Exploring the Relationship between Race and Sports Book Wagering Activity and Daily Slot and Table Game Play

Anthony F. Lucas

Abstract
Using performance data from three Las Vegas hotel-casinos, time series regression models were employed to better understand the relationship between race and sports book wagering volumes, and slot and table game play. Variables representing both race and sports book wagering volumes failed to produce statistically significant effects in seven of twelve hypothesis tests, within models designed to explain the daily variation in slot and table game play. The results directly extend the work of Abarbanel, Lucas and Singh (2011) by examining the relationship between book wagering levels and table game play, and provide additional empirical tests of the Full Service Theory examined in Lucas (2013b). Casino operators and developers gain valuable insight related to the contribution of books to primary casino profit centers, and the methodological approach is readily adaptable to other leisure service businesses interested in estimating the contributions of one profit center to another.

Key words: Race book operations; sports book operations; casino management; slot operations; table game operations; casino operations analysis

Introduction

Over the decade ended December 31, 2012, gross gaming win in Nevada race and sports books peaked in 2006 at $97M and $191M, respectively (Nevada Gaming Control Board (NGCB), 2013). By the end of 2013, Nevada sports books had rebounded from the post-peak decline with a record-high annual win of $203M, while race books continued their steady decline to end at $52M in annual win (NGCB, 2013). The advance of online offshore wagering in the 1990s and the 2008 global financial crisis dealt successive blows to the business volumes of land-based books. The sports books seem to have recovered in recent years, but the race books have not.

The lean years following the global financial crisis prompted gaming executives to question whether the books represented the best use of finite floor space. Lower profits in the books often lead to claims of contributions to other more critical gaming areas such as slot and tables, to stave-off possible reductions in floor space, or worse yet, elimination of the books (Lucas, 2013b). Unfortunately, little is known about the relationship between race and sports books and slot and table game play.

This study directly extends the work of Abarbanel, Lucas and Singh (2011), in an effort to better understand the relationship between race and sports book business volumes and slot and table game play. The results will also add to the battery of findings related to similar propositions couched within the Full Service Theory examined in Lucas (2013b). Advocates for the books are quick to claim contributions to other profit centers (Bontempo, 2007; Eng, 2008; Manteris, 1993; Pugmire, 2009), but offer no rigorous empirical support for these claims. Despite the paucity of empirical research, these

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claims have gained traction. For example, Bontempo (2007) reports that Las Vegas casino executives are making their books larger and more elaborate, in an attempt to lure more patrons to the properties.

Others have taken different paths, ranging from greatly reducing the dedicated footprint of the race and sports book to replacing it with nothing more than a wagering kiosk. The Cromwell, for example, opened on the Las Vegas Strip in 2014 with a kiosk in lieu of a race and sports book (KNTV, 2014). Other newer Strip properties such as the Cosmopolitan and SLS offer books that occupy a minimal amount of dedicated floor space. The Cosmopolitan's book is relegated to the second floor of the property alongside several nongaming outlets (Cosmopolitan, 2014), while the SLS book is configured in a multi-use capacity, embedded within a restaurant (SLS, 2014), similar to that of Legasse's Stadium in the Palazzo.

The industry is headed in multiple directions and improved knowledge of the relationship between book and casino business volumes would be most helpful in making capital investment and floor space decisions related to book operations. Developers of new gaming properties would clearly benefit from such knowledge when considering which gaming amenities to offer, and to what extent each will be offered. Existing operators would also benefit by applying this knowledge to decisions related to (1) expansion of book space; or (2) conversion of book space into alternative uses. Ultimately, both developers and operators seek to optimize the profit per square foot of casino floor space.

Literature Review

There is a dearth of research directly related to the effect of race and sports books on primary casino profit centers; however, similar issues have been examined. This review is divided into several subsections, beginning with a brief overview of race and sports book operations, followed by a summary of the viewpoints held by industry insiders. Next, the Full Service Theory is examined, including a review of the studies that have empirically tested related portions of it. Similar studies and ideas from the retail literature follow, and finally, a theoretical model and hypotheses are advanced.

Operations Background

Race and sports books are often referred to as a single entity (i.e., the race and sports book), but they are actually separate entities and quite different from one another in many important ways. Race books predominantly cater to horserace bettors and employ parimutuel betting. With parimutuel betting, a fraction of the total amount wagered (known as the pool) is withheld for the operator, making it a very steady business in terms of gaming win. As a result, there are no losing days in the race book. Sports books accept wagers on a wide variety of sporting events. Oddsmakers set an opening line on the contest, which is subsequently adjusted by the bookmaker, if necessary. Sports books can have losing days, as contests often receive disproportionate amounts of money wagered on one side. When the overloaded side wins, the book can experience a loss on that betting line. While both of these books can be profitable, their existence often relies on supposed contributions to the casino's primary profit centers, such as slot and table games (Lucas & Kilby, 2012). Many in the industry tout such contributions (Bontempo, 2007; Manteris, 1993; Pugmire, 2009). For more on the operating protocol of race and sports books see Lucas and Kilby (2012).

Trade Literature

In Eng (2008), one prominent gaming executive claims that a state-of-the-art race and sports book will bring customers to other parts of the resort. The same executive highlights the importance of the sports book's contributions to other areas of the casino, given its less noteworthy direct profits (Manteris, 1993). Another senior executive at one of Las Vegas' high-end casinos lauded the sports books for helping the industry through the recent recession by attracting guests to the resorts (Pugmire, 2009). He went on to note that many of the events that draw guests to Las Vegas revolve around major sporting contests, such as the Super Bowl and Kentucky Derby. In his view, the ability to draw customers to the property has always been behind the proliferation of Las Vegas sports books.

Another popular opinion is nicely summarized in Bontempo (2007), which holds that properties without books are perceived as second rate. Bontempo also mentions the importance of including the book in any casino expansion plans. Of course, these views suggest that the book is a critical element in the patronage decisions of casino customers. McCarthy and Perez (2009) describe similar viewpoints regarding the relative attractiveness of casinos that offer sports wagering over those that do not.

The opinions that crowd the trade literature are not accompanied by empirical research. However, if these views are on target, one would expect to see support for them in the data of casino resorts that offer race and sports books. This study addresses this issue by examining performance data from such resorts.

The Full Service Theory

As described in Lucas (2013b), there are revenue-producing departments in the casino that often post marginal profits, if any at all. These same departments often survive by claiming to drive business to the casino's primary profit centers. For example, by having a poker room, the casino is able to attract patrons that would otherwise not visit the property. The profits that result from the poker room itself are known as direct profits, while the estimated contributions to the primary profit centers of the casino are considered indirect profits. While the estimated indirect profit is not recorded on the poker room's income statement, the belief that it exists is enough to justify the poker department's marginal direct profits. The following model from Lucas (2013b) illustrates the assumed relationships described in this paragraph.

