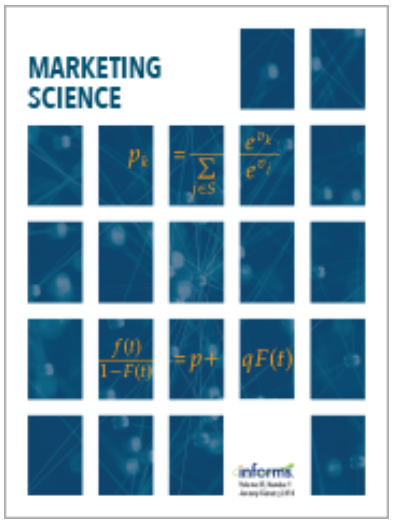

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Economic Value of Celebrity Endorsements: Tiger Woods' Impact on Sales of Nike Golf Balls

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In this paper we quantify the economic worth of celebrity endorsements by studying the sales of endorsed products. We do so with the use of two unique data sets consisting of monthly golf ball sales and professional golfer (celebrity) rankings. In particular, we examine the impact Tiger Woods had on sales of Nike golf balls. Our identification of the causal effect of a celebrity is grounded in the celebrity's random performance over time.

Using two different approaches, reduced form and structural, we find that there are substantial celebrity endorsement effects. From our structural model, we determine that endorsements not only induce consumers to switch brands, a business stealing effect, but also have a primary demand effect. We determine that from 2000 to 2010, the Nike golf ball division reaped an additional profit of $103 million through the acquisition of 9.9 million in sales from Tiger Woods' endorsement effect. Moreover, having Tiger Woods' endorsement led to a price premium of roughly 2.5%. As a result, approximately 57% of Nike's investment in Woods' $181 million endorsement deal was recovered *just* in U.S. golf ball sales alone.

Key words: endorsements; competitive analysis; entertainment marketing
History: Received: September 26, 2011; accepted: August 27, 2012; Michel Wedel served as the guest editor-in-chief and K. Sudhir served as associate editor for this article.

1. Introduction

The general belief among marketing agencies is that the use of celebrity endorsements enhances product recall but not sales. David Ogilvy, founder of the international marketing agency Ogilvy & Mather, is said to have preached that celebrity advertisements triggered above average product recall but resulted in below average sales (Segrave 2005). Similarly, Wilson Tennis division vice president Gene Buwick is said to have remarked that no company should expect an endorsement investment to come back in terms of added sales; rather, the success of an endorsement should be judged in terms of the visibility and exposure the celebrity would give to that company's product and the company itself (Segrave 2005). On the other hand, there are cases that suggest celebrity endorsements actually lead to higher sales. For example, after Chanel signed Nicole Kidman in 2003, it is reported that global sales of Chanel's classic perfume jumped 30% (Cresswell 2008). Similarly, when Tiger Woods switched his endorsed ball from Titleist to Nike in 2000, Nike's market share went from less than 1% to 3.9% in eight months (Grange 2001).

In this paper, we address the fundamental question of whether celebrity endorsements lead to higher sales and thus are a profitable marketing strategy to implement. This is an especially pertinent question today given that celebrity endorsements have become an essential component of many firms' promotional strategies. The importance is corroborated by the fact that in the past 30 years, there has been a surge in both the number and the size of the celebrity endorsement contracts. Despite the importance, few have attempted to quantify the economic worth of celebrity endorsers in product sales. One of the main problems is identifying the endorsement effect amongst many other confounding events that may give rise to the same outcome. Moreover, the impact of an endorsement is said to be contingent upon celebrity quality and credibility (Busler 2002). For these reasons, researchers that have studied this domain have done so in an indirect manner by using the event study methodology and examining the fluctuation of stock prices when a celebrity endorsement is announced. As a result, this approach omits the importance of quality and credibility.[1] In this paper, in contrast to

[1] Specifically, Agrawal and Kamakura (1995) study 110 celebrity endorsement contracts and find that, on average, the market reacts positively to the announcement of celebrity endorsements. Based on this result, they conclude that celebrity endorsements are viewed as a profitable advertising strategy. More recently, Knittel and Stango (2013) study the negative impact of the Tiger Woods scandal (for details, see §7.3.1). By looking at the stock prices of the firms that Woods endorses, they estimate that, after the event in November 2009, shareholders of Woods' sponsors lost $5–$12 billion relative to those firms that Woods did not endorse. Furthermore, they find that sports-related sponsors suffered more

previous attempts, we answer the question by looking directly at the sales of the endorsed product and account for quality and credibility.

We have a unique golf data set that allows us to address our research questions. Studying celebrity endorsements in the context of the golf industry is fitting because golf has been the leading sports industry in the endorsement business. Each year, *Sports Illustrated* compiles a list of the "Fortunate 50," the 50 highest-earning American athletes in terms of salary, endorsement deals, and appearance fees. In 2008 and 2009, Tiger Woods and Phil Mickelson were first and second, respectively, on this list.[2] Tiger Woods has consistently earned more off the course than on the course through a variety of endorsements. In fact, in 2008, Tiger Woods was on his way to becoming the first $1 billion athlete. In 2007, his on-course earnings were $23 million and his endorsement deals totaled $100 million.[3] Structurally, the golf industry is a relatively insulated industry that has had a steady number of participants. It is estimated that over the past 10 years, the number of golfers has remained steady at 26–30 million (National Golf Foundation 2010).

We answer the fundamental question of whether celebrity endorsements lead to higher sales using two empirical approaches, reduced form and structural. We first begin with a reduced-form analysis to determine the impact on sales only. Applying a simple ordinary least squares estimator, we use aggregate brand sales date to determine the impact of celebrity endorsements. We can determine this effect because of endorser quality (world ranking) data, which randomly vary over time. Specifically, our identifying assumption is that as a celebrity's quality level decreases, the endorsement effect he possesses decreases. Thus, the co-movement in exogenous celebrity quality or performance and brand sales over time allows us to identify a celebrity's causal effect on sales. Following our reduced-form analysis, we move to a structural model of consumer demand and firm supply. In this analysis, we employ the same identification strategy to more broadly address the effects of celebrity endorsements. This structural model allows us to determine the impact on profit, price, and market share of not only the endorsed brand but its competitors as well.

By developing and estimating a structural demand model, we find that celebrity endorsements can create product differentiation and generate shifts in market share and thus should be thought of as a profitable marketing strategy. Furthermore, we empirically show that endorsements can have a strong effect on consumer utility. Because of endorsements, existing customers may switch to the more effective endorsed brand (business stealing) and bring in additional sales from the outside (primary demand) that would have otherwise not occurred if not for the endorsement. Finally, we find that firms are able to command a price premium when they sign high-quality celebrities, and competitors react by cutting prices. After implementing several counterfactual scenarios, we find that from 2000 to 2010, the Nike golf ball division reaped an additional profit of $103 million through an additional sale of 9.9 million 12-pack golf balls from Tiger Woods' endorsement effect. As a result, approximately 57% of Nike's investment on the golfer's endorsement was recovered just in U.S. golf ball sales alone.

The rest of this paper is organized as follows: First, to motivate our empirical study, we provide a brief background on the celebrity endorsement and golf industry with a focus on the golf ball market in §2 before providing an overview of the data with preliminary analysis in §3. In §4, we present some reduced-form analyses, and in §5, we describe our structural empirical model. In §6, empirical results are provided, followed by the counterfactual in §7. In §8, we conclude with a discussion on our study's limitations, with directions for future research.

2. Background Information

2.1. The Golf Industry

The golf industry in the United States generated direct revenues of $76 billion in 2005, up from $62 billion in 2000 (Skidmore 2008). At $76 billion, the golf industry is larger than the motion picture and video industries. The golf industry consists of seven main parts ranging from facility operations to real estate. Golfer equipment/supplies and endorsements combined to create a $7.8 billion industry in 2005 (Skidmore 2008). We present a general overview of the golf equipment used in the sport of golf. There are three main categories of golf equipment: bags, clubs, and balls. Given that our paper assesses the impact of endorsements on sales of golf ball equipment, we include an overview of the other two categories in the technical appendix (available at http://dx.doi.org/10.1287/mksc.1120.0760).

2.1.1. Golf Balls. Golf balls are estimated to generate $500 million in annual sales (Answers.com 2010, Dukcevich 2002). There are 1,051 models of golf balls that are listed on the United States Golf Association's list of conforming golf balls. Many golf experts

than his other sponsors. To the best of our knowledge, these two papers are the closest in terms of what we are trying to study in our paper.

[2] See http://sportsillustrated.cnn.com/more/specials/fortunate50/2009/index.html and http://sportsillustrated.cnn.com/more/specials/fortunate50/2008/index.html (accessed January 2011).

[3] See Sirak (2008).

believe that the golf ball has more engineering per cubic centimeter than in any recreational product in the market (Stachura 2010). Golf balls are usually white, weigh no more than 1.62 ounces, and have a diameter of no less than 1.68 inches (United States Golf Association 2012). The current golf ball comprises three main components: the number of layers, the type of outer cover, and the number of dimples.

Golf balls can have two to five layers. The least expensive golf balls (used by most amateurs) have two layers: the outer cover material and a core. The core of a ball is the resilient rubber compound located in the center that provides the transfer of energy from the golf club to the ball at impact. Two-layered golf balls are often called a "two-piece" ball, three-layered a "three-piece" ball, and so on. In three-piece balls, there is an extra layer of material between the core and the cover, a mantle, which is a layer of polymer that is used both to control spin off high-speed impact and to provide "feel." Four-piece balls have either two mantles or two cores. There is only one five-piece ball in the market today. The more layers a golf ball has, the higher the cost of production, and thus the higher the retail price.

The type of outer cover determines how the golf ball "feels" at impact from the golf club. Two main types of covers are most widely used in the golf ball industry; the most popular is ionomer, a durable and resilient material made of a blend of plastic resins. The other is urethane, a softer and more elastic material that is more expensive to manufacture. The urethane cover is about twice as thin as the ionomer cover. During the casting process, urethane has been shown to go from a liquid to a solid in 30 seconds; this leaves no room for manufacturing error. On the other hand, the production of ionomer-covered balls is straightforward. In the time that it takes to produce 160 ionomer-covered balls, only one multilayer urethane-covered ball can be produced. Most nonpremium golf ball covers are made of ionomer material, and most premium golf ball covers that professional golfers use are made of urethane.

Finally, today's golf balls are characterized by the surface dimples—small, identically shaped, usually circular indents that create the necessary aerodynamic forces for the ball to fly further and longer. The trajectory of the flight differs depending on the depth of the dimples, with shallow dimples creating higher flights and deeper dimples creating lower flights. Most current golf balls have between 250 and 450 dimples. To increase the number of dimples covering the ball's surface, some manufacturers have even produced balls with differently shaped dimples; however, it is understood that balls with more dimples are generally more difficult to manufacture, which is reflected in the retail price.

In this paper, the characteristics of the golf ball are important because they help differentiate the products. In estimation, these characteristics become valuable instruments for the endogenous price variable.

2.2. How Celebrity Endorsements Work in the Golf Industry

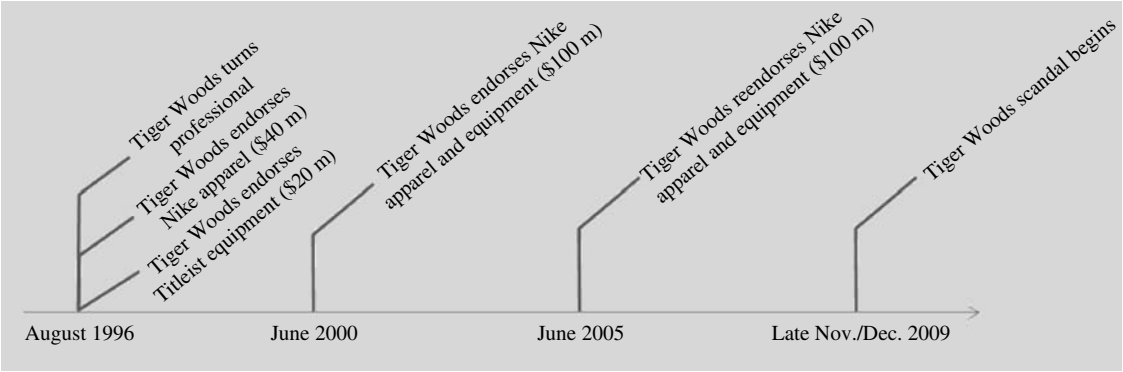
A celebrity endorsement is a relationship between a firm and a celebrity that occurs for an agreed-upon duration of time. In other words, although there is a matching that goes on between a celebrity and the firm, once an agreement is made and the contract is signed, the relationship is binding for the time period agreed upon. For a firm selecting an endorser, there are two important factors to consider: (1) the *attractiveness* of the celebrity (a more attractive/prominent endorser leads to a greater impact on sales) and (2) the *credibility* of the celebrity (the endorser's expertise and trustworthiness must be credible). In this regard, the golf industry is particularly appropriate to study for two reasons. One, all celebrities (players) are ranked each week based on their performance for the previous 104 weeks—a natural measure of celebrity attractiveness. And because each celebrity uses the equipment in weekly tournaments to earn prize money, player credibility issues are thus eliminated.

