimation is based on GMM, and the criterion function gives us the estimator based on the orthogonality of the unobservable characteristics and the instruments for

$$(\hat{\theta}) = \arg\min_{\theta} \left[\begin{array}{cc} \triangle\xi(\theta); & \mathcal{B}(\theta) \end{array} \right] \mathbf{ZWZ'} \left[\begin{array}{c} \triangle\xi(\theta) \\ \mathcal{B}(\theta) \end{array} \right]$$

where $\mathcal{B}(\theta)$ is the set of all micro-moment residuals.

7.1.1 Simulation

Given that the observed data does not include the realized choice set of each consumer, we must infer such information via simulation. As we discussed above, we simulate consumer choice sets. Estimation entails simulating a sample set of "individuals." As Sovinsky [2008] highlights, "simulating individual i's choice set is a two-step process." We begin by drawing J uniform random variables, corresponding to each product available for each individual. We then compute the probability that individual i knows product j for a given value of the parameters. That is, if the computed probability is larger than the corresponding uniform draw for product k, product k is in consumer i's choice set. We repeat this comparison for all products to form i's simulated choice set. We also repeat for each i to simulate the remaining individuals.

An important aspect to note when estimating the above model is the result of simulation error. In order to limit this error, we construct an importance sampler to smooth the simulated choice probabilities, given the simulation of 38,000 consideration sets (38 discrete consumer skill levels, each with 1000 simulated sets). The use of an importance sampler is for variance reduction. We construct the importance sampler by using the initial consideration set weight to smooth the purchase probabilities. Specifically, we use the estimated parameters values (without the use of an importance sampler) to construct the initial weights, where the initial choice set weight is given by the product of all $\phi_{j,t}$ in the simulated choice set multiplied by the product of $1-\phi_{m,t}$ for the goods not in the choice set.

7.2 Identification

Below, we discuss what variation in the data allows us to separately identify the parameters of interest as well as price endogeneity.

7.2.1 Endogeneity of Endorsements and Prestige Effect

A concern with celebrity endorsements is that the selection of celebrities is a strategic decision and may lead to firms with better products selecting higher quality golfers. We follow Rossi [2014] and implement product-channel fixed effects to eliminate this concern. Given that celebrities do not switch brands during the data period and that endorsements are at the brand level (not product), the inclusion of these fixed effects eliminates the need to instrument for endorsements, as the fixed effects capture any persistent unobserved time invariant effect that would otherwise lead to an endorsement contract between player and brand. We further capture the effect of player variation ex-post the signing of a contract with player quality. The identification of the effect associated with celebrity endorsements on consumer utility (prestige) is relatively straight forward. The prestige effect is derived from the exogenous variation of a celebrity's quality (a player's monthly rank in the world golf ranking system) over time. What identifies the causal effect of the endorsement is the connection between product sales and a player's random performance over time, conditional on the consumer being aware of the product. By defining golfer g's primary endorsement variable as an inverse of his world ranking$\left(\frac{1}{rank}\right)$ at time t, we assume that as the golfer's ranking goes to infinity, the endorsement effect approaches zero (see Figure 8). In addition, we do not allow the

endorsement effects to vary by player. We assume that the marginal prestige effect is homogeneous across celebrities. We make such an assumption to be consistent with the way we identify the impact of celebrity endorsements on product awareness below. Finally, there is an alternative identifying explanation given this assumption–the connection between the exogenous variation in the portfolio of celebrity endorsements (summation of the inverse of the world ranking for all golfers endorsing brand b in period t) with product sales.

7.2.2 Unplanned Wins and Second Place Finishes

Our model assumes that wins and second place finishes can impact both consideration set formation and consumer preferences. In order to identify both of these effects, we assume that wins and second place finishes have dynamic components and generate a stock of goodwill. An increase in the number of wins increases the awareness of the product and its utility. Our modeling assumptions assume that wins have a bigger impact on the consideration set formation when the product is new than when old. Therefore, time plays a larger role in identification. This is because as products age, consumers inherently become more aware of the product. For instance, in the case of old products that have high awareness, the marginal impact of an additional win is lower than if the product was new and had less awareness, given our model structure. Thus, if we see a shift in sales given an increase in television expenditures when consumers are highly aware of the product, the increase in sales must be due to an increase in consumer preferences for television expenditures and not due to awareness. This identification strategy is similar to the one employed by Barroso and Llobet [2012] and Ching and Ishihara [2012].

7.2.3 Paid Advertising Exogeneity

Advertising expenditure is unlikely to be correlated with celebrity performance and time specific deviates from the unobserved mean product-channel quality, as advertising is pre-determined–at least 6 months before the season starts. To ensure the former, we regress television and magazine advertising expenditure on celebrity performance and time fixed effects. We show in Table 5 that advertising expenditures are purely seasonal and not correlated to player performance in the form

of winning or finishing second in tournaments or player ranking.[32] A similar approach was used in Chung et al. [2013] to also illustrate a similar pattern existed in golf ball sales. Given the finding that paid advertising is purely seasonal, we assume that expenditures are uncorrelated with $\triangle\xi$, as product-channel fixed effects, month of year indicator variables, and player quality measures are accounted for in consumer preferences. Consequently, we assume that such measures are strictly exogenous and do not require instruments. Note that a similar argument is made in Rossi [2014].