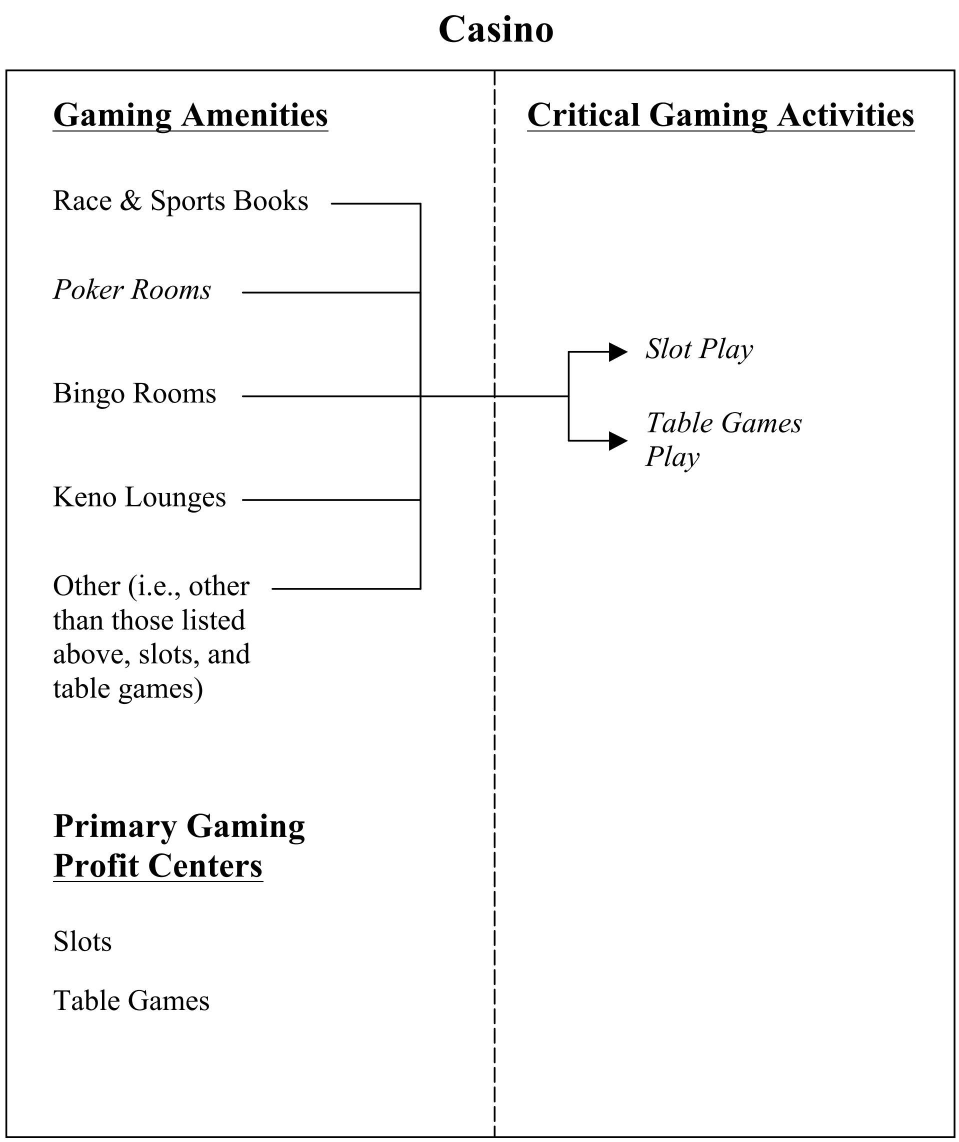

Figure 1. Causal assumptions within the casino, as illustrated in the broader model of the Full Service Theory from Lucas (2013b).

As shown in Figure 1, race and sports books, poker rooms, bingo rooms, and keno lounges are all examples of gaming amenities. Further, the marginal performance of each of these areas is often justified by the belief that each makes considerable contributions to the primary profit centers in the casino, e.g., slots and table games. Such beliefs are collectively referred to as the Full Service Theory (FST), which holds that the indirect contributions from these gaming amenities are sufficient to justify the otherwise marginal profits (Lucas, 2013b). While the FST may be popular among casino operators, the next three subsections describe studies that have empirically tested the underlying assumptions, within the Casino Block of the model shown in Figure 1.

Race and Sports Books

Abarbanel et al. (2011) is the only existing study to have directly addressed the effects of the race and sports books on primary casino business volumes such as slots and table games. However, their study only estimated the impact of the books on slot machine wagering volume. No study has attempted to measure and/or quantify the relationship between wagering volume in the books and table games. Within the context of their model, Abarbanel et al. found variables representing the wagering activity in both the race book and the sports book to have no effect on the dollar-value of daily slot machine wagers. This result was produced from data gathered from a single off-Strip Las Vegas hotel-casino. Daily performance data were gathered over a 250-day period, beginning on January 1, 2009 and ending on September 7, 2009. With an R^2 of 89.6% and an F-statistic of 117.8 (df = 17; 232, $p < 0.001$), their initial theoretical model was well-specified. The failure to find a statistically significant relationship between the book variables and daily coin-in was certainly cause for concern, and grounds for further study.

Kalargyrou, Singh, and Lucas (2012) designed a theoretical model to identify the effect of dining sales on slot machine wagering activity, using daily performance data gathered from a Midwestern racino. Their model included a binary variable representing live racing days. This variable was set to 1 on the days that featured live horse racing. The results indicated a statistically significant decrease in slot machine wagering on the racing days, suggesting that the slot business suffered from the competition of live horse racing. While understanding the relationship between racing days and slot machine wagering volume was not their primary mission, the related result is certainly relevant to the current study.

Poker Rooms

Similar to the case of the race and sports book, it is a widely held opinion that poker rooms drive business to primary casino profit centers such as slots and table games (Cosgrove-Mather, 2005; Grochowski, 2005; Legato, 2010; McGowan, 2010; Taucer, 2004; Walters, 2003; Wiser, 2004). Ollstein (2006) was the first study to challenge the assumption of indirect profit contributions from poker rooms. His time series model analyzed daily data from a sample that began on February 1, 2005 and ended on August 31, 2005, a period that represented the height of the recent live poker craze. Although his results supported a statistically significant and positive relationship between daily poker rake and coin-in levels on slot machines, the magnitude of the positive effect was deemed insufficient to sustain poker operations. That is, given the magnitude of the indirect contribution to slots and the floor space dedicated to the poker room, Ollstein concluded that the poker space would be better utilized to accommodate additional slot machines. Because of the heavy reliance on slot win at the property studied by Ollstein, he did not examine the effect of the poker room on table game play.

Suh and Tsai (2013) studied data gathered from two prominent Las Vegas Strip resorts to examine the link between the poker room and the casino floor. Using a time series model very similar to Ollstein's, Suh and Tsai failed to identify a statistically significant relationship between the daily poker room headcount and the daily coin-in level in slot machines. This result held for the model that examined the relationship between daily poker room headcount and daily cash drop on the table games. However, data from only one of the two properties was examined via this approach. A second model examined the relationship between daily poker room rake and daily coin-in, using data from the second property. These results included a statistically significant effect for the poker rake variable for Property 2 (B = \$157, $p < 0.01$). After multiplying the \$157 by the average house edge, it was estimated that Property 2's slot win increased by \$10.68, for every \$1-increase in poker rake. Unlike Ollstein (2006), the authors did not weigh-in on whether the magnitude of this indirect contribution was sufficient to sustain poker room operations.