Most celebrity endorsements in the golf industry are predetermined, multiyear contracts that specify the celebrity's scope of services, such as physically using the product (ball, club, apparel with logo, bag, etc.) in tournaments during the contract period and other services. For example, Tiger Woods signed a five-year agreement with Nike Golf for $100 million on the condition that he would use Nike golf balls and clubs and wear Nike apparel. The list of services is carefully considered and negotiated by both the golfer's representative and the firm that wants to employ endorsements as part of its promotion strategy. The compensation arrangement varies depending on the scope of services the firm imposes on the celebrity as well as the visibility of the celebrity and his or her potential, which dictates the size of compensation. For example, Woods was able to command $20 million per year from Nike; a typical PGA tour player ranked outside the top 50 earns anywhere from $100,000 to $500,000 per year from an endorsement deal. Contracts often also include a morals clause that prohibits certain behaviors that may negatively impact the firm. In case of unforeseen circumstances, contracts often specify the rights of both parties for early termination from a multiyear endorsement contract.

2.3. Tiger Woods' Endorsements

Tiger Woods' career began with endorsement deals with the Nike and Titleist brands in 1996; he endorsed

Figure 1 Tiger Woods' Endorsement Timeline



Nike golf apparel and shoes and Titleist golf balls and equipment. At the time, Nike was a new player in the golf industry and was only producing apparel and shoes. However, in 1999, Nike entered the golf equipment market, producing golf balls and clubs. In June 2000, Woods was the first player to switch from using Titleist golf balls to Nike golf balls. This switch cost Nike $100 million, and in return, it secured a five-year endorsement contract with Woods that included equipment, apparel, and shoes. After the initial five-year contract expired, Nike entered into another five-year endorsement deal for another $100 million. In total, from 2000 to 2010, Nike paid Woods $200 million ($181 million in 1997 dollars) to endorse its golf products. Figure 1 presents a timeline of the above events.

3. Data and Descriptive Evidence

The data used in this study are aggregated monthly golf ball sales in the United States from February 1997 to April 2010. These data represent the total sales in the United States for on-course (green grass) and off-course golf specialty stores. For on-course shops, the sales represent a mix of public and private course golf shops. For off-course shops, a mix of single-owner and chains stores are represented. The figures are made up of more than 550 on-course shops and more than 250 off-course shops, which are then extrapolated to an aggregate U.S. level. There are a total of 669 unique products represented by a total of 26 different brands. Table 1 shows a plot of summary statistics over time.

In Figure 2, we look at the total sales of golf balls (in units of 12) over time. It is apparent that the golf ball market clearly shows seasonality and a time trend. Seasonality is expected because golf is a seasonal sport that takes place in warm climates. To take this into account, we include year-month interaction indicator variables as well as manufacturer-specific time trends in our estimation.

There is a range of 9 to 17 brands available each month; likewise, the average number of products available in a given month is 66, with a minimum of 35 and a maximum of 102. It is important to highlight a difference between the two respective retail channels, on course and off course. There is a substantial difference between the golf ball prices. This difference results from two important factors: a convenience premium and reduced competition, given that on-course shops have less shelf space than do off-course stores. This latter point is highlighted by the difference between the average number of products available in each channel, which, as shown in the third row of Table 1, is roughly 10.

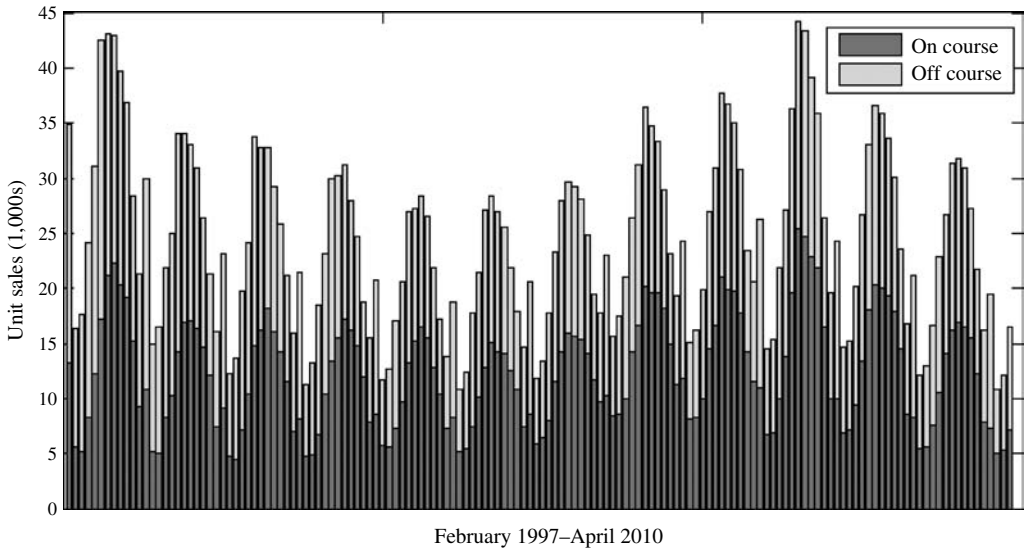
In Table 2, we present a cross-sectional snapshot of market conditions for both the beginning and the end of the data period (April 2000 and April 2010, respectively) for the off-course retail channel. This will give readers a quick synopsis of the changes in the golf ball market that we study. From the table, Titleist is ranked "the number 1 ball in golf," followed by Top-Flite, Pinnacle, and Precept in 2000 and Callaway, Bridgestone, and Nike in 2010. It is notable that Nike rose to become a major player by 2010 with a 10% market share. We also present the Herfindahl–Hirschman Index (HHI) to determine the level of concentration/competition in the industry.

Table 1 Summary Statistics for Each Market (February 1997–April 2010)

	On course	Off course	Overall
Average price (per dozen)	$23.09 [$18.21, $26.37]	$18.50 [$14.97, $22.33]	$20.81 [$14.97, $26.37]
Units sold (in dozens)	12,582 [4,415, 25,441]	12,573 [5,681, 29,461]	12,577 [4,415, 29,461]
No. of products available	61 [35, 90]	71 [41, 102]	66 [35, 102]
No. of brands available	13 [9, 17]	14 [10, 17]	14 [9, 17]

Note. Shown are the average values, with min and max values in brackets.

Figure 2 Total Golf Ball (12-Pack) Sales for On- and Off-Course Shops



The index corresponds to a relatively competitive industry, which is corroborated by the four-firm concentration ratios of 65.40 and 55.40 for 2000 and 2010, respectively.

It is also interesting to note that the total number of products available decreased from 75 to 71. We also note that the average price dispersion decreased—in 2010, it ranged from \$8.47 to \$26.90, whereas in 2000, it ranged from \$8.83 to \$39.68. This brand-level price trend, however, is not very informative because it is the average price for all "products" available, as indicated in the "No. of products" columns.

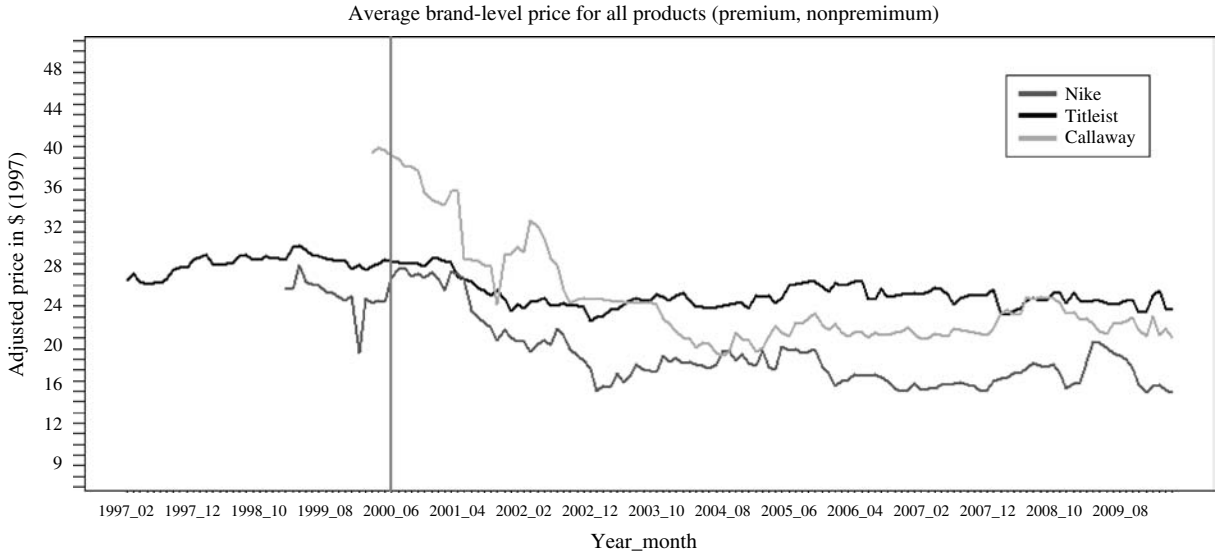
For a better idea of the price trend, we look at price in conjunction with time. Assessing intertemporal price variation is important because it allows us to glean into a consumer's decision-making process in this market. To be more precise, if we observe price drops over time, it is expected that some consumers may intertemporally substitute at the time of their purchases. A time-series plot of the three major brands' prices is shown in Figure 3. The plot is the average price of all products offered by a particular brand. The vertical line represents when Tiger Woods switched from Titleist (black) to Nike (medium gray). Note that the medium gray line does not start until 1999, as Nike golf balls were not introduced until then. Likewise, Callaway (light gray) balls were not introduced until early 2000. We observe

Table 2 Cross-Sectional Market Conditions for April 2000 and April 2010 (Off Course)

2000				2010			
Brand	Share	Avg. price [Max, Min] (\$)	No. of products	Brand	Share	Avg. price [Max, Min] (\$)	No. of products
Titleist	23.51	28.17 [34.46, 22.32]	9	Titleist	23.08	23.64 [36.34, 15.34]	7
Top-Flite	22.74	13.50 [18.01, 10.23]	9	Callaway	11.75	20.87 [34.27, 8.37]	12
Pinnacle	11.63	12.08 [14.91, 9.75]	7	Bridgestone	10.57	26.90 [34.49, 17.67]	8
Precept	7.52	22.82 [31.44, 18.08]	9	Nike	10.00	15.76 [25.48, 8.60]	10
Wilson	7.52	19.67 [26.94, 9.22]	11	TaylorMade	7.50	21.32 [36.29, 12.51]	6
Maxfli	6.23	25.72 [34.85, 14.28]	7	Top-Flite	7.14	9.70 [14.24, 6.20]	6
Strata	4.91	24.79 [25.64, 24.26]	3	Srixon	6.72	21.02 [32.35, 10.61]	7
Callaway	3.67	39.68 [40.30, 39.07]	2	Pinnacle	5.99	9.60 [12.22, 7.94]	6
TaylorMade	2.36	31.36 [33.97, 26.98]	3	Precept	5.79	13.99 [18.21, 8.02]	4
Spalding	2.35	8.83 [26.98, 8.83]	1	Other	4.01	8.61 [8.61, 8.61]	1
Other	2.08	13.24 [13.24, 13.24]	1	Wilson	3.00	8.47 [8.47, 8.47]	1
Dunlop	1.83	11.59 [14.38, 10.04]	4	Noodle	2.26	12.08 [12.23, 11.93]	2
Nike	1.59	26.48 [36.39, 18.14]	4	Volvik	1.77	15.79 [15.79, 15.79]	1
Cobra	0.95	21.22 [22.85, 18.93]	4				
Srixon	0.51	24.17 [24.17, 24.17]	1				
HHI		1,417.03				1,137.89	
Four-firm CR		65.40				55.40	

Notes. Price is adjusted to 1997. CR, concentration ratio.

Figure 3 Plot of Brand-Level Price Over Time



Note. The vertical line indicates Tiger Woods' switch to Nike (June 2000).