Next, in order to identify the impact of television advertising for brands with celebrities in the Top Ten versus those without, we must make the assumption that players in the Top Ten in world ranking do not differ in their impact on planned television advertising. This is because we do not have data on which players are in what television creatives. Thus, we do not separately estimate player-specific television impact. Rather, the estimated impact is at the celebrity portfolio level. In doing so, we eliminate the need for viewing ad creatives and can simply leverage advertising expenditures for brands with and without celebrities ranked in the Top Ten to proxy for exposure.

Finally, as we did in the case of wins and runner-up finishes, we allow television and magazine paid advertisements to impact both choice set formation and preferences. We follow the above wins/second place identification strategy to pin down the separate effects for awareness and preferences. Thus, as products age and consumers become more aware of them, the impact of a change in paid advertisement affects consideration set formation less and preferences more.

7.2.4 Price Endogeneity

We use instrumental variables to correct for the endogeneity in prices to accurately estimate and identify a consumer's price sensitivity. Proper instruments for p are variables that shift cost or margins that are not correlated with the demand shock. Our instruments are as follows: i) price differences in period t for product j in channel r from its time mean, ii) own advertising cost shifters iii) mean advertising cost shifters of all other products and iv) the log number of products each brand sells in period t and the log number of overall products in the market place in period t. It is important to highlight the importance of the first set of instruments. These instruments eliminate

[32] In the appendix we also individually show the result for each of the top three brands: Callaway, TaylorMade and Titleist in Tables 11 & 12

Table 5: Advertising Regressions

	Television Ad: All (N=136)		Magazine Ad: All (N=136)	
Variable	Coef.	SE	Coef.	SE
Prestige Effect: $\left(\sum_g \frac{1}{rank_{g,b}}\right)$	0.5392	0.3682	-0.8660	0.6448
Unplanned (wins+second)	0.0301	0.1541	-0.0349	0.3806
January	3.7614**	0.8349	1.8345	1.0294
February	3.9090**	0.9611	3.4061**	0.5894
March	4.0985**	0.8536	4.7055**	0.7753
April	3.5237**	0.8861	3.6561**	0.5834
May	3.1595**	0.8390	3.0175**	0.8050
June	3.9670**	0.8131	3.3254**	0.5744
July	2.7064**	0.8253	1.8013**	0.6150
August	2.5652**	0.8100	1.8174**	0.5674
September	0.9433	0.8434	2.5341**	0.7728
October	1.8794**	0.6719	3.4704**	0.6312
November	2.0646**	0.7042	2.1396**	0.8621
December	0.8854	0.7520	3.2099**	0.7767

Notes: year, brand fixed effects and lagged dependent variable not reported

**indicates significant at 5%; *indicates significant at 10%;

the correlation with the error term arising from the individual fixed effects and were first proposed by Bhargava and Sargan [1983] and later studied by Arellano and Bover [1995] [Barroso and Llobet, 2012].

8 Results

Table 6 presents the results of four specifications. The first model is where consumers are assumed to have full information and there is no choice set formation. The second is also a full information model but includes the advertising expenditures, wins, runner-up finishes, and consumer specific skill fixed effects. Also, celebrity endorsements affect consumer preference through the prestige effect. The third specification is a limited information model in which choice set formation is modeled as functions of planned advertising only. The last specification further includes unplanned television exposure as part of the choice set formation model so that celebrity endorsement is allowed to affect both consumer preference and awareness.

The results of all four models in Table 6 present the respected signs associated with each model covariate. The full information specifications, consistent with the literature, substantially underesti-

mates consumer's price sensitivity compared with the two limited information specifications, which highlights the importance of modeling consideration set formation. The prestige effect is positive and significant in the first full information and two limited information specifications, which suggests that celebrity endorsements do affect consumer preference.

The results from the third and fourth specifications further indicate that celebrity endorsement affects consumers through raising awareness. Both specifications find that television and magazine ads impact brand awareness and that there is a dynamic carryover effect. Yet, the impact of television ads in the fourth specification differs from that in the third, as part of its impact should be attributed to unplanned exposure. We decompose the effect to planned (celebrities in television ads) and unplanned components of the celebrity endorsement (celebrity wins) in Limited Information model 2.

The results from the last specification indicate that unplanned brand exposure is an important component in a consumer's consideration set formation. Weekly golf tournament wins by celebrity golfers are found to have an impact on consumer awareness, whereas second place is found to have no impact. Finally, similar to the above carryover effect for television ads, the carryover effect for unplanned exposure is positive and significant. This implies that consumers awareness is a function of past tournament success.