Lucas (2013a) also examined the effect of daily poker room rake on slot and table game business volumes, analyzing data from three Las Vegas hotel-casinos identified as Properties 1, 2, and 3. Using time series regression analysis, only Property 1 produced results that included a statistically significant relationship between daily poker rake and the dependent variables: daily coin-in and daily table game drop. A \$1-increase in rake produced a \$45-increase in coin-in and a \$7.45-increase in table game drop. While the continued operation of the poker rooms located at Properties 2 and 3 was questioned, Lucas was unable to comment on the magnitude of positive results for Property 1. Additional proprietary data were needed to determine whether the magnitude of either coefficient was indicative of a sufficient indirect contribution.

Bingo Rooms

For many years, gaming executives have claimed that unprofitable bingo rooms attract highly valuable slot play (Smith, 1997; Stutz, 2004; Suganuma, 2003; Tosh, 1998). Within U.S. casinos these claims of indirect contributions center around slots, as the operating profit margins are generally much greater than those posted by table games.

Lucas and Bowen (2002) created a model designed to measure the effect of lottery promotions in casinos, which included a variable that represented the daily aggregate bingo headcount. This variable produced a statistically significant and positive effect on the dependent variable, daily coin-in ($B = \$563.97$, $p < 0.05$). However, the data set was gathered in 1998, from a property that catered primarily to Las Vegas Valley residents. The competitive conditions of today's Las Vegas locals' market are very different from those in place in 1998.

Increased competition, declining bingo sales, and falling operating profits gave rise to more targeted research into the relationship between the bingo business and slot play. Lucas, Dunn, and Kharitonova (2006) answered this call by examining data from both an off-Strip property that catered to Las Vegas residents and a tribal casino targeting a similar repeater/locals' market in Southern California. Using a model designed to explain the variation in daily coin-in, the bingo headcount variable failed to produce a statistically significant result. This outcome held for both properties. The data set from the tribal casino included daily coin-in for slot machines with wagering units less than \$1, also known as low-denomination slots. It was theorized that the low-denomination slots represented a price point that was more in line with the bingo customer, possibly improving the chances of identifying a positive relationship between bingo and slot play. In step with this idea, the same model was used to explain the day-to-day variation in the tribal casino's low-denomination coin-in, but the result was the same. Once again, the bingo headcount variable failed to produce a statistically significant effect.

Retail Literature

The basic idea of the indirect contribution has been examined within the retail sector in various forms. For instance, the term *cherry picking* has been used in this literature to describe consumer behavior characterized by purchasing only one of two or more supposedly related items. In grocery/retail settings, the sales of full-priced items have failed to increase, even when complementary items have been priced below cost (Walters & Rinne, 1986; Walters & MacKenzie, 1988). For example, if hamburger were priced below cost, no increase would occur in the sales of complementary items such as hamburger buns, ketchup, mustard, and other condiments. Only the loss-leader item (the hamburger) would experience an increase in sales.

Within the gaming literature, Lucas and Brewer (2001) have cited cherry picking as a possible explanation for a finding that failed to support a positive relationship between the number of daily diners in casino operated restaurants and slot play. In spite of the popular view, the bulk of the findings related to the relationship between critical gaming volumes and race and sports books, poker rooms, and bingo rooms would also support the idea of cherry picking (Abarbanel et al., 2011; Kalargyrou et al., 2012; Lucas, 2013a; Lucas et al., 2006; Suh & Tsai, 2013). It is certainly possible that race and sports book patrons have insufficient interest in critical profit centers such as slots and table games, failing to support the protection of these departments under the Full Service Theory.

Spillover Effect

Also with origins in the retail literature, the spillover effect describes the idea that one store's sales can affect sales at other nearby stores. Anchor stores in shopping centers are often credited with some form of spillover effect on the smaller surrounding retail outlets (Eppli & Schilling, 1995). In the current study, the critical issue is whether evidence exists in support of race and sports book patrons spilling over into the slot and table games areas of the casino.

Regarding the gaming research reviewed thus far, only a few results have fully supported the basic idea of the spillover effect (Lucas & Bowen, 2002; Ollstein, 2006). In spite of this underwhelming support, the term *spillover* has made its way into the gaming lexicon. For example, one senior executive from a prominent tribal casino is on record discussing several forms of what he refers to as spillover from poker rooms to slots and table games (Kirdahy, 2008).

Theoretical Model

The model advanced here stems from the one used by Lucas & Bowen (2002), which has been improved upon, revised according to specific purpose, and redeployed in the previously reviewed race and sports book studies (Abarbanel et al., 2011; Kalargyrou et al., 2012), live poker research (Lucas, 2013a; Ollstein, 2006; Suh & Tsai, 2013), and bingo room studies (Lucas et al., 2006). All of these researchers have employed effective versions of this model, substituting different variables of interest into its basic form, such as poker rake, bingo headcount, and both race and sports write. The term *write* is used to describe the aggregate daily dollar-value of all wagers placed in a book. Figure 2 illustrates this established model.

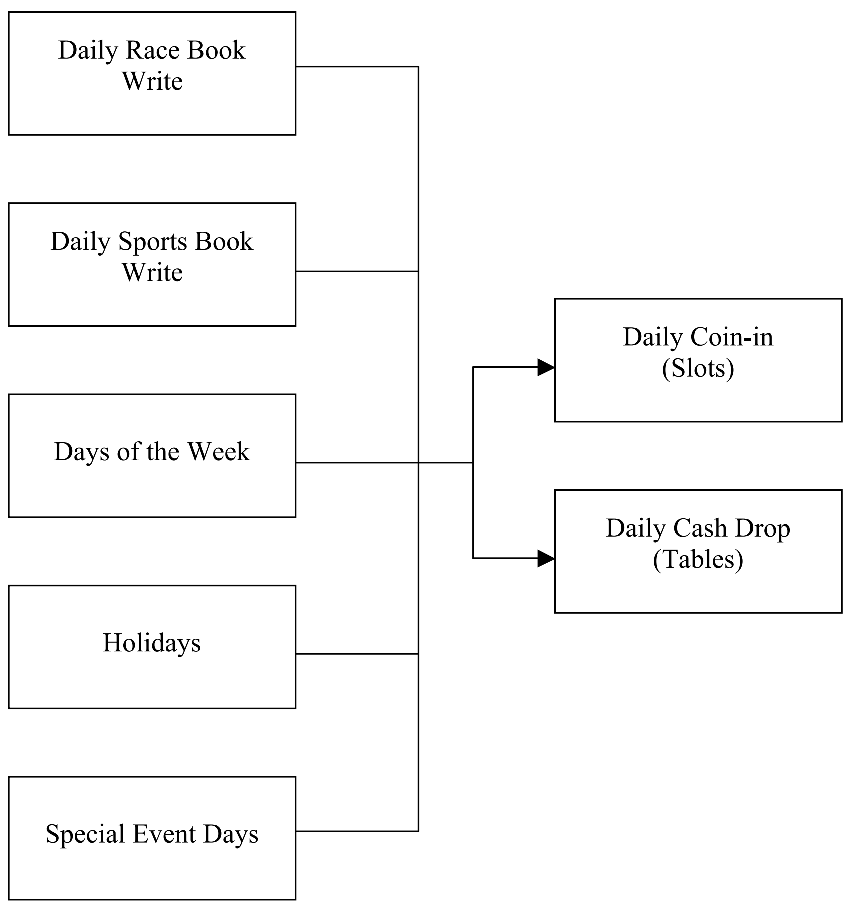

Figure 2. Theoretical model designed to predict daily coin-in and table game drop.