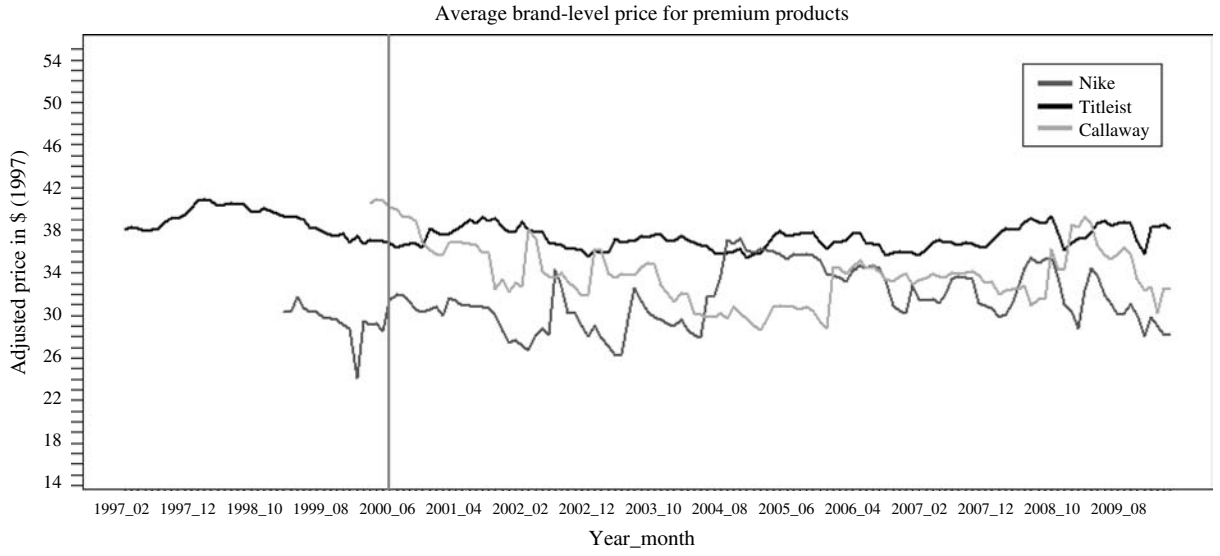
that Callaway's average price decreased over time, at least in the first two years; however, this is because Callaway entered the market with just two premium products (see Table 2) before releasing nonpremium products that drove down its average price. For Nike, we find that there was an increase in price immediately after Tiger Woods' switch before it leveled off in the summer of 2002. As with Callaway, there is a slight decrease in price initially because Nike also entered the market with premium products before releasing nonpremium products.

To empirically support the reasoning of our claim for an initial decline in price for two brands (Nike and Callaway), we employ a subset of the data consisting of only "premium" products, and we plot the time series of average prices. As shown in Figure 4, the two brands' prices are now less drastic and more leveled. Furthermore, for Nike, even within the subset of the data, we again see a small increase in price after Tiger Woods' endorsement contract with Nike in June 2000. Although we cannot attribute this to Tiger Woods, we will see in §7 that, indeed, the presence of his endorsement has an effect on a firm's pricing decision.

3.1. Nike Golf Ball Sales

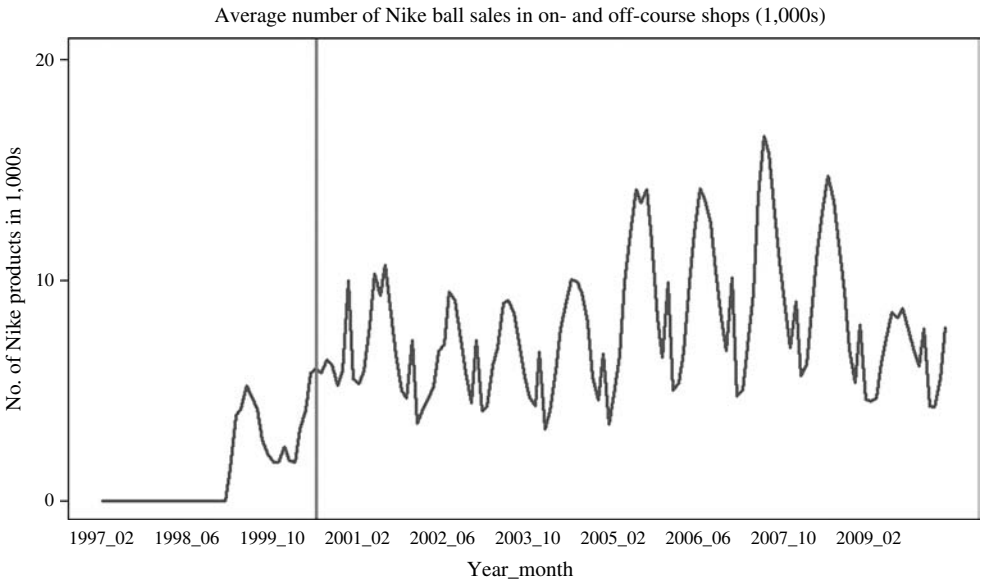
In this section, we explore the data further by looking at the sales of Tiger Woods' endorsed brand, Nike.

Figure 4 Plot of Brand-Level Price Over Time for Premium Products



Note. The vertical line indicates Tiger Woods' switch to Nike (June 2000).

Figure 5 Total Sales of Nike Golf Balls (12-Packs) Before and After Tiger Woods' Endorsement

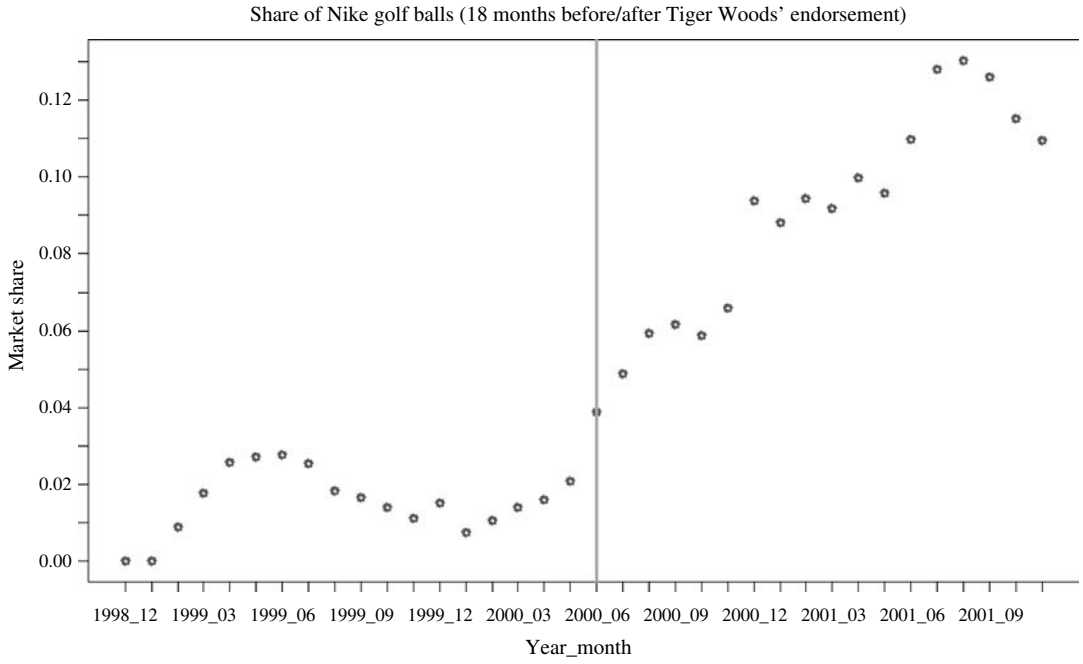


Note. The vertical line indicates Tiger Woods' switch to Nike (June 2000).

In Figure 5, we present the sales of Nike golf balls from its introduction (February 1999) until the end of our data period (April 2010). The vertical line represents June 2000, when Woods made official his switch to the Nike brand. Clearly, even after taking into account the seasonality on sales over months, there appears to be a "jump" in sales for Nike golf balls after Woods' switch.

Figure 6 zooms in on the date Tiger Woods switched endorsements by plotting the market share of Nike golf balls for the off-course retail channel. Again, the vertical line represents the month in which Woods switched. To the left and right of this line are 18 months of market share before and after his switch. This picture is quite clear in highlighting the discrete jump in market share for Nike in the month Woods

Figure 6 Share of Nike Golf Balls Before and After Tiger Woods' Switch



Note. The vertical line indicates Tiger Woods' switch to Nike (June 2000).

Table 3 **Mean Market Share for Titleist and Nike 18 Months Before and After Tiger Woods' Endorsement Switch (Off Course)**

	Before (%)	After (%)
Nike	1.5	6.6
Titleist	24.9	21.8

switched, and it illustrates a significant growth in market share after he switched. Table 3 also presents similar results. Not only is an increase in market share for Nike illustrated, but there is also a substantial decline in share for Titleist.

4. Reduced-Form Analysis

Through our raw data, we have shown that Nike may have benefited from the signing of Tiger Woods to an endorsement contract in the form of increased sales and market share. These observations raise two important questions:

1. Do endorsements increase sales?
2. If so, how profitable are they?

To identify the endorsement effect and to answer these questions, we use the exogenous variation in player ability, measured by a golfer's world ranking, and the variation in sales of the endorsed brand. With this, we employ reduced-form analysis by running a regression to illustrate the potential causal effects of the exogenous ranking variable on sales. However, before we move to this analysis, we first introduce some important variables that will be used in both our reduced-form and structural models.

4.1. Celebrity Endorsement Effect

The impact of a celebrity endorsement can be decomposed into two distinct effects. We specifically discuss each in turn below. The first, a primary effect, captures the quality of a player for the previous 104 weeks. The second effect, or what we call a secondary or short-term unplanned brand exposure effect, occurs when an endorsing celebrity golfer wins a tournament in a given month. In golf, exposures occur every week through televised golf tournaments. We believe these brand-level television exposures by golfers could be substantial and important in influencing the monthly sales of golf balls. As we discuss below, we construct the unplanned brand exposure variable at the brand level based on the winners of the four monthly tournaments in each period t. The celebrity endorsement effect can therefore be written as a function of both the primary and secondary effects.

4.1.1. Primary Endorsement Effect. We capture the primary effect of celebrity endorsements on the sale of the endorsed brand by defining the (row) vector $\mathrm{En}_{bt} = [E_{1bt}, E_{2bt}, E_{3bt}, \ldots, E_{Gbt}]$ for golfer g and brand b in market t, where

$$E_{gbt} = \begin{cases} \left(\dfrac{1}{rank_{gt}}\right)^{\alpha} & \text{if } D_{gbt} = 1, \\ 0 & \text{if } D_{gbt} = 0. \end{cases} \quad (1)$$

For each golfer g, given that the golfer endorses brand b, we define E_{gbt} as a function of the skill level at time t. The indicator variable D_{gbt} equals 1 if player g endorses brand b at time t. Taking quality into account, we use the inverse of the world ranking of the player g at time t as a proxy. Finally, α measures the rate of decay of $1/rank_{gt}$. The ranking is determined accordingly (Official World Golf Ranking 2012):

> The World Ranking Points for each player are accumulated over a two-year "rolling" period with the points awarded for each event maintained for a 13-week period to place additional emphasis on recent performances—ranking points are then reduced in equal decrements for the remaining 91 weeks of the two-year ranking period. Each player is then ranked according to his average points per tournament, which is determined by dividing his total number of points by the tournaments he has played over that two-year period. There is a minimum divisor of 40 tournaments over the two-year ranking period and a maximum divisor of a player's last 52 events.[4]

By taking into account the variability of skill level over time, we maintain that if there exist an endorsement effect, it will be larger when the player is of higher quality.

We include five golfers in our model: Tiger Woods, Phil Mickelson, Ernie Els, Vijay Singh, and David Duval. We chose these five players because all five players were ranked high in world rankings for the majority of time between 1997 and 2010, and all five were under endorsement contracts with the respective company of the golf ball that they used.[5] Because our purpose is to study the impact of celebrity endorsements, we are interested in the top players on the PGA tour.[6] Including just one celebrity might be

[4] The Official World Golf Ranking is published every week, but given that we define our time in months, we use the end of the month's world ranking. See http://www.officialworldgolfranking.com/home/default.sps.

[5] An exception among these five players is David Duval, who ranked high from 1997 to 2003 before falling outside of the top 200 in rank. (He would return to top 200 ranking in 2009.) We decided to include Duval in our estimation because not only do we know the date in which he switched from the Titleist product to the Nike product, but during the time he was highly ranked, he was also considered one of the best golfers of all time.

[6] In fact, for players who were not consistently ranked high in their career, it was difficult to find out whether they had a formal endorsement contract with the firm that manufactured the golf ball they used.

thought to create an omitted variable bias problem, with the rationale being that if another endorser also endorsed the same brand that Tiger Woods endorsed, then not taking into account that endorser's effect would be problematic as the estimate will be biased upward. However, our ranking data suggest that there is no strong correlation between endorsers who endorse the same brand, and thus including only a subset of all golfers who endorse a brand is not problematic.