In our final limited information model, we determine that television and magazine advertising do impact consumer preferences. This result is consistent with Becker and Murphy [1993] in which the more a firm advertises, the more utility the consumer consumes with a purchase of the firm's product. Note that wins and second place finishes do not have any impact on consumer preferences.

We next investigate consumer substitution patterns, and Tables 7 and 8 provide the own and cross price elasticities at the brand level for brands with celebrities, for each of the limited information models.[33] We evaluate the elasticity by considering a 1% price cut that is made permanently, and is known by consumers, as well as the firm, to be a permanent cut. The model where unplanned advertising does enter into the consumers' consideration set model predicts that a permanent 1% percent reduction in the price of a driver would lead to an approximately 2.5-3% increase in average

[33]The complete elasticity matrix, which includes brands without celebrities, is available upon request.

Table 6: Results

	Full Info:		Full Info:		Limited Info: Model 1		Limited Info: Model 2	
Variable	Coef.	SE		SE	Coef.	SE	Coef.	SE
Utility Parameters								
Price ($\bar{\alpha}_p$)	0.0036**	0.0012	0.0017	0.005	-0.0046**	0.0022	-0.0061**	0.0014
Price Off-Course ($\bar{\alpha}_{p,Off}$)	0.0015	0.0015	0.0022	0.0016	-0.0036	0.0036	-0.0036**	0.0016
Prestige Effect: $\left(\sum_g \frac{1}{rank_{g,b}}\right)$	1.1301**	0.1991	0.0902	0.2486	0.5633**	0.2677	0.5780**	0.2201
$\hat{\text{Ad}}_b^{tv}$			0.0697**	0.0223	0.0375	0.0413	0.0610**	0.0177
$\hat{\text{Ad}}_b^{tv}$*(1-I[Endorse])			-0.0174	0.0263			-0.0405**	0.0202
$\hat{\text{Ad}}_b^{mag}$			0.0524**	0.0103	0.0118	0.0151	0.0263**	0.0073
$\hat{\text{Wins}}$			0.1089**	0.0305			0.0249	0.0353
$\hat{\text{Second}}$			0.0690*	0.0396			0.0333	0.0473
Awareness Parameters								
Constantφ_0			-0.1016	2.2798	0.4204**	0.0323	0.4216**	0.0120
Constantφ_0*I[MedHandicap]			0.5388**	0.0341	0.3043**	0.0642	0.3011*	0.1749
Constantφ_0*I[HighHandicap]			-0.9240**	0.0292	-0.4701**	0.0625	-0.4605*	0.2672
$\hat{\text{Ad}}_b^{tv}$					0.0463**	0.0003	0.0481**	0.0008
$\hat{\text{Ad}}_b^{tv}$*(1-I[Endorse])							0.1093	0.0900
$\hat{\text{Ad}}_b^{mag}$					0.1400**	0.0003	0.1362**	0.0006
$\hat{\text{Wins}}$							0.2456**	0.1190
$\hat{\text{Second}}$							0.1635	0.2684
Age					0.0172**	0.0008	0.0173**	0.0009
NerloveArrow Wins:ψ_u			0.7574**	0.0141			0.3300**	0.0890
NerloveArrowTV:ψ_{TV}			0.3111**	0.0250	0.5456**	0.0792	0.5056**	0.0635
NerloveArrow Magazine:ψ_m			0.6121**	0.0113	0.6168**	0.0251	0.7061**	0.0727
GMM	98.8585		37.5427		14.8247		13.9094	

Notes: Utility parameters include Product-Channel and Month of Year FE not reported; Number of Observations=737

****indicates significant at 5%; *indicates significant at 10%;**

Table 7: Brand Elasticity: Limited Information Model 1

	Callaway	TaylorMade	Titleist	Wilson
Callaway	2.4723	-2.8807e-06	-6.4897e-07	-1.7225e-08
TaylorMade	-4.9617e-06	2.1447	-5.2963e-07	-2.1567e-08
Titleist	-6.1306e-06	-2.9997-06	2.3579	-2.2493e-08
Wilson	-4.8723e-06	-3.5935e-06	-6.2930e-07	2.0679

Note only brands with celebrity endorsers reported

Table 8: Brand Elasticity: Limited Information Model 2

	Callaway	TaylorMade	Titleist	Wilson
Callaway	2.9927	-3.3059e-06	-7.3100e-07	-2.0391e-08
TaylorMade	-5.8223e-06	2.5505	-6.0975e-07	-2.5488e-08
Titleist	-6.8221e-06	-3.3293e-06	2.8997	-2.5844e-08
Wilson	-5.9360e-06	-4.2410e-06	-7.5337e-07	2.4813

Note only brands with celebrity endorsers reported

market share of a given club sold during the time period. The cross-price elasticities correspond to the effect of a price cut and range from 0 to -.00005%.

It is important to highlight the difference between the elasticity measures of the two limited information models (Table 7 vs. Table 8). The elasticities in the no-unplanned-exposure model are smaller than those in the complete limited information model. Thus, ignoring the impact of unplanned variables on the consideration set formation can lead to underestimating the consumer's price sensitivity.

