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Estimating the indirect contribution of sports books: Sports wagering as a driver of other in-house revenues

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ESTIMATING THE INDIRECT CONTRIBUTION OF SPORTS BOOKS:
SPORTS WAGERING AS A DRIVER OF
OTHER IN-HOUSE REVENUES

by

Brett Lillian Levine Abarbanel

Bachelor of Science
Brown University
2006

A thesis submitted in partial fulfillment of
the requirements for the

Master of Science in Hotel Administration
William F. Harrah College of Hotel Administration

Graduate College
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THE GRADUATE COLLEGE

We recommend that the thesis prepared under our supervision by

Brett Lillian Levine Abarbanel

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**Estimating the Indirect Contribution of Sports Books: Sports Wagering
as a Driver of Other In-house Revenues**

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ABSTRACT

Estimating the Indirect Contribution of Sports Books: Sports Wagering as a Driver of Other In-house Revenues

by

Brett Lillian Levine Abarbanel

Dr. Anthony Lucas, Examination Committee Chair
Associate Professor of Hotel Administration
University of Nevada, Las Vegas

Using data from a repeater market hotel in Las Vegas, Nevada, the relationship between sports book and slot machine revenues is examined. Daily sports book write and daily slot handle are compared over a 250 day period. Though many industry leaders theorize that sports book gamblers also wager in slot banks, the results of this research fail to demonstrate a statistically significant relationship between sports book write and slot coin-in. In addition, the model used included race book win as an independent variable. Race book win was found to be a highly insignificant indirect contributor to slot revenue volume and was dropped from the model in the early stages of analysis. This study advances literature currently available by establishing the lack of such a relationship and disputing the generally accepted assumption that sports books produce a substantial indirect contribution to other in-house revenues. While the sports book does generate a fairly constant direct profit for the casino, the absolute value of that profit is minimal and the results of the study show there is no indirect profit contribution from sports books to slot machines. Given these results, casino management may want to consider that a large sports book is not an optimal use of casino floor space.

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CHAPTER 1

INTRODUCTION

Purpose

The purpose of this study is to explore the impact of sports book gaming volume on slot gaming volume at a repeater market Las Vegas casino property by estimating the indirect cash flow contribution of the sports book on slot coin-in. It is fairly easy to determine the direct cash flow contribution of a sports book to its casino property. The property's income statements provide a detailed look at the revenues and costs of managing the book. But a sports book requires many operational costs, such as when upgraded to include massive digital high definition television screens to cover entire walls, or for promotions like no-juice days and high-end car giveaways. There are also potential opportunity costs – the casino could be using the space for more profitable amenities.

The casino's decision to operate a sports book may not necessarily be maximizing their potential profit per square foot. It is possible, however, that the indirect benefits of having a sports book may justify the operational costs of such a facility. Evaluating and estimating the indirect effects of the sports book is the purpose of the study.

Practical Significance

Many industry leaders purport that sports gamblers take their winnings from the book and use them to play other in-house games and spend them on other property amenities (Lang & Roxborough, 1992; Manteris, 1993; Roxborough, 1996). The casino wants to optimize the allocation of space such that they will maximize their return on

assets. Even if the sports book is slightly profitable, it may not be the optimal use of available floor space. While an income statement will report the direct revenue generated by the sports book, it will not provide any information on its indirect gaming contribution. Casino industry leaders have discussed the indirect benefit of sports books on the casino floor for many years, but as yet none have provided any empirical proof of their claims. In addition, the current troubled economic times are leading some state governments to seek legalized sports betting. Delaware and New Jersey are pushing for legislation to permit sports betting in order to drive revenues for the states (McCarthy & Perez, 2009). Should this legislation come to fruition, casino operators in those states should heed advice and find empirical evidence of the value of a sports book before investing their time and money in a new addition to their business.

Academic Significance

This study presents a functional model and objective process for estimating the indirect gaming contribution of sports book volume to associated gaming volumes, most specifically slot coin-in. This appears to be the first study to investigate this issue by establishing the effect of a one-unit change in the predictor variable, the dollar value of daily aggregate sports book wagers, on gaming volume measurements. Lucas, Dunn, & Kharitonova (2006) first addressed the issue of indirect gaming contributions with respect to Bingo, and also created the theoretical framework which opened the door to further analysis of other indirect gaming contributions. The author intends that this study will expand on current gaming literature by concentrating on the sports book, a casino staple for many years.