4.1.2. Secondary Endorsement Effect: Unplanned Brand Exposure from Celebrities Winning Tournaments. To create the secondary "unplanned" brand exposure variable, we sum up the number of golf tournament wins by top golfers who endorse brand b in a given month. Therefore, our unplanned variable is at the brand level. This is unplanned exposure by top golfers because, in any given week (PGA golf tournaments are held once a week, four times a month), approximately 140–150 tour golfers participate, and anyone in the field has a chance to win. Therefore, the exposure a brand may receive through the golfer using that firm's product is unplanned. We agree that the probability of winning by the top players may be higher, but it still holds true that from firm's perspective, this exposure is random in the sense that it occurs with a probability of less than 1; it is independent of the firm's marketing strategy.

Each PGA tournament starts on Thursday of a given week with one round (18 holes) played each day for four days. In a four-day competition, the person who scores the lowest accumulative strokes wins. The majority of PGA tournaments are televised; the first two rounds are usually televised on a cable channel, and the last two rounds are televised on a regular network channel (i.e., NBC, ABC, or CBS). In the last two rounds, the players that get the most coverage are those that are high on the leaderboard. In all cases, as long as the player is at the top of the leaderboard in the final round, he will receive the most broadcast coverage, regardless of the world ranking of the player.[7] For viewers, it is not difficult to identify the product that golfers use, because the camera angle allows for an explicit view of the brands. For example, when a player is on the putting green, the camera usually zooms into the golf ball to capture its roll to the hole from a ground-level view.

We define the unplanned brand exposure variable as $UEx_{bt} = \sum_{g=1}^{P} EX_{gbt}$:

$$EX_{gbt} = \begin{cases} MWIN_{gt} + win_{gt} & \text{if } D_{gbt} = 1, \\ 0 & \text{if } D_{gbt} = 0. \end{cases} \quad (2)$$

Here, the win_{gt} is an indicator variable that is 1 if the player g at time t wins the tournament. Again, D_{gbt} is an indicator variable equal to 1 if player g endorses brand b at time t. We include the indicator variable $MWIN_{gt}$, equal to 1 if the player who wins at t won one of the PGA Tour's major tournaments. In the PGA Tour, there are four tournaments that are considered "major": the Masters Tournament, the U.S. Open Championship, the (British) Open Championship, and the PGA Championship. These tournaments are usually widely publicized with typically larger audiences and longer TV coverage than regular tournaments. Therefore, in taking into account the additional exposure at these four major tournaments, a major tournament is assigned a value of 2 and a regular tournament is assigned a value of 1. We include three major golf ball manufacturers—Nike, Callaway, and Titleist—because at one point in their careers, the top five players endorsed at least one of the three brands. For each firm, we match the each PGA Tour winner from 1997 to 2010 to the golf ball he used.[8]

Arguably, we could have used a broader definition of the unplanned variable by taking into account all players who were in "contention" during the tournament coverage. Although the top contenders during the week could have also received extra TV exposure, trying to take the remaining players into account is difficult. First, because records of nonwinners are usually not readily available, determining the players who finished in top five from 1997 to 2010 is difficult. Second, even if this information could be obtained, we are hesitant on whether the top five players actually did receive the extra coverage that we know the winner received, as it is not unusual to see players who end up in contention finish their final round of golf before the live coverage begins. Therefore, at best, highlights of their play are covered in the beginning of the live broadcast coverage. Finally, the tee times for the final round of golf are determined by the reverse order of the accumulated rank of the first three days of play. Because leaders start last on Sunday afternoon (the time when the live coverage starts), we hesitate to make a broader definition of the unplanned variable because we are uncertain if the nonwinners received the exposure that we describe above.[9]

[7] When Tiger Woods won the Masters tournament in April 2000, it was measured that he was on-screen for 32% of the broadcast time while the rest of the field was on for 36% of the time (Grange 2001).

[8] Although we made every effort to match the winners, in rare occasions, we were not able to ascertain which ball the golfer would have used to win the tournament. This was especially the case for the Titleist brand. In such cases, we left the value as 0.

[9] Moreover, matching the player with the brand used is not always straightforward. Although we made every effort to determine this, there were instances even among the winners where determination of the brand used during tournament coverage was difficult. To this end, we limit ourselves to the winner of the golf tournament.

Table 4 PGA Winning as a Proxy for Advertisement Variable

Nike	Titleist	Callaway
Tiger Woods	Tiger Woods	Phil Mickelson
David Duval	Phil Mickelson	Ernie Els
Stewart Cink	David Duval	
K. J. Choi	Vijay Singh	
Trevor Immelman	Ernie Els	
Anthony Kim	Davis Love III	
Paul Casey	David Toms	
	Steve Stricker	
	Padraig Harington	
	...	

We tabulate the players that make up each brand's unplanned exposure variable in Table 4.[10]

We believe that unexpected brand exposure of golf ball products is highly unlikely to be correlated with the primary individual celebrity endorsement variable, given that exposure is also exogenous and is based on who wins tournaments. However, erring on the conservative side, we include this variable to control for the fact that perhaps player ranking and unplanned brand exposure are correlated. If we were to omit unplanned brand exposure, the model error term would consequently be correlated with the endorsement variable and thus bias our estimate. Our inclusion of such a term is motivated by a simple example. Suppose a brand b endorser increases his rankings over several months and does so by not winning. Also assume that during these months, other players who have endorsement contracts with brand b and play brand b golf balls win several tournaments and generate unplanned exposure for brand b, which then leads to greater sales. Without accounting for the unplanned brand exposure variable, the resulting primary endorsement effect would be overestimated because the two variables are positively correlated.

4.2. Planned Exposure: Advertisement-Level Spending

We believe that traditional planned advertising exposure in major media outlets will vary over time and that this may possibly influence our goal of consistently estimating the endorsement variables. In the traditional planned method, firms spend their marketing budget in different media outlets. For example, firms are likely to allocate different amounts of money on TV, magazines, and Internet ads each month. Although these budgets are usually determined months in advance, firms can adjust their marketing tactics as they see fit. If it is the case that these adjustments are made, especially when an endorser's performance increases or a player wins a tournament, it is imperative that we capture the advertising effect to isolate out the endorsement effect on sales for each celebrity.

Our specification must include the planned advertisement spending level by firms that use celebrity endorsements as a marketing strategy. This is because one may argue that when the firm's endorser is ranked number one, then the firm is likely to spend more on advertising to highlight the fact that the product used by the number one golfer in the world is from that firm. Similarly, when a player wins a tournament and thus increases brand b's unplanned brand exposure, the firm spends more on advertising to again highlight the player's win.

We agree that the advertisement level is an important component that, if omitted, could potentially create omitted variable bias in our estimation. The concern is that if, indeed, firms are spending more when the endorser is performing better and if the advertisement level is omitted, then the error is now correlated with the endorsement variables. To control for the potential bias, we should include the advertisement-level spending data that span our data from 1997 to 2010. Unfortunately, given the long sales data of 13 years, we were unable to obtain advertisement-level spending data of equal length. However, we did obtain a subset of the golf-ball-related advertisement-level spending data that span from January 2003 to December 2009. Given this data limitation, we ran a pretest that allowed us to rule out the omitted variable issue with reasonable confidence.

To test our argument that *if the endorser is ranked number one, then the firm is likely to spend more on advertising* or *if unplanned brand exposure increases, firms also increase advertising*, we run a regression that regresses the level of planned advertisement on the endorsement variables, $1/rank$ and *unplanned brand exposure*, while controlling for seasonality. Our parameters of interest here are the endorsement variables, as they would tell us whether firms are indeed spending more on advertising when the endorser leads in world ranking or a player wins a tournament. We find these variables to be not statistically significant, as shown in Table 5. In fact, advertising seems to be purely seasonal, occurring in the summer and spring.

Having found that for 7 out of the total 13 years studied there is no significant endorsement effect on

[10] Some players show up in multiple brands, given that they switched their endorsed brand between 1997 and 2010. Also, we name only the top players for the Titleist brand, given that there were significantly more players who won under the Titleist brand than the other brands on the PGA Tour. This is expected because the Titleist brand is the most widely used golf ball on the PGA Tour. For recent winners (e.g., Ian Poulter, Hunter Mahan, and Jason Bohn), we used the PGA Tour website (http://www.pgatour.com/golfers/pgatour/), which provides player profiles that show whether they used Titleist golf balls. For winners that trace back further, we made every effort to ascertain whether Titleist balls were used. For example, Brad Faxon used Titleist during his winning tournaments beginning in 1991.

Table 5 Regression of Planned Advertising on Truncated Data, 2003–2010

Parameters	Estimate	Std. error
Unplanned brand exposure	−44.99	91.85
1/*rank: Tiger Woods*[a]	−736.19	653.14
1/*rank: David Duval*[a]	919.38	11,823
1/*rank: Phil Mickelson*[b]	685.59	702.40
1/*rank: Ernie Els*[b]	−1,485.80	12,824
1/*rank: Ernie Els*[c]	877.29	1,664.50
1/*rank: Phil Mickelson*[c]	−732.41	560.50
1/*rank: Vijay Singh*[c]	−1,281.10	1,120
Month 2	605.71***	247.46
Month 3	1,707.10***	246.70
Month 4	1,410.90***	249.20
Month 5	1,205.40***	261.76
Month 6	2,094.40***	257.87
Month 7	975.09***	260.76
Month 8	644.79***	262.48
Month 9	243.89	272.48
Month 10	−113.05	263.29
Month 11	−159.74	258.73
Month 12	−69.62	257.93

Note. Brand and year fixed effects are not reported.
[a]Using the Nike brand.
[b]Using the Callaway brand.
[c]Using the Titleist brand.
***$p < 0.05$.

planned exposure, we are reasonably confident that excluding the planned advertisement variable from our estimation on the full data set will not create an omitted variable bias problem.

Consequently, when we present the full structural model in §5, we can either proceed and estimate a random coefficient model using the subset of the data where advertising data are available or take this test measure to justify the rationale for omitting the planned advertisement-level variable and estimate the model based on the entire data set. We took the latter choice for three important reasons.

First, we believe that throwing away about half of the monthly data is certainly not desirable given the richness of month-to-month variation that these data present us with. Second, it prevents us from identifying several celebrity endorsement variables we had originally included. Mainly, in a truncated data set, we exclude two celebrities, Tiger Woods and David Duval, both under the Titleist golf brand. This is because both players endorsed the Titleist golf brand prior to 2003, our initial year of the truncated data. We want to point out that it is imperative that we keep the data prior to 2000 so that we are able to estimate the endorsement effect of Tiger Woods on the Titleist golf ball brand. This will allow us to run a more realistic counterfactual study to assess the economic value of celebrity endorsements. In other words, by separately identifying Tiger Woods' endorsing of two separate brands under two independent multiyear contracts, we are able to run studies that ask interesting questions such as, "What would have been Nike's profit if Tiger Woods stayed with the Titleist brand?" Finally, the objective in this paper is to assess the economic value of celebrity endorsements, not to measure the influence of advertisement on sales. To be more precise, our main concern for including advertising in our specification is to control for the potential bias that can come from omission, which, as shown above, is unlikely to be the case.

4.3. Reduced-Form Results

We now present reduced-form work to motivate the use of $1/rank$ as our primary endorsement variable in our structural model below. These regressions illustrate that our primary endorsement variable is an appropriate measure to captures the impact of a celebrity on sales. We do so by regressing the log of monthly sales (per 12-pack of golf balls) on the main variable of interest, the exogenous endorsement variable ranking, while including controls for brand, year, and month fixed effects. We transform the sales figure with a natural logarithm as sales across brands are substantially different. For example, Titleist sold, on average, 577,000 12-packs per month from 1997 to 2010; in contrast, Nike sold, on average, 117,000 12-packs per month. Therefore, keeping the sales figures level, we would constrain the variables to grow by a fixed amount each month, which in our case is inappropriate. By making this transformation, our estimates of the endorsement variable are interpreted as the proportional change in sales on a unit change of the regressor.

Before we present the results of our reduced-form work, we present a brief discussion regarding the identification of the primary celebrity endorsement effects. First, what enables us to determine a celebrity's effect is the presence of endorser quality data and the fact that endorser ranking exogenously varies over time. Specifically, to identify such an effect, we make the assumption that as a celebrity's quality level decreases, the endorsement effect he possesses decreases. Thus, the comovement in a player's random performance over time and brand sales allows us to identify a celebrity's causal effect on sales after controlling for any correlation between brand exposure and player quality. Again, what enables us to determine such an effect is the presence of exogenous endorser quality data and the fact that brands do not increase planned advertising as celebrity quality increases or celebrities win tournaments.

Our first regression consists of aggregating sales up to the brand level and restricting the data to include only Nike and Titleist, as these are the two brands Tiger Woods has endorsed over his career. We also omit a portion of sales data when Tiger Woods was not a part of an endorsement deal with either brand.