Lastly, we calculate a television elasticity measure for Titleist in 1997. To do so, we assume that television expenditures increase by 10% for only Titleist in each month of 1997. We then determine the change in sales for each period and average the results. This leads to a television elasticity measure of 1.50%. Given the dynamic nature of the goodwill measure for television we also calculated the percent change in sales for all of 1997. This measure was 1.57%. These results are inline with the existing literature regarding television advertising elasticity measures [Sethuraman et al., 2011].

9 Counterfactuals

Given the demand estimates, we run several counterfactuals to answer the following questions: 1) what is the impact of Titleist's celebrity endorsements on brand awareness, 2) what is the impact of the planned advertising and unplanned media exposure on sales, profit, and awareness, separately, and 3) how should a firm manage planned and unplanned exposure? Yet, before presenting any results, we outline the supply side model employed to recover marginal cost estimates.

9.1 Firm Behavior

In the market for titanium drivers, we assume there are $f = 1, ..., F$ non-cooperative Bertrand-Nash competitive firms, with each firm producing a subset of the J products, $\mathcal{J}_f$. Profits for firm f are

$$\Pi_{jt} = \sum_{J_F} (p_{jt} - mc_{jt}) M_t s_{j,t}(p, a_m) - \sum_m a_{jmt}$$

where M is the market size, s_{jt} is the market share for product j produced by firm F, mc_j is the marginal costs for firm $F's$ product j, and a_m are advertising expenditures for medium m. Since we observe p_j and estimate demand parameters, marginal cost and markups are able to be computed. The first-order condition of the above profit function with respect to product j price is as follows:

$$\text{FOC:} M_t \left\{ \sum_{r \in F} [p_{jt} - mc_{jt}] \frac{\partial s_{rt}(\mathbf{x}, \mathbf{a}, \xi, \mathbf{p}; \theta_d)}{\partial p_{jt}} + s_{jt}(\mathbf{x}, \mathbf{a}, \xi, \mathbf{p}; \theta_d) \right\} = 0. \tag{3}$$

We highlight the fact that we do not assume that advertising is set optimally given celebrity performance. Instead, we assume it is set exogeneously and independent of celebrity performance. This assumption is based upon regression results that indicate firms do not coordinate advertising with celebrity winnings or long term rankings. From the first order conditions of each product, we are able to recover estimates of marginal cost and employ them to form estimates of variable profits.

9.2 Impact of Celebrity Exposure

The first set of counterfactual exercises measures the overall impact that celebrity exposure (planned and unplanned) has on Titleist brand awareness and its sales and profits. These counterfactuals look to disentangle the impact of planned and unplanned celebrity exposure. We first present the

impact on sales and profits and then analyze how such exposure moderates awareness.

9.2.1 Sales and Profit

We simulate sales under two counterfactual scenarios. In the first scenario, we "turn off" the unplanned impact of wins and keep paid advertising.[34] Consequently, we do not allow effects associated with winning to occur. We determine the impact of unplanned exposure by differencing the results from this counterfactual exercise from the original data.

The second scenario further eliminates the planned impact by replacing the coefficient of television advertising with celebrities with the coefficient without celebrities and reducing television advertising expenditures to be at the mean level of brands that do not have celebrities. By differencing this result from the first scenario results, we are able to isolate the impact of planned celebrity exposure on sales and awareness.

Table 9 presents the outcomes of these two simulated scenarios as well as the decomposition of the impact of planned and unplanned exposure. We see from the table that unplanned and planned exposure accounts for roughly 22% and 24% of sales for the 36 months of data, respectively. This impact is from changes in both utility and awareness.

Table 9: Titleist Results
Observed and Simulated Sales and Profits

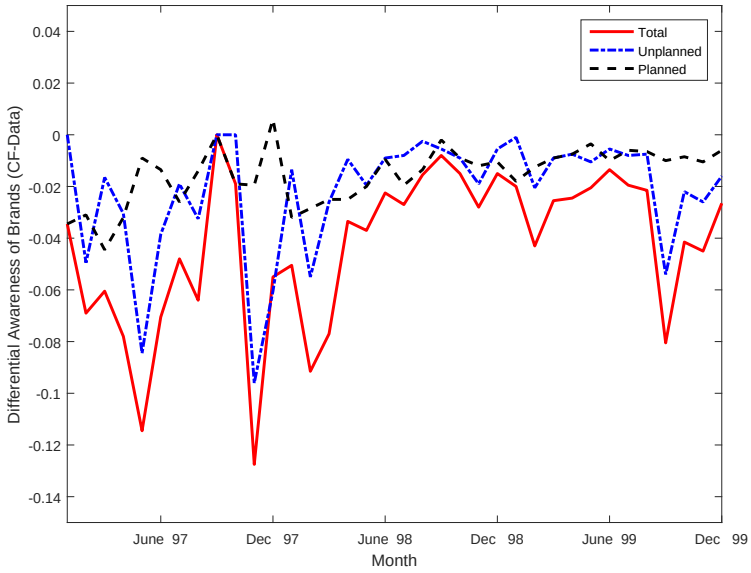
	Data	**No Unplanned Exposure**	**No Planned &Unplanned Exposure**
Sales	142,320	111,100	76,964
Profit w/o Ad expend	7,910,030	6,275,760	4,354,463