Delimitation

No attempt was made to investigate the relationship of an indirect cash flow contribution between sports book revenue and the table games department. The only pit games wagering volume measured by the property was total drop. Total drop includes credit play, which can produce disproportionate increases in business volume, and can cause inaccuracies in correlation-based estimation techniques (Lucas & Santos, 2003). In addition, total drop represents the customers' total buy-in, not the actual dollar amount wagered by patrons. The casino is not guaranteed that the total drop will be used as wagers, and therefore have no guarantee at a chance to win the entire buy-in. An automated bet-tracking system would be necessary to capture actual wagering volume, but such facilities were unavailable at the property. As such, the true dollar amount wagered by table games customers is unknown.

CHAPTER 2

REVIEW OF RELATED LITERATURE

The In-House Sports Book –A Desired Amenity?

Sports Book Operations Within a Casino

Kilby, Fox, & Lucas (2005) describe how ultimately, all games in the casino compete for floor space via profit per square foot. This does not necessarily relate to direct profit, as many casino operations departments will keep some poorly-grossing ventures and even some operations that consistently take a loss, like bingo (Lucas, Dunn, & Kharitonova, 2006), with the belief that they will drive other revenues on the property. When considering the concept of highest and best use of space, Kilby et al. (2005) inspire the question – does a sports book constitute the most valuable use of the property’s facilities?

During the 1990s, sports books more frequently became a part of the typical casino layout, a new concept compared to the stand-alone sports books that had been in operation (Lang & Roxborough, 1992). Noting how the sports book provides access to other attractions within the casino-hotel, Lang and Roxborough (1992) postulate that the sports book serves the latent function of keeping pit players near the action. That is, they conclude that casino pit patrons would head to the sports book before, during, and after a gambling session, rather than leaving the casino property. Roxborough (1996) later also declares the sports book to be a core profit center.

Manteris (1993) further describes the use of the sports book as an essential part of the casino-hotel environment in an article detailing why the Sport of Kings, a stand-alone sports book, failed. In contrast to Roxborough’s (1996) claim, he states that sports books

are low on the casino revenue-generating list. Manteris (1993) goes on, however, to propose that while the sports book itself may not generate high revenues, the opening and expansion of sports books within casino-hotels runs hand-in-hand with increases in hotel, food and beverage, and slot and casino revenues. He additionally states that the casino wants to avoid a situation in which a valuable patron leaves the premises to place a sports wager at a rival property, and while there, “drops a bundle” at the competitor’s gaming facilities (Manteris, 1991). Manteris further reiterates this theory with regard to race books, stating that there had previously been a period of time during which the floor space allocated to race books was shrinking (Eng, 2008). Eng (2008) details how Manteris is quick to note, however, that a state-of-the-art race book is a big draw to the property, since it “gives the guests what they want,” and that customers who come to the property to use the race book will use the other facility services – most specifically, the “king of gambling profits”: the slot machine. Eng (2008) also reports on the point of view of the race and sports book director at Planet Hollywood, a Las Vegas Strip property, who indicates that it is no secret among casino managers that a casino establishment could generate higher revenues if the race and sports book floor space were used for slots, but that operators strive to offer a full-service model, and therefore keep the race and sports wagering facility.

When considering recent updates in sports book operations, one must acknowledge the ever-changing face of technology. Berosh (2008) describes new technology implemented in Station casinos, a repeater market collection of properties, where large amounts of cash have been injected into one of their sports books for new digital high-definition televisions that cover the walls of the book. Holtmann (2006)

illustrates how new technologies and marketing efforts are increasing sports betting volume. He states that sports book operators know their sports books are not major revenue generators, but they “make sure the customer sticks around” to spend their money elsewhere on the property by providing them with advanced technological amenities.

Berosh (2008) also describes how Harrah’s, whose properties in Las Vegas are primarily in the Strip market, has adapted their amenities to put the theory of the sports wagering facility driving wagering in other casino games into practice. Concerned that their players were being forced to select between playing table games or placing wagers in the sports book and watching the games there, Harrah’s created the Sports Pit. The Harrah’s Sports Pit integrates the sports book with a sampling of casino games such as craps and blackjack. The new layout allows casino patrons to wager their money in two ways at the same time. A sports bettor can now place a bet at the book and watch the game while they play, for example, blackjack. The patron can also leave the game to place another wager at the book, without losing their seat at the table. The Sports Pit puts into practice one of the solutions to the theoretical problem postulated by previous experts – that the sports book serves to feed into the other casino games.