Table 6 Regression of Log(Sales) on the Parametric Endorsement Variable $(1/\textbf{\textit{rank}})^{\alpha}$

Variable	$\alpha = 1$	$\alpha = 0.5$	$\alpha = 0.4$	$\alpha = 0.3$	$\alpha = 0.2$	$\alpha = 0.1$
Unplanned exposure	0.022 (0.014)	0.022 (0.014)	0.021 (0.014)	0.021 (0.014)	0.021 (0.014)	0.021 (0.014)
1/*rank of Tiger Woods*	0.127 (0.057)**	0.181 (0.087)**	0.205 (0.101)**	0.245 (0.124)**	0.3257(0.210)	0.566 (0.310)
Brand fixed: Nike	4.059 (0.084)**	4.000 (0.107)**	3.979 (0.120)**	3.939 (0.140)**	3.858 (0.184)**	3.616 (0.318)**
Brand fixed: Titleist	6.383 (0.107)**	6.328 (0.127)**	6.303 (0.137)**	6.262 (0.156)**	6.182 (0.196)**	5.941 (0.3271)**
Adjusted R^2	0.9796	0.9794	0.9793	0.9793	0.9793	0.9792

Notes. Estimate significance; standard errors are in parentheses. Sales are in thousands of 12-packs.
**$p < 0.05$.

We report our results in Table 6; we excluded the month and year fixed effects to preserve space.

As shown from the R^2 statistics, the model with $\alpha = 1$ generates the largest adjusted R^2 value, with 98% of the variance being explained by the regressors. For our variable of interest, we see that the exogenous world-ranking variable of Tiger Woods is statistically significant. The model predicts that when Tiger Woods endorses a golf ball brand and moves from second ranked to first ranked in the world, the proportional change in sales is 6.5% (0.127/2). Note also that the unplanned brand exposure variable is insignificant. The model consequently attributes all of the endorser's impact to the primary endorsement effect (the rank variable) and not to the secondary effect associated with a spike in unplanned brand exposure from a celebrity winning. A similar result is found below, where we specifically look at the impact endorsements have on levels of Nike golf ball sales.

We complete our reduced-form analysis by looking exclusively at Tiger Woods' effect on Nike golf ball by regressing Nike sales during the time period in which he was an endorser on the golfer's ranking (see Table 7). Although one can get a sense of the proportional change in Nike golf ball sales from the above analysis, we run a separate regression on level sales to estimate the additional quantity of 12-packs sold through Tiger Woods' endorsement effect. Again, month and year fixed effects are not reported.

We find that the exogenous ranking variable $(1/rank)$ has a significant effect on the sales of Nike golf balls. And again, the model with $\alpha = 1$ provides the best fit to the data. Given that the sales are in thousands of 12-packs of balls, and each observation corresponds to a month, the regression output above suggests Tiger Woods' effect on Nike sales is that 20,517 additional 12-packs are sold when he goes from number two in the world to number one. In the online appendix, we also include additional results that assume a nonparametric form for the exogenous ranking variable that estimates the effect of each rank while preserving the rank order model; this further highlights and supports the role celebrity quality has on brand sales. From all of these results, we determine that the parametric model with a decay rate equal to 1 is the best-fitting and most appropriate model.

In this section we provide a preliminary analysis of the impact celebrity endorsements have on sales of golf balls. We were able to estimate and show that the endorsing golfer's ranking variable is the primary endorsement effect and is an appropriate measure for capturing such an effect.

5. The Structural Model

We now introduce our main model. The main advantage of the structural model is that it allows us to run policy scenarios where we can subtract the additive separable endorsement effect in the consumer's utility function and add it to a different firm that may have otherwise signed an endorsement contract with the golfer. This allows us to test how the market would have reacted if one endorser had endorsed a different brand. Additionally, by modeling consumer demand in a structural framework, we are able to assess not only the magnitude of the benefit of celebrity endorsement in dollars but also the source of this benefit (primary demand and a business stealing effect), taking into account the competitors' reaction to celebrity endorsements (pricing decision). This is important because it can answer the two questions

Table 7 Regression of Nike Golf Ball Sales on the Parametric Endorsement Variable $(1/\textbf{\textit{rank}})^{\alpha}$

Variable	$\alpha = 1$	$\alpha = 0.5$	$\alpha = 0.4$	$\alpha = 0.3$	$\alpha = 0.2$	$\alpha = 0.1$
Intercept	23.406 (21.317)	−3.550 (31.895)	−17.209 (37.558)	−40.059 (47.233)	−85.887 (67.004)	−223.627 (127.294)
1/*rank of Tiger Woods*	41.033 (17.682)**	67.997 (29.590)**	81.659 (35.622)**	104.511 (45.710)**	150.340 (65.941)**	288.083 (126.740)**
Unplanned exposure	0.893 (3.642)	0.8270 (3.644)	0.831 (3.644)	0.835 (3.645)	0.839 (3.645)	0.843 (3.646)
Adjusted R^2	0.9030	0.9029	0.9028	0.9028	0.9028	0.9028

Note. Sales are in thousands of 12-packs.
**$p < 0.05$.

posed previously in a more realistic fashion while facilitating a better understanding of the mechanism by which celebrity endorsements affect the market. In our context, we study the possible effects on Titleist products if Tiger Woods had stayed with Titleist, where the endorsement effect would have stayed with its products rather than switch to Nike. In this way, we can access whether Nike's investment of $200 million ($181 million inflation adjusted) for 10 years was a profitable strategy.

We posit that endorsements play a direct role in a consumer's utility function when using the endorsed brand. Coming from Bagwell (2007), we assume celebrity endorsements take a complementary view where a consumer's purchase process can be either enhanced or worsened through additional or negative utility associated with the endorsed brand. The complementary view is different from the persuasive and informative views. The complementary view does not make a distinction between the endorsement that provides any information or influence of consumer behavior. Moreover, the complementary view allows for alternative explanations, such as consumers valuing the social prestige associated with the use of a brand a celebrity endorses (Bagwell 2007). Newman et al. (2011) show that consumers value celebrity products through contagion. With this view, we predict that endorsements in and of themselves can alter demand and increase or decrease, as a result of a celebrity scandal, a firm's market share.

The underlying theory behind our model construct originates from Stigler and Becker (1977) and Becker and Murphy (1993), who analyze models that incorporate a brand's advertising level into a consumer's utility function. When such an interaction is positive, they find that the likelihood of consumption increases. Moreover, "advertising can in itself create prestige, differentiation, or association that may change the utility a consumer obtains from consuming a product" (Ackerberg 2001, p. 317). This line of literature is closely related to our study in that one may think of the quality of a celebrity endorser as the analog to the advertising levels. It must be noted, however, that we make a clear distinction between the endorsement and the advertisement. We define the endorsement effect as the overall effect the endorser has on the company during the time period in which he is under contract. We define the advertisement effects as the overall brand (planned and unplanned) exposure effect in the media at a given time.

Given the aggregated nature of the data structure, we jointly estimate the demand and supply by following the methodology of Berry et al. (1995), but with implementation of Skrainka and Judd's (2012) quadrature approach to more efficiently and quickly calculate market shares.

We include the supply equation in the estimation because we want to recover the marginal cost, as it will be necessary in §7, when we calculate profit. Furthermore, having the supply side will allow us to study the pricing decisions of firms in the presence and absence of celebrity endorsements. We are cognizant of the advantages and the disadvantages of including the supply side. From the estimation point of view, the supply side gives us additional moment conditions that allow us to recover the marginal cost. On the other hand, this additional assumption can lead to demand estimation that is misleading. This often leads the researchers to assume a marginal cost rather than estimating it.

We show that including the supply side does not significantly affect our estimates by estimating both a demand-only model as well as a demand and supply model.

5.1. The Demand Side

We define a market as the national golf market for each month from February 1997 to April 2010 for both on- and off-course golf shops. We assume that the market size for the golf ball market is 40 million per year.[11] The indirect utility of consumer i from purchasing a 12-pack of j golf balls from brand b in market t is characterized by K different golf ball characteristics in matrix X, price $p_{j_b t}$, endorsement brand vector En_{bt}, and "unplanned" brand exposure variable UEx_{bt-1}. We are also interested in studying the effect of Tiger Woods' scandal (see §7.3.1). We do this by including the vector Nike $\times$ Sc_t, where Nike is an indicator variable for all Nike products and $Sc_t = [S_{\mathrm{first}\,2}, S_{\mathrm{last}\,3}]$, where $S_{\mathrm{first}\,2}$ is an indicator variable for the first two months after the scandal (December 2009 and January 2010). Similarly, $S_{\mathrm{last}\,3}$ are the following three months, February–April 2010, the end of our data point. By defining the scandal variable of Nike products in two time periods, we can separately identify the scandal effect on Nike golf ball sales immediately after the scandal as well as during the last three months of our data periods. Furthermore, we include the year-month fixed effect variable TD (dummy of year-month interaction) and the firm-specific time trend matrix F_{Tr}. The TD variable controls for any time-specific demand shock that comes from the seasonal nature of golf. We include a firm-specific time trend to capture any trend on firm value/performance that may increase

[11] We make this assumption based both on the size of the population of golfers and the quantity of products sold in each market while maintaining a large enough market to allow for a nonzero outside share. In the appendix we include a detailed discussion regarding how we determined the potential market size to be 40 million people and also provide sensitivity analysis around this measure.

or decrease over time. By including these two variables, the scandal variable Sc_t captures the impact of sales during the scandal above and beyond the general time-specific shock from seasonality as well as the general firm-specific trend that may be present during those months. Finally, the utility is characterized by the unobservable (to the econometrician) product- and time-specific characteristics $\Delta\xi_{j_bt}$ and individual taste parameter ε_{ij_bt}, an independent and identically distributed Type 1 extreme value across i, j, and t. Note that in estimation we include product-specific fixed effects rather than product characteristics such as the number of layers a ball has or how many dimples it has because these characteristics are time invariant. For example, the 392 dimples and three-piece construction of the Titleist Pro V1 ball have been invariant since its introduction in late 2000 to April 2010, the end of our data period.[12] Usually, in the golf ball market, when the essential product characteristics change, the product name also changes.

Consumer i's indirect utility for golf ball j in market t is

$$u_{ij_bt} = X_{j_bt}\beta_i + \alpha_i p_{j_bt} + \mathrm{En}_{bt}\Gamma + UEx_{bt-1}\lambda + (\mathrm{Nike}\times Sc_t)\Upsilon + \kappa TD + F_{Tr}\Xi + \Delta\xi_{j_bt} + \varepsilon_{ij_bt}, \quad (3)$$

$$\begin{pmatrix}\alpha_i\\ \beta_i\end{pmatrix} = \begin{pmatrix}\bar{\alpha}\\ \bar{\beta}\end{pmatrix} + v_i\Sigma, \quad v_i \sim \mathrm{N}(0, I_{K+1}). \quad (4)$$

For golf ball price p_{j_bt}, we adjust the price to 1997 dollars. Here, $\bar{\alpha}$ and $\bar{\beta}$ are mean marginal utilities toward price and product characteristics, respectively, and Σ is the estimate of the standard deviation of our random coefficients. The model parameters of interest consist of both linear and nonlinear parameters. The model parameters are $\theta = (\theta_1, \theta_2)$, where the vector $\theta_1 = (\bar{\alpha}, \Gamma, \lambda, \Upsilon, \kappa, \Xi)$ contains the linear parameters and $\theta_2 = \Sigma$ is the nonlinear parameter. Consumers are assumed to purchase one unit of goods in each period that gives the highest utility, including the outside option, which is normalized to 0.

We now elaborate on the unobservable product- and time-specific characteristics $\Delta\xi_{j_bt}$. In the absence of the product and year-month fixed effect, we have ξ_{j_bt} rather than $\Delta\xi_{j_bt}$. Its interpretation is a standard unobserved product characteristic. By including the product and year-month fixed effect, we have essentially decomposed the unobserved component in the following way:

$$\xi_{j_bt} = \underbrace{\xi_{j_b}}_{\substack{\text{Product}\\ \text{fixed}}} + \underbrace{\xi_t}_{\substack{\text{Time}\\ \text{fixed}}} + \Delta\xi_{j_bt}.$$

5.2. The Supply Side

The market we study is an oligopoly with multiproduct firms. Assuming that the observed prices are the result of an interior, pure-strategy, Bertrand-Nash equilibrium, we can make use of the information from the first-order conditions of profit maximization. Mainly, given the profit function for firm F,

$$\pi_{Ft} = \sum_{j\in F} M \cdot s_{jt}(p_{jt} - mc_{jt}),$$

where M is the market size, s_j is the market share for product j produced by firm F, and mc_j is the marginal costs for firm F's product j. We write the first-order condition of the above profit function with respect to product j price as follows:

$$M\left\{\sum_{r\in F}[p_j - mc_j]\frac{\partial s_{rt}(\mathbf{x}, \xi, \mathbf{p}, \boldsymbol{\theta}_d)}{\partial p_{jt}} + s_{jt}(\mathbf{x}, \boldsymbol{\xi}, \mathbf{p}, \boldsymbol{\theta}_d)\right\} = 0.$$

Since we observe p_j and θ_d to be the parameters from the demand side we estimate, we can compute the marginal cost mc_j. We assume that the marginal cost decomposes into an observable component w_{jt} and an unobservable component ω_{jt} (to the econometrician), $mc_{jt} = w_{jt}\gamma + \omega_{jt}$, with γ being the vector of parameters to be estimated. In our case, we define w_{jt} as a matrix consisting of vectors of golf ball characteristics (e.g., material cover, layers, dimples), a firm indicator, a channel indicator, a firm-specific time trend, and time dummy variables. We assume that the observed component w_{jt} is uncorrelated with ω_{jt}. However, for the markup, which is a function of market share, we use the predicted markup and the predicted market share from the demand side as instruments. As the predicted markup from the demand side is a function of exogenous variable and the instruments for price, we are effectively instrumenting for the markup with demand shifters (Berry et al. 2004).