Planned and Unplanned Effects on Observed Sales and Profits

	Effect of Unplanned Exposure	**Effect of Planned Exposure**
Sales	31,220 (22%)	34,136 (24%)
Profit w/o Ad expend	1,634,270	1,921,297

[34]Given second place finishes are found to be insignificant we hold its parameter value to what was estimated

Figure 9: Titleist Awareness



9.2.2 Awareness

We next focus on the impact through awareness and disentangle the planned and unplanned components over time. Below in Figure 9, we present the difference in mean awareness for all brands using celebrity endorsements for the above counterfactual exercises. We highlight the slight decreasing total effect from celebrity endorsements over time. This is due to product awareness naturally increasing as the product ages. Figure 9 also illustrates that the majority of the impact on awareness originates from the unplanned exposure effect associated with celebrity endorsements rather than with planned television exposure. Planned exposure is found to impact sales and profits more through preferences.

9.3 Management of Unplanned vs. Planned Celebrity Advertisements

Should Titleist advertise right after Tiger Woods or any of its endorsers wins a tournament or wait until the effect of winning wears off? Our next counterfactual exercise analyzes the relationship between planned advertising and unplanned media exposure over time and whether these types of advertisements should be negatively, positively, or independently related. We also investigate how time moderates the relationship– e.g., how does the relationship change as products get older and consumers become more informed? Moreover, from the data above in Figure 4, we clearly see that firms are setting advertisement expenditures seasonally and exogenously from unplanned exposure.

We, thus, ask the question of whether firms can benefit from coordinating the planned exposure alongside the unplanned.

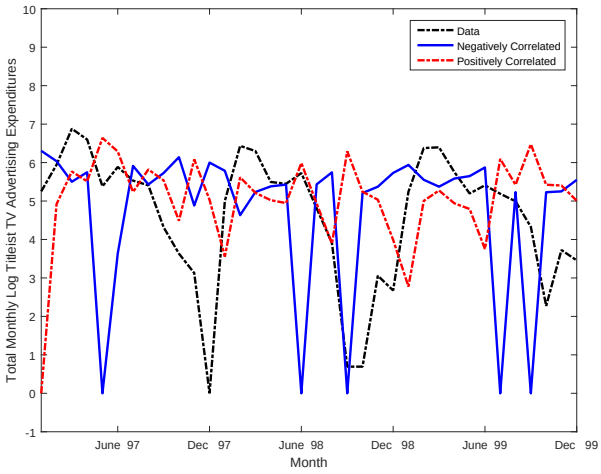
Given the uncertainty associated with unplanned exposure, we assume that such a measure is a random shock to firms and consumers. In order to identify whether television advertisement with celebrities are substitutes, complements, or independent of unplanned exposure, we generate two additional data patterns for television expenditures that are negatively and positively correlated with unplanned exposure for Titleist. Negative correlation among the two variables would indicate substitutes, whereas positive correlation would capture a relationship of complements. Details of the construction of both data patterns are presented below.

In order to construct an advertising expenditure pattern that is negatively or positively correlated with unplanned exposure, we keep the total yearly television expenditure the same and reallocate it over time within a year so that the allocation moves along/against the unplanned wins over time. First, we aggregate television expenditures over the course of each year. We then multiply the aggregate television expenditures by a specific month weight $\hat{Ad}_t^{TV} = \left(\sum_{t=1}^{T} Ad_t^{TV}\right) * w_t$. This weight is constructed accordingly:

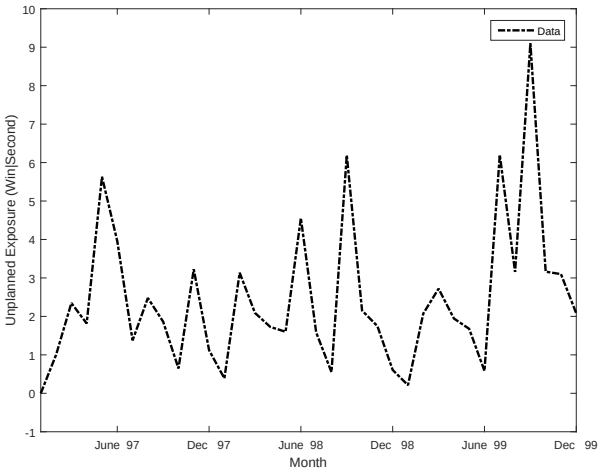
$$w_t = \frac{BrandWinsNA_t + BrandSecondNA_t}{\sum_{t=1}^{T}(BrandWinsNA_t + BrandSecondNA_t)}$$

for positive correlation and $\varpi_t = 2/12 - w_t$ for data that is negatively. Below in Figure 10a, we present the three corresponding data patterns for television advertising: the observed data, negatively and positively correlated with unplanned exposure. In Figure 10b, we present Titleist's unplanned celebrity expenditure over time, while Figure 11 presents the corresponding weights (w_t) associated with each counterfactual exercise.