Nover (2008) describes another way of incorporating the sports book with other gaming amenities, in which sports wagering is brought to the other-games bettor, rather vice versa at Harrah’s Sports Pit. He illustrates an integrated slot machine which provides a real-time dynamic betting environment. With Las Vegas Gaming Inc.’s WagerVision, the bettor is playing the video slot machine and may receive casino-generated prompts alerting them to a racing or sporting event whose start time is

approaching. If the customer elects to place a wager on the event, they can select the details of their ticket from the interface on the slot machine, and the wager amount will be deducted from their cash balance. The customer then has the option to watch the event in real-time on the video screen while continuing their slot game (Nover, 2008).

The Information Age

Even back in 1992, Lang & Roxborough were suggesting that sports bettors had access to more information than they had previously been able to obtain. This idea proves even more relevant now, in 2009, in the age of the Internet. Truly, race and sports gambling have come a long way since the days of hand-written tickets and chalk blackboards listing the various odds (Nover, 2008). The betting public now has easy access to information on a variety of factors that may influence the outcome of a sports game, such as injuries or personal events. If a starting quarterback recently went through a divorce, for example, bettors will be able to obtain the information and use it to judge how it may affect the outcome of a football game. Lang & Roxborough (1992) proposed that more knowledgeable bettors would be able to make more educated wagers, which could cut down on the casino's ability to profit.

Roxborough (1996) later touches on the subject of the sports bettor demographic, describing the typical patron as young, better educated, and with more disposable income. Not only that, but this typical bettor is willing to part with their cash not only at the sports book, but in other areas of the property as well.

More educated bettors may also contribute to increases in gaming volume by taking advantage of promotion situations in which the sports book is directly used as a

loss leader (Holtmann, 2006). With promotions that result in an overlay, wherein the customer knows there is more money being paid out than is going in, the casino is knowingly taking a hit with the hopes that the new patrons drawn to the promotion will also utilize the other property amenities. He does not, however, offer any suggestion that the casino managers provide any empirical proof for their belief in the profitable effects of the promotion. In the end, it is odd that the casino would consider an overlay to be a good promotion. There is no evidence provided that there is a noticeable difference between before and after the promotion is offered.

Holtmann (2006) also tells of a cross promotion relationship between Manga Entertainment, managers of several race tracks, and Youbet.com, a horse racing wagering website, in which several of Manga's financially suffering racetracks offered marketing events teamed with offers from the website. Sports betting online is currently illegal, since the United States Court of Appeals ruled that the Federal Wire Act prohibited sports wagering over the Internet (Thompson v. Mastercard, 2002). Before the ban, however, online wagering experienced an explosion of popularity (McCoy, 2002) and experienced great success. Some sports bettors have found a way around this ban, however. Companies have found their way into some loopholes in the law, by setting up base outside the United States. Some of these sites offer straight sports wagers with the house, while some offer something new: individual bettors are matched up to bet directly with each other (Nover, 2008). Matchbook.com, an online betting site of the World Sports Exchange in Antigua, eliminates the middleman by connecting bettors in this way. Unlike straight wagering with a bookmaker, there is no ten percent vigorish charged; the site takes a one or two percent commission on all final profit (Nover, 2008). Smart

bettors who recognize the importance of the reduced built-in house edge will likely start gravitating towards betting options like these.

It is also important to consider that should online wagering once again become legal, many new internet wagering sites are expected to crop up and land-based sports books may be facing further struggles to get patrons to leave the comfort of their own home to come to the casino property.

Importance of Slot Machines as Revenue Drivers

Slot coin-in is preferred as the dependent variable in this study because slot performance has been reviewed to be central to the continued success of most casino operations (Lucas et al., 2006). The term “coin-in” originally referred to the actual, physical coins that gambling customers would drop into a slot machine in order to pull the handle. In our more modern age, very few machines still accept coins, but the terminology still stands to describe the amount of money wagered on the slot floor (Brewer & Cummings, 1995). The term “slot machine” is used by the casino industry to describe any video poker, reel slot, multi-game, or video keno machine (Lucas & Brewer, 2001).

Brewer and Cummings (1995) found that slot revenues typically account for fifty (50) to eighty (80) percent of total casino revenue, a significant increase over their revenue contribution from years prior to 1995. The Nevada Gaming Control Board (2009) shows slot revenues reliably composing the vast majority of total gaming revenues of hotel casino properties outside the Las Vegas Strip and downtown markets, and still a very large portion of revenues in those two markets. Brewer and Cummings (1995)

additionally stated that casino operations managers are spending more time focusing on slot operations.