5.3. Identification

5.3.1. Identification of the Endorsement Parameters. Our identification of the endorsement parameters originates from the exogenous variation of a celebrity's quality (a player's monthly rank in the world golf ranking system). What identifies the causal effect of the endorsement is the connection between product sales and a player's random performance

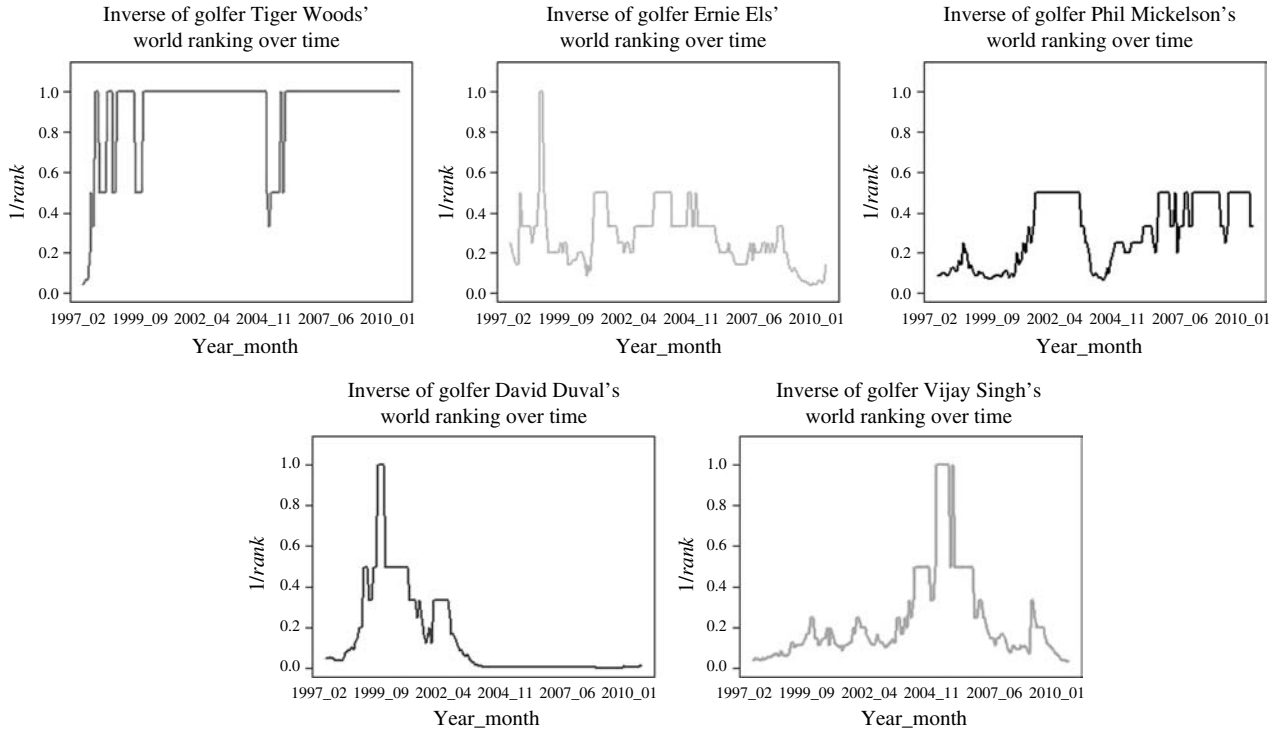
[12] Titleist has produced a "newer" version of its Pro V1 golf ball approximately every two years since its introduction. Although the ball's main characteristics have remained constant over the years, its packaging has slightly changed (color and graphics). Moreover, each golf ball has a unique side stamp that designates the time (version) of that golf ball's production. For more information on these stamps, see http://www.titleist.com/teamtitleist/teamtitleist/f/5/t/4578.aspx#18058 (accessed May 2012).

over time. By defining golfer g's primary endorsement variable as an inverse of the world ranking of that golfer at time t, we are assuming that the primary endorsement effect would approach zero as the golfer's ranking goes to infinity (see Figure 7). Also note that we allow this primary endorsement effect to vary by player and sponsor. For instance, we allow Tiger Woods' impact to differ for Nike and Titleist.

We argue that our study does not have the endogeneity bias that arises from the primary endorsement variable being correlated with $\Delta\xi_{j_b t}$, given that $\Delta\xi_{j_b t}$ are likely random demand shocks. However, if we more narrowly interpret $\Delta\xi_{j_b t}$ to be a product-specific time-varying promotion or marketing campaign, then it is possible that our primary endorsement variables are correlated with the error term. Examples of a manufacturer promotion include a "mail-in rebate" or a "buy a dozen golf balls, get a free fleece jacket"-type of promotion that occurs at the product level. Under this narrow interpretation, firms could time these promotions to coincide with a celebrity's movement in his performance. However, we believe this to be quite unlikely. Our reasoning is based on the analysis we ran on the firms dynamically adjusting advertising. Table 5 presents results from a regression of advertising levels on celebrity endorsement variables and month fixed effects. We see from these results that firms do not adjust advertising spending with movement in player performance. Advertising appears to be only a function of the month of the year. Given this evidence, it is unlikely that firms would adjust promotional or other marketing campaign tactics with player performance. The concern regarding endogeneity bias of our primary endorsement effects is therefore mitigated with either interpretation a reader makes with regard to $\Delta\xi_{j_b t}$. Also note that the identical argument can be made to identify the secondary endorsement effect or unplanned brand exposure from a celebrity's winning. Again, our concern is that firms adjust advertising or promotions to coincide with a player winning a tournament, creating a correlation between the secondary endorsement effect and the model error term. Table 5 presents results that eliminate such a concern by presenting an insignificant parameter estimate for brand exposure.

5.3.2. Instrumental Variables for Price Endogeneity. We assume that the explanatory variables less the price variable p are uncorrelated with the error term $\Delta\xi_{j_b t}$. Therefore, we allow these variables to instrument for themselves. For p, however, we look for variables that shift cost or margins that are not correlated with the demand shock $\Delta\xi_{j_b t}$. We have five instruments closely following the type of instruments used in Berry et al. (1995), which capture how competitive the market is in product space. For instance, a greater number of balls with the same number of layers faces greater price competition. Our instruments are as follows: the total number of competitors' products in period t, the total number of firm f's products, an

Figure 7 Inverse of World Ranking of Celebrity Endorsers



off-course shop indicator, the sum of a firm's competitors' layer characteristics, and the sum of the own firm's layer characteristics.[13] Now although these instruments are standard in the empirical industrial organization literature, it is important to understand that it is plausible that unobservables are driving the firm selection of product characteristics. However, it is typically recognized that changes in product characteristics are difficult and time consuming to implement. Thus, the use of these instruments is valid only if we assume that firms cannot adjust product characteristics in each period. Finally, because we have two separate markets with an observed price premium for on-course shops, we include the off-course shop indicator variable as an instrument for price. This variable captures the mean relative difference in marginal cost across channels for all products. The first stage of the two-stage least squares is outlined in Table 8, reporting just the estimate of the excluded instruments for price to preserve space.

We show that all of the instruments are statistically significant, whereas 95% of the price variation is explained by the regressors. Additionally, we test for the strength of the instruments by running an F-test. From this test we conclude that our instruments are strong. To satisfy the exclusion restriction, these variables must (1) not enter the demand equation and (2) be uncorrelated with the unobservable product characteristics $\Delta\xi_{j_b t}$. We argue that these variables do not belong in the demand equation because consumer i's utility is not dictated by the state of "competition" for product j in market t. In fact, although our institutional knowledge tells us that consumer i's utility from product j is a function of the type of material, layers, and even brand loyalty on product j, which we capture through product-specific fixed effect variable PD, the relative competition of a particular product's layer as well as the level of product diversification of a particular manufacturer is not part of the consumer's decision-making process. For the indicator variable *off-course shop*, as mentioned in §3, it is clear that there are markups on golf balls sold in on-course pro shops. In fact, the same product offered in off-course shops commands a price premium in on-course shops. For this reason, *off-course shop* is a good instrument because it is correlated with price yet not with the demand shock.

5.4. The Moment Conditions

We have two sets of moment conditions coming from the demand-side and supply-side equations. The demand-side moments are $E[\Delta\xi' Z^d] = 0$, where $\Delta\xi = [\Delta\xi_1, \ldots, \Delta\xi_T]'$. Here, $\Delta\xi_t$ is a J-dimensional vector of $\Delta\xi_{j_b t}$, where j is the product ($j = 1..J$) in market t ($t = 1..T$); $\Delta\xi_{j_b t} = \delta_{jt} - (\alpha p_{jt} + \mathrm{En}_{jt}\Gamma + UEx_{t-1}\lambda + (\mathrm{Nike} \times Sc_t)\Upsilon + \phi PD + \kappa TD + F_{Tr}\Xi)$. The expression δ_{jt} is recovered by equating the predicted and the observed market shares for product j in market t through the contraction mapping; $Z^d = [z_p^d, Rd]'$, where $Rd = [\mathrm{En}, UEx, \mathrm{Nike} \times Sc, PD, TD, F_{Tr}]$ and z_p^d are the demand-side instruments.

The supply-side moments are $E[\omega' Z^s] = 0$, where ω is a vector of marginal cost error terms and $Z^s = [\widehat{\mathrm{markup}}^d, w]'$. More specifically, $\widehat{\mathrm{markup}}^d$ is the estimated markup, and w is the regressor for the supply equation. With the addition of the supply side, we form additional moment conditions and jointly estimate the parameters of the demand- and the supply-side equations. Because the marginal cost is a function of markup, which in turn is a function of the price sensitivity parameter α, by forming the supply-side moment condition and estimating the parameters jointly, it allows the estimation to take into account the cross-equation restrictions on the parameter of interest.

Table 8 First-Stage Price Regression

Variable	Estimate
Number of competing products	7.618 (0.661)**
Number of own products	7.379 (0.661)**
Off-course shop	−4.219 (0.041)**
Sum of competitor's layer char.	−0.052 (0.004)**
Sum of own firm's layer char.	−0.044 (0.007)**
F-statistic = 5,805.75	

Note. Excluded instruments only reported.
**$p < 0.05$.

6. Estimation Results

We estimate the model using generalized method of moments as part of a nested fixed-point algorithm matching the simulated market share to the observed market share and forming moment conditions. As a benchmark, we first estimate the logit model with and without the instrumental variables. The estimation procedure and results are in the appendix. For the proposed random coefficient model, to save space, we do not report the estimated values of PD, TD, and F_{Tr}. However, they were statistically significant.

As shown in Table 9, Tiger Woods' endorsement effect on both Nike and Titleist products is statistically significant, with estimated coefficients of 0.301 and 0.271, respectively. This suggests that Woods had the endorsement effect on all Titleist products between 1997 and 2000 and on all Nike products during the endorsement period 2000–2010 by contributing to additional utility associated with the respective brand products. Among other golfers, it is noteworthy that Ernie Els and David Duval had a larger marginal impact on the Titleist brand—at 0.664 and

[13] We also run a model with the lag measure of the total number of a firm's products and find that the results do not differ.