Figure 10: Titleist Monthly Brand Advertising

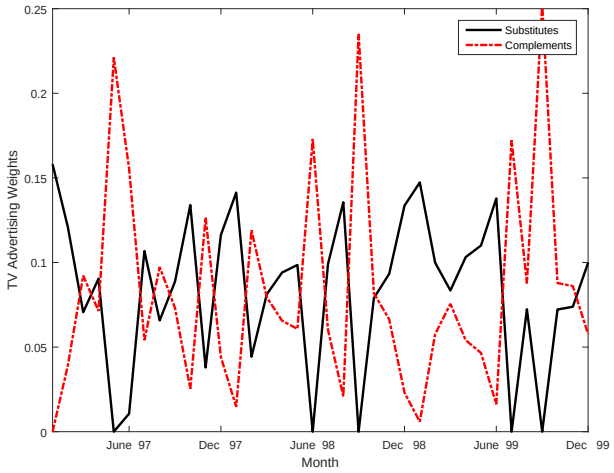


(a) Titleist Counterfactual television Advertising



(b) Titleist Unplanned Celebrity Exposure (i.e., wins|second)

Figure 11: Titleist Monthly Brand Advertising Weights



We determine the profit maximizing relationship as well as understand the moderating effects of time by presenting the results of each scenario broken down by year in Table 10. Specifically, we run these counterfactual exercises by substituting the observed television expenditures for Titleist with that of the new simulated data. We then calculate discounted profit (in January 1997 dollars) for each of the three years, assuming a discount rate of 0.975. Table 10a presents the observed sales and the simulated sales, whereas Table 10b presents profits. From these results, we determine that the

profit maximizing relationship changes over the course of the three years. In year one, the optimal strategy (of the three) is one of substitutes, with an overall profit excluding advertising expenditures of $765,141 dollars compared to $652,341 dollars in the observed data pattern. Moreover, total sales in 1997 under a negative relationship is 1,560 units larger than that of the observed data. In year two, the optimal strategy shifts to a positive relationship. This shift is a consequence of consumers becoming more aware of the products over time, which leads to a diminishing marginal benefit in coordinating planned and unplanned exposure. In Appendix C, we present a formal derivation of when and why firms should use planned celebrity advertising as substitutes (complements) to unplanned exposure. In summary, when the product is young and consumers are unaware, it is best to smooth exposure to keep awareness at a high level. Once consumers become more aware of the product as it ages, the strategy switches to complementary in order to capitalize on the exposure due to the reduced marginal benefit.

Table 10: Results

	Data	**Complements**	Substitutes
Sales 97	7,760	8,922	9,320
Sales 98	54,450	60,207	54,436
Sales 99	80,110	86,248	83,063
Total	142,320	155,378	146,819

(a) Sales

	Data	**Complements**	Substitutes
Profit 97	652,341	734,590	765,141
Profit 98	3,483,497	3,813,424	3,448,962
Profit 99	3,774,191	4,018,955	3,916,034
Total	7,910,030	8,566,969	8,130,137

(b) Profit

10 Limitations and Conclusion

We examine the impact of celebrity endorsement on new product (Titanium Drivers) sales by modeling consumers' choice set formation within a discrete choice framework. The uniqueness of this advertising tool is that it has a planned component (i.e., celebrities in television ads) and an unplanned component (i.e., celebrity performance). The latter is captured by a long-term performance measure or player ranking and a short-term performance measure or wins and second place finishes. We find that celebrity endorsement affects both preference and awareness through three channels: the prestige effect of player ranking on preference, the effect of wins on awareness, and the effect of celebrities on television ad effectiveness.

Counterfactual results show that the unplanned aspect contributes to 22% of incremental sales and the planned aspects contributes to 24%. Celebrity endorsement is particularly effective for new product introduction, especially in the early stage. We also find that firms can benefit from coordinating the planned paid advertising expenditures with the unplanned player performance. The planned and unplanned components are substitutes in the early stage of the product's life cycle and complements later, as the marginal impact on awareness decreases over time.

One limitation of the paper is that, similar to Sovinsky [2008], we do not model consumers' new product adoption as a dynamic process, for computational tractability reasons. Consumers are not assumed to be forward-looking and thus do not form expectations about future prices, player performance, advertising levels and wins/runner-ups.

We are also keenly aware of the fact our results may not be completely generalizable to other sports markets. For us to make such a claim, more data on different markets is needed. But, the type of data we need is difficult to obtain as it requires a diverse set (sales, planned advertising, long-term player quality, unplanned tournament television exposure). The results of our paper however should not be discounted because of this, as our recent informal conversations with managers reinforce the issue as how firms should manage planned and unplanned advertising.