Along with the ever-rising popularity of slot machines, many studies have investigated methods to increase slot revenue. Lucas and Brandmeir (2005) studied the changes in customer satisfaction when the par value of a slot machine was increased. The par value is the casino's expected value associated with each slot machine's pay table, and is individualized to the specific slot machine. In video poker, the pay table is displayed to the player, from single- to max-coin wagers. In reel slots, however, the pay table, and therefore the par value, is unknown to the customer. Lucas and Brandmeir (2005) found that players did not notice a change in the machine when the par value was increased. That is, they found that a player's performances did not change significantly with a higher par value. They further suggest that an increase in par value allows the casino to acquire the player's bankroll more rapidly. They also concluded that the increase in par value failed to significantly increase the casino's share of the player's wallet – the player was not likely to be willing to increase their bankroll after their loss.

Kilby et al. (2005) went to a more individualized level, investigating how variations in hit frequency affected slot play. Hit frequency is defined as the proportion of spins in a slot machine's life during which the slot pays the player at least a one coin return. They found no relationship between hit frequency and pulls per losing player – that is, the hit frequency of the slot machine did not significantly influence the length of time the player sat at the machine (as defined by the number of pulls or spins the player completed before bankruptcy or a double bankroll). Kilby et al. (2005) considered losing or bankrupt players to value time-on-device as a proxy for monetary loss. Lucas, Singh,

and Gewali (2007) advanced this literature by investigating the patron's time-on-device when the par value was held constant but the standard deviation of the pay table was varied. Lucas et al. (2007) found, with much more compelling results, an inverse relationship between standard deviation of a pay table and pulls per losing player – an increase in standard deviation results in a decrease of time-on-device. Kilby et al. (2005) were not able to unearth evidence that an increase in hit frequency resulted in an increase in time-on-device. Having built on the research conducted by Kilby et al. (2005), Lucas et al. (2007) showed that the standard deviation of a pay table is a much stronger proxy of time-on-device than hit frequency. Gaming operations management could – to a point – lower hit frequency while keeping the standard deviation of the pay table at a lower level without significantly decreasing time-on-machine, an important factor to consider in conjunction with the conclusions of Lucas and Brandmeir (2005).

Lucas, Dunn, and Singh (2006) also examined the potential to increase slot revenues at an individual level by looking at the effects of direct mail incentives on trip slot play volume of individual players. They failed to find evidence that exhibited a positive slot play cash flow after the direct mail catalyst.

Floor layout and spatial attributes of games were found to have a significant impact on slot revenues (Lucas, Dunn, Roehl, & Wolcott, 2004). The highest performing slots were found near table games and exhibited easy access and visibility from the customer's typical walk through the casino floor. It is this concept that drives the idea of a sports book indirectly contributing to slot revenues – the patron must be both willing and able to move about the casino property's physical landscape and to use both gambling amenities.

Servicescape and Casino Atmospherics

There have been many general theories put forth regarding the impact of environment atmospherics on satisfaction. The ability of the physical environment to influence behaviors and to create an image is particularly apparent for service businesses such as hotels, restaurants, professional offices, banks, retail stores, and hospitals (Bitner, 1992). Bitner's (1992) now classic article speaks to the servicescape as the physical, manmade, built environment of a facility. This includes not only the physical layout of the space and the use of the allotted space, but also ambient conditions such as air temperature and quality, noise, music, scent, and lighting.

While her work does not specifically speak to the servicescape qualities of a sports book, it leads to an important insight to how having a stimulating sports book on the casino floor may increase the customer's satisfaction with their experience on the property. The complex environment of a sports book, let alone the entire casino floor, could create a microcosm in which stimuli serve as an incentive to patrons to engage in behaviors profitable to the casino. As a direct example derived from the hypothesis of the thesis, perhaps the casino atmospherics could induce sports book patrons to spend their money on slot machines in addition to their sports book bankroll.

Bitner (1992) also details how the dimensions of the servicescape act as a package deal, rather than as individual features. The patron is interacting with a dynamic environment, and it is possible that sports book patrons will be driven to spend their bankroll over the entire environment – including other casino amenities. How the company defines their servicescape can signal a particular market segment and help

customers differentiate between brands (Bitner, 1992), a theory which can be seen in practice at Harrah's Sports Pit (Berosh, 2008).