Hypotheses

In this study, the primary aim was to examine the relationship between race and sports book write and critical gaming volumes. While the majority of findings related to the Gaming Amenities Section of Figure 1 have failed to support the Full Service Theory, the overall body of results remains mixed. This, combined with the broad support for the Full Service Theory within the gaming industry, served as the basis for the following null hypotheses:

Coin-in Model:

H_0 1: $B_{Race} = 0$

H_0 2: $B_{Sports} = 0$

Table Game Drop Model:

H_0 3: $B_{Race} = 0$

H_0 4: $B_{Sports} = 0$

The hypotheses are separated by model here to acknowledge that Figure 1 displays two separate models within one figure. The B_{Race} and B_{Sports} terms represent the coefficients for the model variables expressing daily race book write and daily sports book write. The specific expression of each model variable will be described in the forthcoming Methodology Section.

Methodology

Data Sources

In exchange for access to actual performance data, the management of the donor properties requested that the names of the hotel-casinos be omitted from the study. In deference to this request, the three properties are hereafter referred to as Property A, Property B, and Property C. While the annual gross gaming win for all three of these properties was in excess of the Nevada Gaming Control Board's top reporting tier, there were critical differences in the resorts. Property A was located off of the Las Vegas Strip and catered to a local clientele, while Properties B and C were located on the Strip, with tourist-dominated customer bases. Property B targeted a clientele characterized by its management team as low- to mid-rollers, while Property C pursued mid- to high-rollers. This difference was evident in the quality and price-points of the onsite restaurants, hotel rooms, entertainment venues, and other amenities. Property A featured close to 500 hotel rooms, while Properties B and C both offered in excess of 3,500 rooms. Exact hotel capacities are not provided to preserve the anonymity of the properties.

Samples

The sample period was identical for all three properties. The data were sequentially ordered by day, over a 212-day sample period, which began on February 1, 2009 and ended on August 31, 2009. These were the dates for which all three properties were able to supply a common data set. This general period is often selected for time series analysis of Las Vegas properties, as it avoids the volatility associated with the year-end and new-year months (Lucas, 2013b). Specifically, it avoids the protracted lull in business in November and most of December, the spike in gaming activity during the ensuing holiday period, and the second lull in business, beginning in mid-January. These successive extremes create problems when fitting the data to a times series model.

Method

Times series regression analysis was used in the formal analysis of the data, given its many effective applications to similar gaming data sets (Abarbanel et al., 2011; Lucas, 2013a; Ollstein, 2006; Suh & Tsai, 2013). Simultaneously entry of the predictor variables was employed and all hypothesis tests were two-tailed, at 0.05 alpha. The data were screened in SPSS, v. 20, and the time series regression analysis was conducted in EViews, v. 3.1.

Expression of Dependent Variables

With slot and table game data from three properties there were six dependent variables, as each property supplied both a coin-in series and a drop series. Given the marked difference in the scale of operations across the three donor properties, both the dependent variables and the key independent variables were converted to their natural log form. This allowed for more meaningful comparisons of the critical results. This double-log form is common in econometric modeling (Dielman, 1996), featuring regression coefficients which are expressed as elasticities, as in the elasticity of Y with respect to X (Kahane, 2008, p. 84). This expression mitigates considerable differences in the scale of operation between integrated resorts on the Las Vegas Strip (Property C) and off-Strip resorts (Property A), which generate business volumes well below those of Strip properties. Further, use of the double-log model facilitates theory development by producing results in a common metric (an elasticity), which can be compared across gaming properties of all sizes.

On the slot side, the dependent variable was the natural log of daily aggregate coin-in (COIN-IN). In general, coin-in represents the total amount of money wagered in some number of electronic gaming devices, over a specified period of time such as a day, month, or year. In this study, slots or slot machines refers to any coin- or ticket-operated gaming device, including but not limited to reels, video poker games, and electronic table games. So, COIN-IN was the natural log of the aggregate daily dollar-amount of wagers placed in electronic gaming devices.

In the table game models, the natural log of the daily aggregate drop served as the dependent variable. Drop is the most commonly employed business volume measure for table games (Lucas & Kilby, 2012). For Nevada casinos, Lucas and Kilby (2012) describe drop by way of the following formula:

> Table Game Drop = Dollar-value of Currency in the Drop Box + Dollar-value of Gaming Cheques in the Drop Box + Dollar-value of Marker Issue Slips in the Drop Box – Dollar-value of Marker Redemption Slips in the Drop Box

Marker Issue Slips represents the dollar value of credit granted to players, while Marker Redemption Slips represents the dollar value of credit retired on the table games. In Nevada, when players pay-off a marker on the game itself, a marker redemption slip is completed and placed in the game's drop box, as evidence of the player's payment.

Expression of Predictor Variables

The two key predictor variables were RACE and SPORTS, with the former representing the natural log of the total dollar amount of wagers placed in the race book on each gaming day, and the latter representing the natural log of the total dollar amount of wagers placed in the sports book during each gaming day. In the gaming industry, these wagering volumes are referred to as write, hence the use of Daily Race Book Write and Daily Sports Book Write in Figure 2. Although often collectively referred to as a race and sports book, these two operations are unique, catering to very different customer bases. For more on the differences in race and sports book operations, see Lucas and Kilby (2012).

The day-of-the-week, holiday, and special events variables were all expressed in a binary format. For instance, on Saturdays, SAT was set to a value of one, with all other day-of-the-week variables assigned a value of zero for that day. The day-of-the-week variable system included MON, TUE, THU, FRI, SAT and SUN, with WED serving as the base period. The holiday variables were set to a value of one on the holiday itself, and in some cases, on the surrounding days. These variables were set to zero on all other days. The holiday variables included Presidents' Day (PRESDAY), Saint Patrick's Day (STPATS), Memorial Day (MEMDAY), and Independence Day (INDDAY). The special event variables were set to a value of one on the special event day(s), and a value of zero on all other days. The only special event variables were KDERBY (Kentucky Derby) and NCAA (The 1st and 2nd rounds of the Collegiate Men's Basketball Tournament).