Finally, the paper illustrates how celebrity endorsements can impact consumer adoption decision through consumer awareness and preferences. The unique relationship between the planned and unplanned aspects of this advertising tool can be increasingly relevant, as firms' ability to manipulate planned advertising alongside the unplanned has substantially improved through the introduction

of new advertising tools (e.g., social networks and media). Future research can study the impact of celebrity endorsement in other industries and scenarios in which new planned advertising tools are available.

Appendix A: Advertising Regressions

Table 11: Firm Specific Television Ad Regression

	Television Ad: Callaway		Television Ad: TaylorMade		Television Ad: Titleist	
Variable	Coef.	SE	Coef.	SE	Coef.	SE
Prestige Effect: $\left(\sum_g \frac{1}{rank_{g,b}}\right)$	1.2659	1.8837	-0.9572	1.4204	-0.9982	0.7910
Unplanned (wins+second)	-0.0812	0.2348	0.0228	0.2180	0.1413	0.1228
January	6.4467**	0.6532	5.7082**	0.9055	5.4635**	0.2826
February	6.2122**	0.6454	8.0093**	0.8824	6.4986**	0.6453
March	7.3761**	0.6532	8.2388**	0.9027	6.8328**	0.5431
April	7.3261**	0.6394	7.8583**	0.8888	6.3334**	0.5255
May	6.9222**	0.5776	7.3445**	0.9734	5.4845**	0.5500
June	7.5508**	0.6305	8.2737**	0.9793	5.8861**	0.5527
July	7.0267**	0.7889	8.0043**	0.9154	5.5678**	0.6294
August	6.4907**	0.6418	6.3320**	0.8539	5.4657**	0.6900
September	5.4544**	0.6790	4.3075**	0.8484	2.4958**	1.6316
October	5.9154**	0.6746	5.4185**	0.8687	2.9771**	0.9560
November	5.5981**	0.6917	5.0161**	0.8951	3.7202**	0.6594
December	4.4108**	0.6746	4.2091**	0.9230	2.7350**	1.3482

Notes: Year Fixed Effects not reported; Number of Observations=36

****indicates significant at 5%; *indicates significant at 10%;**

Table 12: Magazine Advertising Regression

	Magazine Ad: Callaway		Magazine Ad: TaylorMade		Magazine Ad: Titleist	
Variable	Coef.	SE	Coef.	SE	Coef.	SE
Prestige Effect: $\left(\sum_g \frac{1}{rank_{g,b}}\right)$	3.5817	3.8633	-2.3894	2.6114	2.1071	1.6749
Unplanned (wins+second)	0.5648	0.4816	0.3420	0.4008	-0.0188	0.2682
January	5.2320**	1.3397	7.0887**	1.6648	2.1624**	1.0935
February	5.1784**	1.3236	7.2102**	1.6222	2.3566*	1.4136
March	6.0507**	1.3397	9.4782**	1.6596	1.7231	1.3892
April	5.8563**	1.3113	8.7147**	1.6339	2.9889**	1.3118
May	5.3003**	1.1847	7.3129**	1.7895	3.3444**	1.3260
June	5.0947**	1.2931	7.4375**	1.8004	2.7831**	1.3822
July	3.4906**	1.6179	6.0064**	1.6829	2.6015*	1.4729
August	3.0609**	1.3162	4.9930**	1.5699	1.6378	1.6666
September	4.5127**	1.3925	5.2141**	1.5598	-0.3833	2.4778
October	5.9718**	1.3835	6.8679**	1.5971	2.7034*	1.5475
November	2.7196*	1.4187	7.2760**	1.6456	2.0329	1.5874
December	5.2941**	1.3835	7.6147**	1.6969	1.6112	1.5091

Notes: Year Fixed Effects not reported; Number of Observations=36

****indicates significant at 5%; *indicates significant at 10%;**

Appendix B: Sensitivity Analysis

Table 13: Results

	Limited Info: Ratio 3.5		Limited Info: Ratio 4.5	
Variable	Coef.	SE	Coef.	SE
Utility Parameters				
Price ($\bar{\alpha}_p$)	-0.0066**	0.0017	-0.0085**	0.0018
Price OffCourse ($\bar{\alpha}_{p,Off}$)	-0.0042**	0.0019	-0.0051**	0.0021
Prestige Effect: $\left(\sum_g \frac{1}{rank_{g,b}}\right)$	0.8728**	0.3526	1.1104**	0.4278
$\hat{\text{Ad}}_b^{tv}$	0.0525**	0.0211	0.0503**	0.0230
$\hat{\text{Ad}}_b^{tv}$*(1-I[Endorse])	-0.0147	0.0243	-0.0091	0.0279
$\hat{\text{Ad}}_b^{mag}$	0.0176**	0.0083	0.0172*	0.0101
$\hat{\text{Wins}}$	0.0221	0.1174	0.0618	0.1414
$\hat{\text{Second}}$	0.0358	0.1096	0.0469	0.0707
Awareness Parameters				
Constantφ_0	0.4222**	0.0238	0.4173*	0.2494
Constantφ_0*I[MedHandicap]	0.3017*	0.3197	0.2987*	0.1911
Constantφ_0*I[HighHandicap]	-0.4665*	0.2772	-0.4525	0.2804
$\hat{\text{Ad}}_b^{tv}$	0.0473**	0.0117	0.0468**	0.0020
$\hat{\text{Ad}}_b^{tv}$*(1-I[Endorse])	0.1074	0.0490	0.1067	0.1213
$\hat{\text{Ad}}_b^{mag}$	0.1378**	0.0120	0.1386**	0.0015
$\hat{\text{Wins}}$	0.2493**	0.1165	0.2446**	0.0418
$\hat{\text{Second}}$	0.1569	0.4807	0.1628	0.9805
Age	0.0165**	0.0024	0.0168**	0.0019
NerloveArrow Wins:ψ_u	0.3228**	0.1540	0.3320*	0.2050
NerloveArrowTV:ψ_{TV}	0.5199**	0.1108	0.5196**	0.0389
NerloveArrow Magazine:ψ_m	0.7281**	0.1114	0.7287**	0.03152