Table 9 Estimates of the Random Coefficient Model

	Supply and demand		Demand-only	
Linear parameters	Estimate	SE	Estimate	SE
Winning of tournaments (unplanned exposure)	0.023	0.015	0.021	0.014
Woods' scandal on Nike products (Dec. 2009–Jan. 2010)	−0.037	0.090	−0.044	0.089
Woods' scandal on Nike products (Feb. 2010–Apr. 2010)	−0.169	0.094	−0.180	0.093
Woods' Nike endorsement	0.301**	0.079	0.302**	0.079
Duval's Nike endorsement	−0.364	0.247	−0.387	0.244
Mickelson's Callaway endorsement	1.284**	0.207	1.299**	0.206
Els' Callaway endorsement	1.289**	0.311	1.357**	0.311
Woods' Titleist endorsement	0.271**	0.076	0.291**	0.074
Mickelson's Titleist endorsement	−0.329	0.194	−0.340	0.192
Duval's Titleist endorsement	0.484**	0.108	0.488**	0.106
Singh's Titleist endorsement	−0.117	0.094	−0.121	0.093
Els' Titleist endorsement	0.664**	0.138	0.668**	0.136
Nonlinear parameters	Estimate	SD	Estimate	SD
Price	−0.088**	0.021**	−0.089**	1.71E–08
	(0.003)	(0.008)	(0.008)	(9.984)
Layers		−4.362e–08		−2.17E–07
		(547.839)		(1,438.543)

Note. Supply-side estimates are available from the authors upon request.
**$p < 0.05$.

0.484, respectively—than Woods at 0.271. We point out that this is a marginal effect, and because the endorsement effect is a function of the inverse of the world ranking, Woods' effect is larger most of the time in our data period. We point out that the endorsement effect disappears when Duval endorses Nike. If one is familiar with the context of Duval as a player, it is not difficult to understand this phenomenon. Duval's dramatic decline in performance is well known in the golf community. In fact, it was around the time when he switched to Nike in the 2001–2002 season that his skill level dropped significantly. This result exemplifies our source of identification where the endorsement variable approaches 0 as the ranking of the player approaches infinity. Because we explicitly take into account the variability of skill level for each player through the world ranking, this result confirms our belief that Duval's fall as a top athlete should have caused a drastic change in the impact he had on Nike, his newly endorsed brand. We also find statistically significant results for Ernie Els. He switched to Callaway in 2007 and was an effective endorser under Titleist (at 0.664); this marginal effect increased when he endorsed Callaway products.

A random coefficient was set on price and the golf ball characteristic layers. As expected, we find customer heterogeneity in price sensitivity but none in regard to layers. With the average price sensitivity of −0.088 per dollar, 95% of the consumers are estimated to have marginal price sensitivities between −0.130 and −0.046. In Table 10, we present elasticities for a subset of golf balls sold in on-course golf shops in June 2007. We use this table as a sanity check to determine (1) whether our results are reasonable and (2) that the model we impose is consistent with a profit-maximizing firm that sets price on the elastic portion of the demand curve. From Table 10, we see that all cross-price elasticities are positive, whereas own-price elasticities are less than −1, indicating that the results are reasonable and consistent with a profit-maximizing firm.

Finally, for the supply side, we estimate the parameters of marginal cost. We find that our regressors are all significant, with signs and magnitudes that correspond with our prior knowledge of the production process being affected by firm and ball characteristics. For example, we find that the layer estimate is positive and significant, which is in line with our knowledge that the cost to produce multilayer balls is higher than for two-piece balls. In fact, although institutional knowledge estimates the marginal cost of a 12-pack of golf balls to be \$4–\$8, our model estimates show that the average marginal cost for a 12-pack is \$7.34, an indication of good model fit. We include the estimates in the appendix because they provide little pertinent information outside aggregate marginal cost, which we use in the counterfactuals below.

Table 10 Price Elasticities of Top Brands Sold in On-Course Shops in June 2007

Brand	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) Titleist Pro V1	−2.672	0.383	0.366	0.365	0.361	0.379	0.379	0.382	0.364	0.380	0.362	0.373	0.374	0.360	0.377	0.375	0.354	0.354
(2) Titleist Pro V1x	0.247	−2.824	0.236	0.235	0.233	0.245	0.244	0.246	0.235	0.246	0.234	0.241	0.241	0.232	0.243	0.242	0.228	0.228
(3) Titleist NXT TOUR	0.129	0.129	−1.914	0.134	0.134	0.130	0.130	0.129	0.134	0.129	0.134	0.131	0.131	0.135	0.130	0.131	0.136	0.136
(4) Titleist NXT	0.114	0.114	0.119	−1.861	0.120	0.115	0.115	0.114	0.119	0.115	0.120	0.117	0.117	0.120	0.116	0.116	0.122	0.122
(5) Titleist DT SOLO	0.088	0.088	0.093	0.093	−1.667	0.089	0.089	0.088	0.093	0.088	0.094	0.091	0.091	0.095	0.090	0.090	0.096	0.096
(6) Bridgestone Tour B330	0.012	0.012	0.011	0.011	0.011	−2.819	0.012	0.012	0.011	0.012	0.011	0.012	0.012	0.011	0.012	0.012	0.011	0.011
(7) Bridgestone Tour B330-S	0.003	0.003	0.003	0.003	0.003	0.003	−2.806	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
(8) Callaway HX Tour	0.016	0.016	0.015	0.015	0.015	0.016	0.016	−2.967	0.015	0.016	0.015	0.015	0.015	0.015	0.016	0.016	0.015	0.015
(9) Callaway HX Tour 56	0.024	0.024	0.025	0.025	0.025	0.024	0.024	0.024	−1.944	0.024	0.025	0.025	0.025	0.026	0.025	0.025	0.026	0.026
(10) Nike One Platinum	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	−2.896	0.015	0.015	0.015	0.015	0.015	0.015	0.014	0.014
(11) Nike One Black	0.003	0.003	0.004	0.004	0.004	0.003	0.003	0.003	0.004	0.003	−1.841	0.004	0.004	0.004	0.003	0.004	0.004	0.004
(12) Nike (other)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	−2.488	0.002	0.002	0.002	0.002	0.002	0.002
(13) Srixon Z-UR	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	−2.514	0.003	0.003	0.003	0.003	0.003
(14) Srixon Z-URS	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	−1.689	0.002	0.002	0.002	0.002
(15) TaylorMade TP Black	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	−2.702	0.008	0.008	0.008
(16) TaylorMade TP Red	0.011	0.011	0.010	0.010	0.010	0.011	0.011	0.011	0.010	0.011	0.010	0.010	0.010	0.010	0.011	−2.586	0.010	0.010
(17) Top-Flite D2 Distance	0.003	0.003	0.004	0.004	0.004	0.003	0.003	0.003	0.004	0.003	0.004	0.004	0.004	0.004	0.003	0.004	−1.281	0.004
(18) Top-Flite D2 Feel	0.003	0.003	0.004	0.004	0.004	0.003	0.003	0.003	0.004	0.003	0.004	0.004	0.004	0.004	0.003	0.004	0.004	−1.283

Note. Change in market share for product i with 1% change in price of product j, where i = row and j = column.

7. Counterfactuals

By incorporating the endorsement and unplanned exposure levels into the consumer's utility function, we found that consumers attach additional utility to celebrity endorsed brands. In this section we first look at the overall effect of celebrity endorsements on the golf industry. Mainly, we want to assess whether or not endorsements can also "create prestige, differentiation, or association that may change the utility a consumer obtains from consuming a product" (Ackerberg 2001, p. 317). Once we show that celebrity endorsements generate shifts in market share, we assess the economic value of celebrity endorsements by looking specifically at Tiger Woods.

7.1. Product Differentiation Through Celebrity Endorsements

Our demand estimate suggests that there are statistically significant celebrity endorsement effects associated with endorsed brands. Given this finding, we assess whether the extra utility attached to the endorsed brands is large enough to generate shifts in market share. We first want to assess the overall endorsement effect in the golf market. To do this, we run the counterfactual by assuming that no celebrity endorsements exist in the golf industry and compare it with a regime where celebrity endorsements exist in the industry.

As Table 11 shows, with the presence of endorsements in the industry, Nike, Titleist, and Callaway benefit. This is not surprising because we have shown in our demand estimation the positive and significant endorsement effects on these brands. On the other hand, we find that the rest of the market suffers in market share as a result of these endorsements. It is interesting to note that the endorsement effect increases the share for the company with effective endorsers as well as the overall demand for the presence of endorsements in the golf market. Recall that the outside option in our model is a "no purchase," and through our counterfactual, we observe that the size of the outside option share decreases with the introduction of endorsements in the industry. This suggests that the endorsement effect is large enough such that those who would have otherwise not purchased a product do so in the presence of celebrity endorsements. This counterfactual not only

Table 11 Change in Share with the Presence of Endorsement

	Change in share
Nike	0.013
Titleist	0.031
Callaway	0.015
Others	−0.025
Outside option	−0.034

makes clear that, indeed, endorsement effects are large enough to create product differentiation and shift market shares within the market but also is characterized as having a "primary demand" component where it attract customers who would have otherwise not purchased a product in the absence of celebrity endorsements.

7.2. Economic Value of Celebrity Endorsements

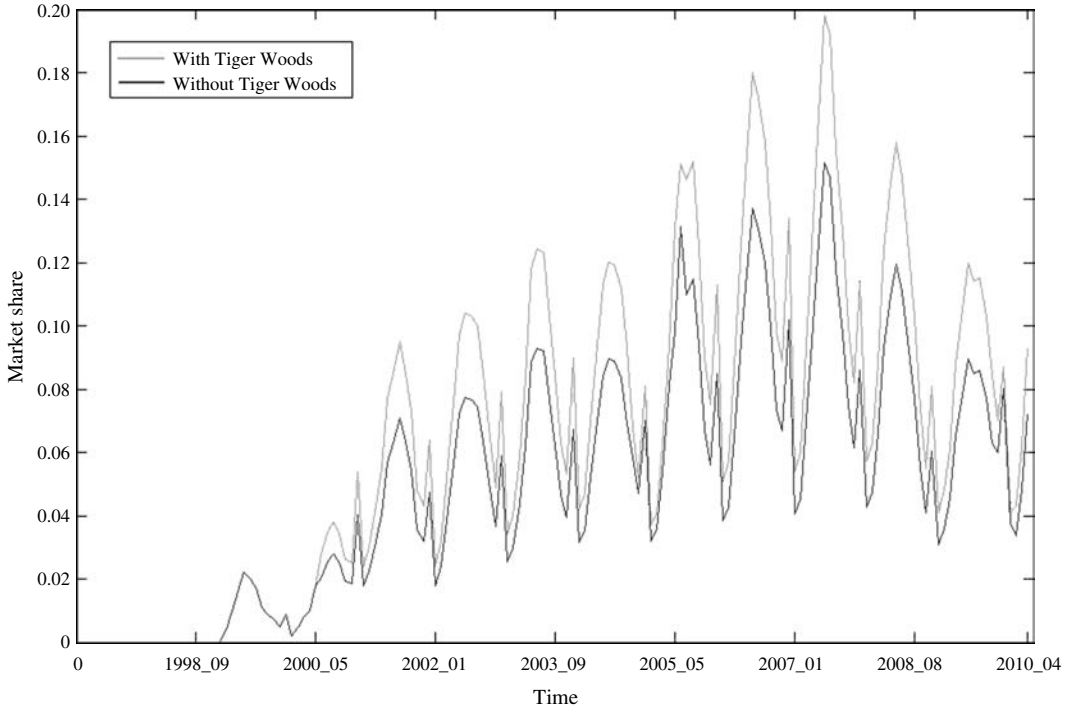
Having shown that celebrity endorsements can change the utility a consumer obtains from using a product, we assess the economic value of a celebrity endorsement by looking at Tiger Woods. Our demand estimates suggest that he had a significantly positive effect on Nike products during the endorsement period. Given this finding, we ask the following question: What would have been the share of Nike's products if Woods elected to forgo endorsing Nike for the past 10 years? In 2000, Woods reportedly signed a five-year, $100 million renewal contract with Nike, agreeing to endorse both apparel and golf balls, a segment that Nike entered in 1999. In 2005, he was reported to have signed a five-year, $100 million extension. We want to assess whether Woods' endorsement translated into sales and whether such sizable contracts were profitable. Therefore, by focusing on Woods' impact on the Nike golf ball brand, we run the counterfactuals to measure the economic value of a celebrity endorsement.

To determine the impact Tiger Woods had on Nike's golf ball sales, we calculate the new market share of the Nike product in an environment where consumers choose a product without the extra "utility" associated with Nike products. To do so, assume that Woods would have continued his endorsement of the Titleist golf ball brand if not for Nike's offer in 2000. Therefore, we run the counterfactual by "assuming" that the statistically significant values of the "Tiger effects" are absent in the consumer utility for Nike products while the extra utility shown to be statistically significant for Titleist between 1997 and 2000 is present in 2000–2010. By doing this, we study the consumer's choice of Nike and isolate the endorser's impact on sales by looking at a "Tiger-less" environment.

The aggregated market shares for Nike golf balls for all time periods for both on- and off-course shops combined are shown in Figure 8. We can clearly see that the market share is higher during the time that Tiger Woods was under Nike sponsorship. What this suggests is that for some consumers, the endorsement effect is large enough that they switch their brand choice.