Model Specification

Putting it all together, the following equations represent the base template used to test the overall theoretical model and the individual hypotheses advanced in the Literature Review.

$$COIN\text{-}IN_{ij} = c + B_j(RACE_{ij}) + B_j(SPORTS_{ij}) + B_j(MON_{ij}) + B_j(TUE_{ij}) + B_j(THU_{ij}) + B_j(FRI_{ij}) + B_j(SAT_{ij}) + B_j(SUN_{ij}) + B_j(PRESDAY_{ij}) + B_j(STPATS_{ij}) + B_j(MEMDAY_{ij}) + B_j(INDDAY_{ij}) + B_j(NCAA_{ij}) + B_j(KDERBY_{ij}) + e_{ij}$$

$$DROP_{ij} = c + B_j(RACE_{ij}) + B_j(SPORTS_{ij}) + B_j(MON_{ij}) + B_j(TUE_{ij}) + B_j(THU_{ij}) + B_j(FRI_{ij}) + B_j(SAT_{ij}) + B_j(SUN_{ij}) + B_j(PRESDAY_{ij}) + B_j(STPATS_{ij}) + B_j(MEMDAY_{ij}) + B_j(INDDAY_{ij}) + B_j(NCAA_{ij}) + B_j(KDERBY_{ij}) + e_{ij}$$

COIN-IN and DROP were predicted for the i^{th} day at the j^{th} hotel-casino, where i ranged from 1 to 212, and j ranged from 1 to 3. Both equations represent the full model, which was applied to the data from all three resorts. However, not all of the final COIN-IN and DROP models for each property included all of the control variables listed in the previous equations. When a control variable failed to produce a statistically significant effect in a given model, it was dropped from the final model.

Although not part of the theoretical model per se, correction variables were also employed. For example, AR (autoregressive) and MA (moving average) terms were added as needed, to produce an independent error process, and trend variables were added to correct for non-constant means in dependent variable values. Finally, binary variables were also added to reflect the effects of valid outliers.

Results

Time Series Plots

Prior to the formal data analysis, time series plots of all dependent variables were reviewed to determine whether each series was stationary. A requirement for time series regression, a stationary series is characterized by a constant mean and constant variance over time. As endorsed by Kennedy (1998, p. 264), the line plots shown in Figures 3, 4, and 5 were visually examined to assess the extent of the first and second order stationarity, or the presence of a constant mean and variance, respectively.

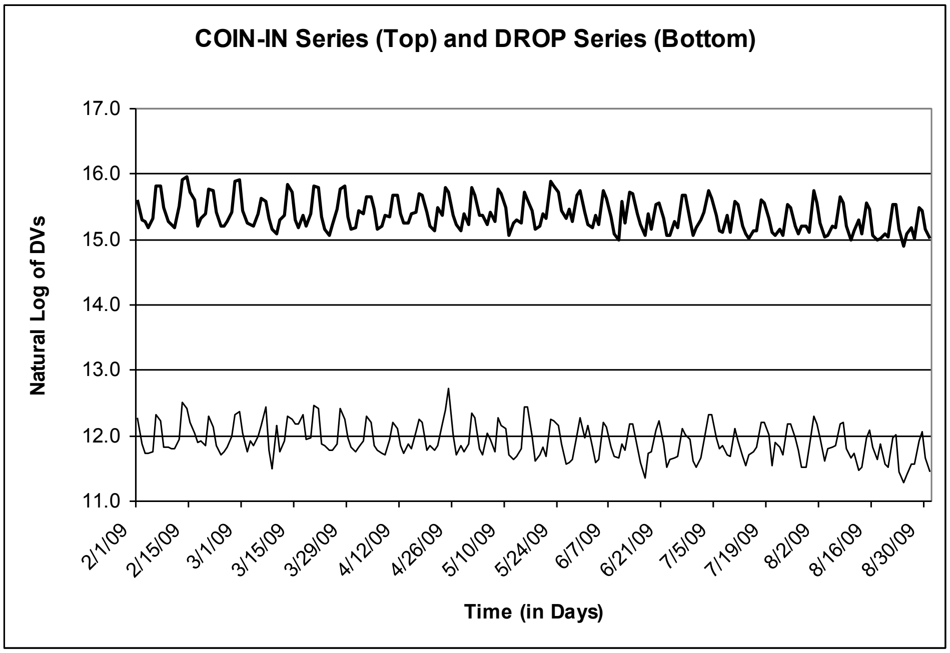

Figure 3. Time series plots of dependent variables: Property A.

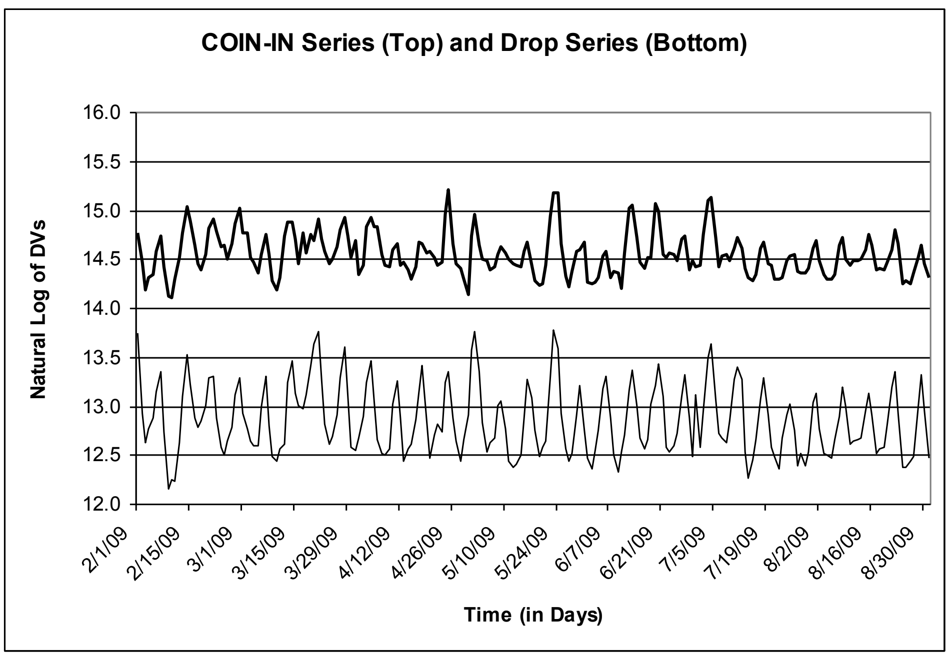

Figure 4. Time series plots of dependent variables: Property B.