Notes: Utility parameters include Product-Channel and Month of Year FE not reported; Number of Observations=737

****indicates significant at 5%; *indicates significant at 10%;**

Appendix C: Proof of Strategic Planning of Unplanned Exposure

We further discuss the intuition of such a result below and present a proposition that shows the conditions under which it is optimal to have planned celebrity advertising act as a substitute (complement) to unplanned exposure.

Proposition 1. *A firm's strategy is to negatively (positively) coordinate planned celebrity advertising with unplanned when initial awareness of the brand is small (large).*

Proof. Assume γ_0 is the initial value of the components of ϕ in the choice set formation model as in Equation 1. Also assume that in period 1 the celebrity wins a tournament and unplanned exposure increases but in period 2 it does not. Define $g(\gamma) \equiv \frac{\partial \phi}{\partial \gamma} = \frac{exp(\gamma)}{(1+exp(\gamma))^2}$.

Under a setting where planned advertising is negatively correlated with wins, the total derivative of the impact of winning in period one is

$$substitutes: \; g(\gamma_0)\Delta win + g(\gamma_0 + \Delta win)(\Delta ad + \Delta t)$$

whereas the positive correlation or complements setting is

$$complements: \; g(\gamma_0)(\Delta win + \Delta ad) + g(\gamma_0 + \Delta win + \Delta ad)\Delta t.$$

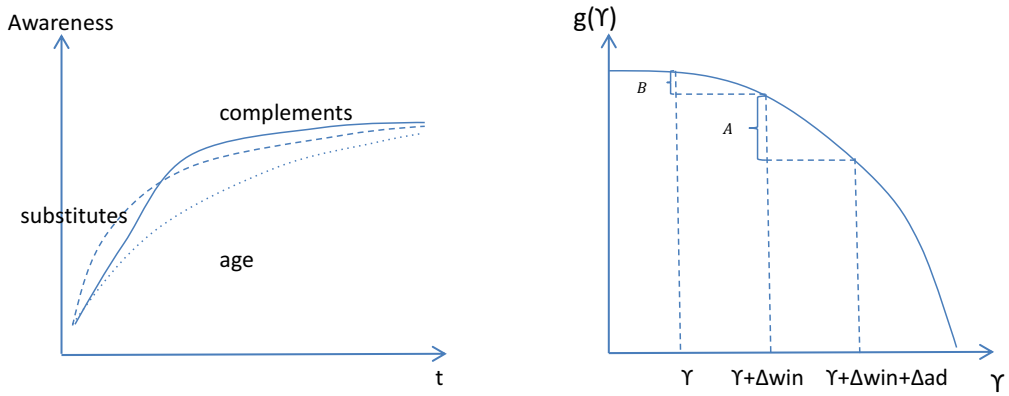
Firms therefore manage planned celebrity advertising with unplanned in a negative relationship when

$$\underbrace{\Delta t \left[g(\gamma_0 + \Delta win) - g(\gamma_0 + \Delta win + \Delta ad) + g\right]}_{A} > \underbrace{\Delta ad \left[g(\gamma_0) - g(\gamma_0 + \Delta win)\right]}_{B}$$

and such a relationship holds (does not) when γ_0 is small (large). This is due to the marginal return of a win decreasing as γ_0 increases, because the product naturally generates awareness with time. Thus, the marginal effect of a win diminishes as a product ages. The right figure of Figure12 illustrates this relationship. The left figure further shows the shape of the awareness curves for both coordination strategies and the curve when there is no planned celebrity advertising over time.

Given the presented analysis, we determine that Titleist's strategy should be to have planned and unplanned exposure act as substitutes early in the life cycle in order to smooth awareness across months and keep awareness high. After reaching the point where the marginal return of a win in a substitutes setting falls below that of a complements strategy, the firm should shift planned advertising to reinforce its players' successes in the same period. □

Figure 12: Awareness and Marginal Return



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