Having shown that there is a general increase in the market share for Nike products over the time when Tiger Woods was under contract with Nike, we now calculate the economic impact for Nike in terms of additional revenue, profit, and customer acquisition. Assuming a pure-strategy, Nash-Bertrand equilibrium, we allow the firms to adjust their price-setting behavior according to the environment. For example, it is reasonable to think that Nike takes Woods'

Figure 8 Share of the Nike Products for On- and Off-Course Shops Combined



endorsement into account before setting prices. With Woods, we expect that Nike would command a price premium given the additional utility attached to its products. In fact, other firms also take this information into account before setting prices. For non-Nike products, to compete against Nike, we expect them to lower prices. Specifically, in our scenario where we set Nike to be Tiger-less, we expect Nike to set its prices lower than when in contract with Tiger. For Titleist, because we assume that Woods would have stayed with the company if it was not for Nike's multimillion-dollar contract, we expect the price for Titleist products to be higher. In sum, depending on the market environment, we allow for the price vector to adjust so that it satisfies the first-order condition of the profit function for each firm.

In Table 12, we empirically verify that Nike in a Tiger-less environment adjusts its price accordingly by cutting prices. For Titleist, we observe that its price is adjusted upward in an environment where it did not lose Tiger Woods to Nike. For other firms, we see that when Woods was with Titleist, they were able to command a price premium of \$0.25. Solving for the profit-maximizing prices for two regimes, and with the estimated marginal cost, we calculate the revenue, profit, and customer acquisitions for Nike, as shown in Table 13.

We find that during the endorsement period, Nike earned approximately \$176 million in extra revenue from both on- and off-course shops combined. Furthermore, we estimate that the total additional profit earned by Nike's golf ball division was approximately \$103 million for the 10-year endorsement period. More importantly, for the Nike Golf division, we find that the company acquired approximately 9.9 million additional sales during the endorsement period. We believe that, at least in the first half of the decade, this was pivotal for Nike as it was trying to launch its nascent golf division with the help of Tiger Woods as its primary endorser (McLaughlin 2001). Through Woods' endorsement, Nike was able to induce a significant portion of the population to switch their golf ball brand as a result of the extra utility attached to Nike golf balls.

Recall that Tiger Woods signed two, five-year \$100 million contracts. Therefore, given that he was paid a total of \$200 million (\$181 million in 1997 prices) for 10 years, our estimates show that, in golf ball sales in the United States alone, Nike recovered approximately 57% of its investment on endorsement. Given that golf is also widely popular outside the United States, we conjecture that Nike would have recovered the majority, if not all, of its endorsement investment through golf ball sales alone. Considering the sales in the apparel and other equipment that Tiger Woods also endorsed as part of the contract agreement, we believe that he could have commanded an even larger contract from Nike.

Table 12 **Average Price Adjustments Before and After Policy**

	Tiger with Nike (\$)	Tiger with Titleist (\$)	Difference (\$)
Average price of Titleist	25.79	26.45	0.66
Average price of Nike	17.27	17.21	−0.07
Other	15.63	15.87	0.25

Table 13 **Economic Value of Tiger Woods, 2000–2010**

	Off course	On course	Both retail
Revenue gain (\$)	90,158,776	85,593,260	175,752,036
Profit gain (\$)	61,125,284	42,158,596	103,283,880
Change in sales	5,642,710	4,221,855	9,864,565

7.3. Additional Counterfactuals

7.3.1. Negative Publicity. With the presence of a structural model, we also are able to run simulations on the impact Tiger Woods' negative publicity, stemming from accusations of marital infidelity, had on Nike. Note, however, that the counterfactuals below are only loose estimates of the impact, as the structural model does not identify the effect of the scandal as cleanly as the endorsement effect. What our model is identifying with respect to the scandal variable is a variant of a pre- and post-effect. Although we do include a time (year-month interaction) fixed effect variable *TD* as well as firm-specific time trend F_{Tr} to control for any seasonality, there could be a number of other time-varying factors that could still bias our results. Therefore, we believe the results of the counterfactuals here should be viewed more skeptically than the ones presented previously.

Things began to unravel for Tigers Woods at his Orlando area home on Thanksgiving 2009, when he crashed his Cadillac SUV into a tree and fire hydrant after fleeing from an altercation from then wife Elin Nordegren. For the next few days, rumors swirled that the altercation and accident resulted from Nordegren becoming aware of an extramarital affair. Fueling these rumors, more women began to report similar affairs with Woods; by December 7th, over a dozen women came forward. In response, Woods decided to take an indefinite leave from the game of golf on December 11th. After this decision, companies with which Woods had brand endorsement contracts began to reevaluate their positions. For instance, Gillette began to reduce its exposure of Woods on December 12th, and Accenture eliminated Woods as an endorser on December 13th (AT&T and Gatorade would follow). Nike elected to publicly announce that it was standing by its celebrity endorser on

December 14th. It was not until mid-February 2010 that Woods reemerged into public life with a TV apology, and he did not return to golf until early April for the Masters, having missed the first three months of the tour season.

In Tables 14 and 15, we address the question of the impact of Tiger Woods' scandal on Nike golf ball sales and profits for the six months following November 2009 with a counterfactual that assumes the scandal never occurred. Additionally, to assess whether Nike's strategy to stand by Woods was the correct decision, in the next subsection, we run a second counterfactual that assumes the scandal occurs but that Nike dispenses with Woods' services.

With firms adjusting to their environment and setting prices accordingly, we expect that Nike would take into account the negative impact that Tiger Woods' scandal had on Nike products. Empirically, in Table 14 we find that without the scandal effect, Nike would have commanded a price premium of \$0.25. For the non-Nike products, it was −\$0.04.

Nonetheless, taking into account the price adjustments, in Table 15 we find that Nike lost approximately \$2.2 million in revenue, which we estimate to be a profit loss of \$1.5 million. The number of sales lost as a result the scandal is estimated at approximately 136,000. This suggests that without the negative publicity from the scandal, Nike would have, ceteris paribus, earned \$1.5 million more in profit.

7.3.2. Nike's Decision. We now assess Nike's decision to stand by Tiger Woods. To do this, we run the counterfactual where Nike elects to terminate its ties with Woods. This is different from our second counterfactual, where we assumed that Woods would have stayed with Titleist if not for Nike. Here, we assume that Nike would have retained Woods' services until November 2009 and thereafter terminated its contract with him, leaving him with no endorsement. This is reasonable because we do not believe that after the scandal (November 2009–April 2010) any company would have signed a contract with him. We also assume that Nike does not sign any other top "celebrities" in place of Woods. This is natural, as endorsement contracts in golf are usually multiyear deals where top players are committed to the company. In fact, in November 2009, the next best player (in rankings) was Phil Mickelson, and he was tied to the Callaway brand.

Table 14 Average Price Adjustments Before and After Tiger Woods' Scandal

	Tiger with scandal (\$)	Tiger without scandal (\$)	Difference (\$)
Average price of Nike	11.84	12.08	0.25
Other	14.48	14.44	−0.04

Table 15 Economic Value of Scandal on Nike

	Off course	On course	Both retail
Revenue gain (\$)	−1,174,396	−950,513	−2,124,909
Profit gain (\$)	−947,138	−518,936	−1,466,074
Change in sales	−79,890	−55,797	−135,687

Table 16 Economic Value of Tiger Woods During the Scandal Period (December 2009–April 2010)

	Off course	On course	Both retail
Revenue gain (\$)	2,442,246	1,072,907	3,515,153
Profit gain (\$)	2,124,528	547,060	2,671,588
Change in sales	116,591	69,722	186,314

Although we have shown that Woods' scandal generated relative loss in terms of revenue, profit, and sales, our results[14] indicate that Nike would have lost even more had it ended its relationship with him (see Table 16).

We find that Nike still benefited from the relationship with Tiger Woods despite the negative impact of the scandal on the company. From November 2009 to April 2010, had Nike ended its relationship with the golfer, Nike would have lost \$3.5 million in revenue or \$2.7 million in profit. From this, we conclude that Nike's decision not to join the likes of Accenture, AT&T, and Gatorade was the correct decision. We find that even in the midst of the scandal, Nike was actually better off with Tiger Woods than without.

8. Discussion and Conclusion

Our contribution to the marketing literature is twofold. First, we contribute to a topic that has been underresearched. To the best of our knowledge, we were able to identify only two other studies on the economic value of celebrity endorsement. Even so, we believe that we are the first to study this domain by looking directly at the sales of the endorsed product. Although it is terribly difficult to identify an endorser's effect on a firm's profit, we were able to do so in this paper. Second, not only is this topic underresearched, but it is also an important topic that deserves the attention of marketing researchers. Over the past 30 years, celebrity endorsement has become an essential component of many firm's promotional strategies, and the use of celebrity endorsers continues to grow. As a result, we have seen a surge in both the number and the size of celebrity endorsement contracts. Given the increasing importance and presence of celebrity endorsements, we believe this topic is timely and relevant for researchers to study.

[14] (Scandal with Nike standing by Tiger Woods) − (Scandal with Nike terminating contract with Tiger Woods).

Our paper is not without any limitations. In regard to data, as discussed, we had a data limitation issue where we were not able to include the "planned" advertisement-level spending in our model. Although we were able to make the case that excluding this variable would not create endogeneity bias, where the error terms are correlated with the endorsement variable, in an ideal setting we would include this variable in our full estimation.

In §7, we ran a series of interesting policy simulations and were able to quantify the economic value of a celebrity endorsement in the context of Tiger Woods. We did this by "turning off" the endorsement effect in the consumer utility and comparing Nike's profits before and after. In this regard, we are essentially studying a scenario where there is no consumer "inertia" or "stickiness" of the celebrity endorsement effect. One may argue that when Woods switched from the Titleist brand to the Nike brand, some consumers may have still attached the endorsement effect that Woods has had on Titleist to be present, although this would have eventually died out as Woods continued to endorse Nike products. Therefore, one may look at our counterfactual as an upper bound of the economic value of celebrity endorsement. For the last counterfactual on Nike decision's to stand by Woods in the wake of his scandal, the direction is uncertain. This is because, if we believe that there is some residual value of an endorsement effect that is present even after the early termination of a contract, one may argue that this is also an upper bound of the firm's decision. But likewise, the negative scandal effect may not completely "shut off" after Nike makes a decision to terminate its contract with Woods. Therefore, in this case, the direction is ambiguous.

Our study is in a static setting for two main reasons. First, we consider golf balls as "nondurable" goods. We are comfortable with this, as we do not believe that consumers make an intertemporal trade-off when purchasing golf balls. Not only are golf ball purchases a small portion of a consumer's budget, but historically, there has been no large fluctuation in price over time. Second, and most important, we do not believe that studying this in a static setting detracts from our main insight and contribution in the marketing literature on quantifying the economic value of celebrity endorsements. Even though Tiger Woods was paid an exorbitant amount of $200 million for 10 years by Nike, the endorsement fee was well justified. In golf ball sales in the United States alone, we quantify the endorsement effect on profit and find that approximately 57% of its investment was recovered. Taking into account the worldwide sales of golf balls and the sales in the apparel and other equipment that Woods also endorsed as part of the contract agreement, we believe that Woods' contract was actually not that large. In fact, we believe that he could have commanded an even larger contract from Nike.

For future directions, although we have studied the economic value of celebrity endorsements in the context of Tiger Woods and the golf ball market, the implication of the endorsement effect extends to many other industries. Our study has looked into an endorsed product that is physically used in the profession by the endorser, but it would be interesting to see how the endorsement effect changes for a brand that is not explicitly used by the endorser in his profession. This would provide further insight into why firms such as AT&T and Accenture cut ties with Woods.

Historically, celebrity endorsements have been used for centuries and are an accepted strategy used by many executives. With the size of more recent endorsements reaching the tens to hundreds of millions of dollars, we were curious about the effectiveness of these endorsements. In this paper, by taking a direct approach and studying the endorsement period in conjunction with the sales of the endorsed product, we shed some light on the economic value of celebrity endorsements. By studying the golf ball market, we found that after controlling for brand-level exposure and the inherent quality of the endorser, there is a significant endorsement effect as a result of the extra utility attached to the endorsed brand. We empirically showed that endorsements can have a strong effect on consumer utility such that there is a shift in market share in the industry. In fact, we observe that endorsements have a dual component where existing customers switch to the more effective endorsed brand (business stealing) while bringing in additional sales from the outside (primary demand), which would have otherwise not occurred if not for the endorsement. However, managers must also be cognizant that, unlike typical advertisement strategies, in celebrity endorsements there exist a negative component that can bring losses to the company. For Tiger Woods, we observed that although there was an overall positive endorsement effect, the negative publicity hurt Nike in profit and sales. What differentiates celebrity endorsements from other forms of promotion strategy is the natural evolution of the endorser over time. Firms must take this into account before making the decision to sign an extended contract with an endorser.

Electronic Companion

An electronic companion to this paper is available as part of the online version at http://dx.doi.org/10.1287/mksc.1120.0760.

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