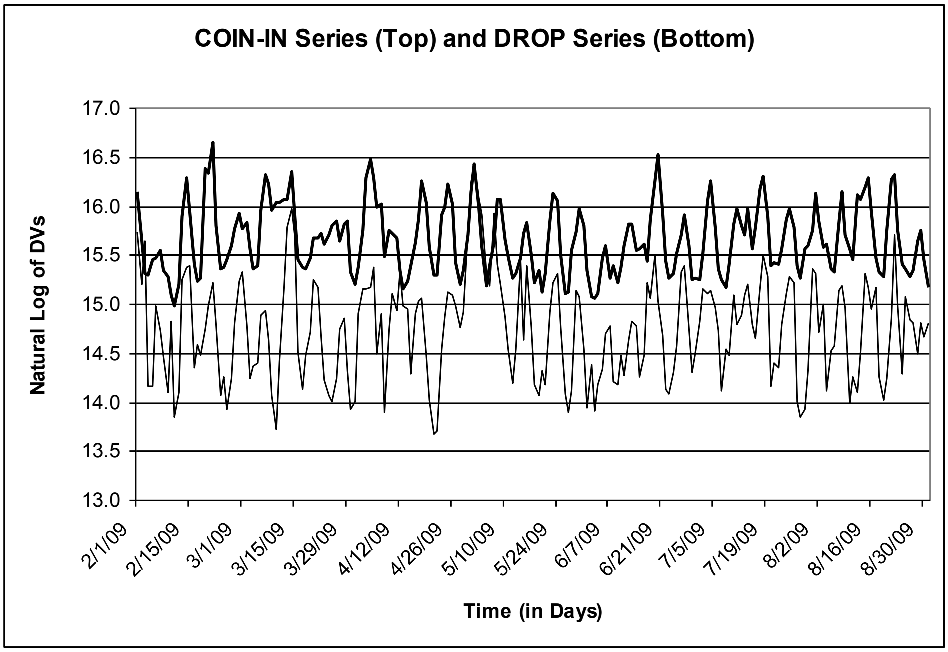

Figure 5. Time series plots of dependent variables: Property C.

While none of these plots provided cause for concern, Property A's COIN-IN and DROP data reflected the possibility of a mild linear decline over the sample terms. As a result, a linear trend variable was added to both models. With respect to second order stationarity, the graphs failed to indicate a problematic departure from a constant variance. Consistent with Lucas (2013a), no unit root tests were performed, as such tests have been repeatedly found to lack statistical power, and the presence or absence of a unit root has been found inconsequential in the analysis of time series data (Campbell & Perron, 1991; Cochrane, 1991).

Descriptive Statistics

Table 1 lists the descriptive statistics for all continuous variables appearing in the final models. Aside from RACE and SPORTS, predictor variables that failed to produce a statistically significant effect are not shown in any of the tables appearing in the Results section.

Table 1
Descriptive Statistics for Continuous Model Variables: Resorts A, B, and C (n = 212)

	Mean	Std. Dev.	Min.	Max.
Resort A Variables:				
COIN-IN	15.31	0.24	14.90	15.96
DROP	11.92	0.26	11.28	12.72
RACE	10.12	0.82	6.70	12.08
SPORTS	10.79	0.57	7.11	13.47
TREND	n/a	n/a	1.00	212.00
Resort B Variables:				
COIN-IN	14.56	0.22	14.11	15.22
DROP	12.86	0.35	12.16	13.78
RACE	8.35	0.74	6.30	11.13
SPORTS	9.66	0.91	7.01	13.66
Resort C Variables:				
COIN-IN	15.67	0.35	14.99	16.65
DROP	14.75	0.53	13.67	16.43
RACE	10.53	0.26	9.96	12.21
SPORTS	11.01	0.89	7.06	14.96

Notes. Except for TREND, all values are expressed as the natural log of the original metric.

TREND was assigned a value of 1 on the first day of the sample and increased by a value of 1 on each day, until reaching its maximum value of 212. Therefore, its mean and standard deviation were meaningless, hence their omission from Table 1. The increased standard deviation in Property C's DROP variable was due to its high-end table game clientele. Finally, the standard deviation of SPORTS was expected to be greater than that of RACE, given the well-known volatility of sports wagering. However, for Resort A, RACE posted a greater standard deviation than SPORTS, making this an unusual result. Table 2 lists the bivariate correlation coefficients for the continuous model variables.

Table 2
Correlation Matrices for Continuous Model Variables: Resorts A, B, and C (n = 212)

	COIN-IN	DROP	RACE	SPORTS	TREND
Resort A Variables:					
COIN-IN	--				
DROP	0.83*	--			
RACE	0.68*	0.61*	--		
SPORTS	0.37*	0.35*	0.36*	--	
TREND	-0.32*	-0.32*	-0.01	-0.25*	--
Resort B Variables:					
COIN-IN	--				
DROP	0.80*	--			
RACE	0.46*	0.59*	--		
SPORTS	0.51*	0.60*	0.31*	--	
TREND	n/a	n/a	n/a	n/a	--
Resort C Variables:					
COIN-IN	--				
DROP	0.56*	--			
RACE	0.48*	0.45*	--		
SPORTS	0.40*	0.37*	0.57*	--	
TREND	n/a	n/a	n/a	n/a	--

Notes. * indicates significant at 0.05 alpha (2-tailed). TREND was not present in the final models for Resorts B and C, hence the “n/a” for not applicable.

COIN-IN Models

Table 3 lists the results of the COIN-IN model time series regression for all three properties. The Resort A model produced an R^2 of 88.8% and an F-statistic of 116.16 (df = 12, 199, $p < 0.00005$). Although SPORTS failed to generate a statistically significant result, a 1.0% increase in RACE was associated with a 0.0399% increase in COIN-IN (B = 0.0399, $p = 0.0082$). The Resort B model posted an R^2 of 80.2%, with an F-statistic of 52.51 (df = 14, 197, $p < 0.00005$). RACE failed to produce a statistically significant result, but a 1.0% increase in SPORTS generated a 0.0229% increase in COIN-IN (B = 0.0229, $p = 0.0309$). Finally, the Resort C model recorded an R^2 of 80.5%, posting an F-statistic of 74.43 (df = 10, 201, $p < 0.00005$). In the Resort C model neither RACE nor SPORTS produced a statistically significant effect on COIN-IN.

Table 3
Results of Double-log Time Series Regression Analyses
Dependent Variable: Natural Log of Aggregate Daily Coin-in

	Resort A		Resort B		Resort C	
Variable	B	p	B	p	B	p
Constant	15.0056		14.0223		14.7836	
RACE	0.0399	0.0082	0.0194	0.1402	0.0493	0.4517
SPORTS	0.0050	0.7135	0.0229	0.0309	0.0076	0.6306
MON	-0.1096	0.0001	0.0672	0.0008	0.0920	0.0049
TUE	-0.1167	0.0000	n/a	n/a	n/a	n/a
THU	-0.0460	0.0201	0.0584	0.0064	0.2220	0.0000
FRI	0.3721	0.0000	0.2713	0.0000	0.5125	0.0000
SAT	0.3051	0.0000	0.3657	0.0000	0.6795	0.0000
SUN	n/a	n/a	0.1922	0.0000	0.3892	0.0000
PRESDAY	n/a	n/a	n/a	n/a	0.6721	0.0000
STPATS	n/a	n/a	0.2920	0.0008	n/a	n/a
MEMDAY	0.2557	0.0017	0.2484	0.0018	n/a	n/a
INDDAY	n/a	n/a	0.1868	0.0260	n/a	n/a
TREND	-0.0014	0.0000	n/a	n/a	n/a	n/a
MAR 12	n/a	n/a	0.2262	0.0096	n/a	n/a
APR 25	n/a	n/a	0.3280	0.0001	n/a	n/a
APR 30	n/a	n/a	-0.2944	0.0008	n/a	n/a
JUN 10	0.3159	0.0001	n/a	n/a	n/a	n/a
JUN 19	n/a	n/a	0.2618	0.0028	n/a	n/a
AUG 12	n/a	n/a	n/a	n/a	0.4490	0.0002
AR (1)	0.2787	0.0001	0.6660	0.0000	0.5900	0.0000
AR (2)	0.1522	0.0342	n/a	n/a	n/a	n/a
AR (7)	0.1339	0.0443	n/a	n/a	n/a	n/a
MA (1)	n/a	n/a	n/a	n/a	0.3416	0.0001
R^2	88.77%		80.16%		80.45%	
Model F-Stat.	116.16	0.0000	52.51	0.0000	74.43	0.0000

Notes. "n/a" represents not applicable, i.e., the variable did not appear in the final model. The VIFs for RACE were 4.5, 1.6, and 2.2 for the Resort A, Resort B, and Resort C models, respectively. The VIFs for SPORTS were 1.3, 1.3, and 1.6 for the Resort A, Resort B, and Resort C models, respectively. A p-value of 0.0000 indicates a value less than 0.00005.

The following variables from Property A's full COIN-IN model failed to produce statistically significant effects: SUN, PRESDAY, STPATS, INDDAY, NCAA, and KDERBY. For Property B, the following variables were eliminated from the COIN-IN model for failing to produce statistically significant results: TUE, PRESDAY, NCAA, and KDERBY. Finally, the following variables in Property C's COIN-IN model failed to post statistically significant effects: TUE, STPATS, MEMDAY, INDDAY, NCAA, and KDERBY.

Individual date variables like JUN 10, which appeared in Resort A's model represented the effect of outliers.. Outliers were days with studentized deleted residuals in excess of 3.0 that also appeared distant from the mass of points on a scatter plot of the model errors. Given the sample sizes, outliers were expected in all six models.

DROP Models

Table 4 contains the results of the DROP model time series regression for all three properties. Resort A's DROP model produced an R^2 of 83.9%, with an F-statistic of 67.50 (df = 14, 197, $p < 0.00005$). Like the COIN-IN model, SPORTS failed to generate a statistically significant result, but a 1.0% increase in RACE was associated with a 0.0059% increase in DROP (B = 0.0535, $p = 0.0059$). The Resort B model posted an

R^2 of 90.6% and an F-statistic of 174.93 (df = 10, 201, $p < 0.00005$). A 1.0% increase in RACE produced a 0.0396% increase in DROP (B = 0.0396, $p = 0.0047$). Likewise, a 1.0% increase in SPORTS generated a 0.0225% increase in DROP (B = 0.0225, $p = 0.0483$). Lastly, the Resort C model recorded an R^2 of 64.5% and an F-statistic of 30.02 (df = 11, 200, $p < 0.00005$). In the Resort C model neither RACE nor SPORTS produced a statistically significant effect on DROP.

Table 4
Results of Double-log Time Series Regression Analyses
Dependent Variable: Natural Log of Aggregate Daily Table Game Drop

	Resort A		Resort B		Resort C	
Variable	B	p	B	p	B	p
Constant	11.3275		12.0624		14.2277	
RACE	0.0535	0.0059	0.0396	0.0047	0.0513	0.7343
SPORTS	0.0006	0.9731	0.0225	0.0483	-0.0322	0.3804
TUE	0.0603	0.0105	-0.0675	0.0001	n/a	n/a
THU	0.0591	0.0165	0.1454	0.0000	0.2410	0.0004
FRI	0.4597	0.0000	0.5082	0.0000	0.6775	0.0000
SAT	0.4158	0.0000	0.6958	0.0000	0.7615	0.0000
SUN	0.1191	0.0006	0.3480	0.0000	0.5111	0.0000
MEMDAY	n/a	n/a	0.3021	0.0006	n/a	n/a
NCAA	0.3448	0.0000	n/a	n/a	n/a	n/a
KDERBY	n/a	n/a	0.2141	0.0210	0.9162	0.0001
TREND	-0.0012	0.0000	n/a	n/a	n/a	n/a
FEB 04	n/a	n/a	n/a	n/a	-0.5447	0.0408
MAR 10	0.4478	0.0000	n/a	n/a	n/a	n/a
APR 08	n/a	n/a	n/a	n/a	-0.7640	0.0079
APR 25	0.4067	0.0001	n/a	n/a	n/a	n/a
MAY 15	n/a	n/a	n/a	n/a	-0.8994	0.0026
JUN 01	0.4149	0.0001	n/a	n/a	n/a	n/a
JUN 16	-0.3548	0.0009	n/a	n/a	n/a	n/a
JUN 17	n/a	n/a	n/a	n/a	0.5989	0.0369
JUN 30	n/a	n/a	0.6472	0.0000	n/a	n/a
AUG 23	-0.2282	0.0308	n/a	n/a	n/a	n/a
AR (1)	0.3765	0.0000	0.7268	0.0000	0.5510	0.0000
R^2	83.85%		90.63%		64.53%	
Model F-Stat.	67.50	0.0000	174.93	0.0000	30.02	0.0000

Notes. "n/a" represents not applicable, i.e., the variable did not appear in the final model. The VIFs for RACE were 4.3, 1.6, and 2.3 for the Resort A, Resort B, and Resort C models, respectively. The VIFs for SPORTS were 1.3, 1.4, and 1.6 for the Resort A, Resort B, and Resort C models, respectively. A p-value of 0.0000 indicates a value less than 0.00005.

Working from Property A's full DROP model, both MEMDAY and KDERBY failed to produce statistically significant effects. Only NCAA failed to produce a statistically significant effect in Property B's DROP model. Finally, the following variables were dropped from Property C's final DROP model for failing to post statistically significant results: TUE, MEMDAY, and NCAA.

Time Series Regression Diagnostics

When working with time series data the most pressing concern is usually the independence of the error process. This is assessed by way of correlograms depicting the ACF (autocorrelation function) and PACF (partial autocorrelation function). The ACF relates to correlation among lagged values of the dependent variable, while the PACF relates to correlation among the error terms. AR terms are added to address correlation between lagged values of the dependent variable, while MA terms address serial correlation among the error terms. Initially all six models exhibited problematic correlation in the error process. However, after the addition of the appropriate AR and MA terms each of the six models produced an independent error process. More specifically, the Q-statistics associated with the correlograms revealed no statistically significant correlations in the error process, across 30 lags.

The linearity assumption was examined by reviewing scatter plots of the model residuals against the predictor variable values. The variance of the model errors was also assessed via scatter plots. In this case, studentized deleted residuals were plotted against corresponding predicted values. Regarding linearity and nonconstant variance, the scatter plots revealed no cause for concern. Finally, histograms of the model errors revealed no problematic departures from the normal distribution.

Multicollinearity was assessed by examining variance inflation factors (VIFs) for each model's predictor variables. As RACE and SPORTS were the key variables in this study, the VIFs associated with these variables were the primary concern. As listed in the notes of Tables 3 and 4, the VIFs for RACE ranged from 1.6 to 4.5 in the COIN-IN models, and from 1.6 to 4.3 in the DROP models. The VIFs for SPORTS ranged from 1.3 to 1.6 in the COIN-IN models, and from 1.3 to 1.6 in the DROP models. These results indicated reasonable levels of multicollinearity. Aside from RACE and SPORTS, the greatest VIF of any other predictor variable was 2.6 in the COININ models and 3.3 in the DROP models.

Discussion

Overall, the models were effective predictors of COIN-IN and DROP, as evidenced by the R^2 values. Property C's DROP model was the least effective, due to its reliance on high-roller table game play, which is well known for its random volatility. Regarding the key variables RACE and SPORTS, twelve hypotheses were tested. Two hypotheses were tested (RACE and SPORTS) in each of two models (COIN-IN and DROP), at three different properties (Properties A, B, and C). The null hypothesis was rejected in only five instances. Therefore, the results of seven of the 12 hypothesis tests related to the effects of RACE and SPORTS failed to support the associated portion of the Full Service Theory described in Figure 1. RACE fared better than SPORTS, posting positive and significant effects in one of the three COIN-IN models and two of the three DROP models. SPORTS only produced a positive and significant effect in Property B's COIN-IN and DROP models. For Properties A and C, SPORTS failed to impact both COIN-IN and DROP.

The overall results of this work were consistent with the majority of findings from others who have empirically tested the effect of gaming amenities within the Full Service Theory (Abarbanel et al., 2011; Lucas, 2013a; Lucas et al., 2006; Suh & Tsai, 2013). Further, the findings offered support for the general notion of cherry picking, as described in the retail literature. That is, failure to reject the null hypothesis in seven of 12 opportunities suggested that many race and sports patrons were in the casino to make race and sports bets, with little or no interest in making slot and table game wagers. These same results offered little support for the spillover effect. Specifically, the majority of outcomes were not consistent with the idea that race and sports players are initially attracted to the casino by the books, but eventually become slot and table game players.

Within the existing literature, the results of the current study are most directly comparable to those of Abarbanel et al., (2011). In their study, neither the race book nor the sports book write produced a statistically significant impact on daily aggregate coin-in. For the most part, the findings of this study supported those of Abarbanel et al, with only two of the six book variables posting a significant and positive effect on COIN-IN. Although the DROP models were slightly better, Abarbanel et al. did not examine the effect of the books on the table game business.

As noted in the ensuing section, the results varied by property. This is likely due to differences in factors such as (1) clientele; (2) proximity of the books to primary gaming areas; and (3) management and marketing activities related to the books, slots, and tables. Of course, this is an abridged list. Other factors could have influenced the individual results. Differences in the results across resorts were not surprising, as no two casinos are alike. With respect to the general impact of race and sports books, the robustness of the results must be determined by the level of the agreement in the individual findings from this study along with those from Abarbanel et al. (2011) and any future studies. At the individual resort level, the results are immediately useful.

Managerial Implications

Given the results of Properties A and C, operating assumptions related to the sports book's indirect contribution may be reframed by the results of this study. While further research is advised, these results certainly do not support expansion of the book, nor do they bode well for the book's profit-per-square foot estimates, which almost always include an indirect contribution component.

Property B's sports book was another story, posting more encouraging results. A 1.0% increase in SPORTS produced 0.0229% and 0.0225% increases in COIN-IN and DROP, respectively. These results certainly support claims of indirect contributions, within the broader conversation of the book's overall profit per square foot. The impact on COIN-IN is most critical for Property B executives, as this property relies heavily on profit from slot operations.

Property A has what could be considered a hyper-dependency on slot win, making the RACE result from the COIN-IN model most critical. For Property A, a 1.0% increase in RACE produced a 0.0399% increase in COIN-IN. Similarly, a 1.0% increase in RACE also generated a 0.0535% increase in DROP. In the battle for floor space at Property A, these results will certainly help the race book, quite possibly at the expense of the adjacent sports book.

Property C executives may want to revisit their book operations, to the extent that they rely on assumed indirect contributions. Given that Property C is an integrated resort, there are many potential uses of this floor space, ranging from restaurants to retail. With only the direct profits from book operations to consider, decisions related to the use of this space may have become a little less complex. These two books must attempt to maximize direct operating profits to avoid a reduction in space, or worse yet, total displacement.

Regardless of the specific outcomes, property executives can use this business intelligence to make more informed space allocation and development decisions related to share of the gaming floor. Such results may also be helpful for use in capital expenditure decisions. Executives may wish to water the green spots by investing in new systems and infrastructure for the areas that are producing the most value. For Property A, this would be the race book. Others may choose to invest in the ailing areas, in an effort to improve indirect contributions.

Results of this work also help casino developers frame the design of new gaming properties. Specifically, these findings provide developers with a better understanding of what they can expect from the books when they hear arguments from various parties related to the necessary components of the casino.

Limitations & Future Research

The results produced in this work cannot be generalized beyond the three donor hotel-casinos. Additionally, the results cannot be generalized beyond the sample period of this study, which did not include the National Football League's (NFL) regular season and playoffs, and the majority of the collegiate football season. Examining data from this period could influence results associated with a variable representing a sports book's wagering volume, as wagers on football comprise a meaningful portion of annual wagering volume in most sports books. Unfortunately, a good portion of the football season coincides with year-end and early-year periods, which are notorious for volatile wagering volumes in the casino. As noted in the Methodology Section, these periods are often omitted from casino samples for this reason. However, given the potential importance of this period to the sports books, future researchers should attempt to study the relationship between sports books and critical gaming volumes during all or part of the football season.

Any replication of this study would be helpful in gaining a broader understanding of the relationships between books and critical gaming volumes. Results from only one other study are available (Abarbanel et al., 2011), and it did not include a table game component. Future researchers may also want to consider adding dependent variables that represent hyper-profitable non-gaming operations. For example, given the importance of profits from hotel operations, any research aimed at the relationship between book and hotel business volumes would be valuable. This approach would at least partially address the argument that the opportunity to wager on major sporting events brings guests to the hotel, especially in destination markets such as Las Vegas.

Alternatively, an observation study of patron migration from the books may yield valuable results related to the broader issue of crossover from the books to the casino. At a minimum, results from such a study would provide a valuable comparison against those produced by the current work.

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