Wakefield and Blodgett (1996) found that servicescape was more important to the customer the longer they stayed in the environment, and as they participated in more leisure activities. A customer who felt very crowded was more likely to have a higher negative view of the servicescape (Underhill, 2008; Wakefield & Blodgett, 1996). The sports book is certainly a location on the casino property in which a customer can sit for long periods of time without having to stand up. They can place their bet at the window and then, if such amenities are available at their respective property, perhaps sit at a table with a private screen or in a wide club chair in front of a large television screen placed up on the wall. Sports books hold the potential to engross a patron for hours at a time. Given Wakefield and Blodgett's (1996) and Underhill's (2008) finding that the amount of time spent in the servicescape depends on their satisfaction with the facility aesthetics, the existence of a sports book holds the potential to drive customer satisfaction with the property.

Johnson, Mayer, and Champaner (2004) extended the concept of servicescape to the casino environment, examining atmospherics on the casino floor from the customer's point of view. They found a relationship between the elements of atmosphere and a slot player's satisfaction with their overall gambling experience. Because the customers are aware of these atmospheric effects on their own satisfaction, casino management needs to be even more aware of these aspects of casino design. Johnson et al. (2004) also found that the theme and décor of the environment, employee uniforms, and noise level contributed positively to a patron's satisfaction with their gaming experience. All of

these atmospheric elements could conceivably be influenced by sports book operations. It is theoretically possible that customers who come to the property to participate in gambling aside from the sports book may still feel the atmospheric effects of the sports book's presence. Given that this research finds that a sports book does not drive slot revenues, it would still be effective for casino operations to properly repurpose the space in a manner that adheres to those positively contributing aspects of casino design. It is not advised, however, that the casino consider its physical environment attributes to be the sole driver of patronage. A number of studies conducted in several United States casino markets found convenience of location to be a primary decision-making criterion for patron choice of a casino property (Richard & Adrian, 1996; Turco & Riley, 1996; Pfaffenburg & Costello, 2001; Shoemaker & Zemke, 2005). After all, casino managers cannot simply lift up the property and move it down the street.

While servicescape study has not yet been applied to sports books setting, Cockrill, Goode, and Emberson (2008) applied its concepts and effect on consumer behavior to betting shops in the United Kingdom. Betting shops, while very different in feel from sports books, have many similarities in how bets are accepted as well as the way in which the games are played out on televisions near the betting windows. Cockrill et al. (2008) found that patrons of United Kingdom betting shops were unaffected by many elements of servicescape, such as ambient conditions, spatial layout, and functionality of space. They did find, however, that staff knowledge made a significant impact on the individual customer's experience. Once again, it is plausible that the sports book will have an effect on customers' interpretation of the property's servicescape. If

the sports book is contributing to the quality of the servicescape in a positive way, it could contribute to higher gaming revenues; the converse is also true.

Indirect Drivers of Slot Revenues

Casino Games

Lucas and Brewer (2001) examined a theoretical model designed to explain the variation in daily slot handle at a locals market casino in Las Vegas, including, among other non-gaming independent variables, bingo headcount. Using a regression model to look at variables that had been hypothesized to influence slot handle by previous research, Lucas and Brewer found that several variables produced a significant effect on daily slot handle, including bingo headcount. They determined that while each one-unit increase in bingo headcount produced a \$17 increase in daily slot coin-in, the positive effect of the bingo gaming amenity could not ultimately overcome the annual loss the department incurred. Lucas and Brewer also found that temporal variables appeared to be strong predictors of slot coin-in.

Lucas et al. (2006) expanded upon Lucas and Brewer's (2001) conclusions, focusing specifically on the contribution of bingo rooms to slot coin-in. Lucas et al. also examined data provided by repeater market casinos, and used regression analysis to determine that bingo was not a positive significant contributor to slot coin-in, and yet it was used as a loss-leader – that is, the bingo room had negative revenues and was using valuable floor space that could otherwise be used by more profitable gaming amenities.

Ollstein (2006) used a similar methodology to examine the indirect gaming contribution of poker to slot coin-in. Unlike the research on which his study was based,

Ollstein used data from a Las Vegas Strip casino property, part of a tourist/transient market rather than a repeater market. Similar to the results of Lucas and Brewer's (2001) research, Ollstein found his independent variable, poker rake, to serve as a legitimate driver of slot revenue. Like Lucas and Brewer (2001), however, he questioned the marginal financial benefit. Ollstein found that a one-unit increase in poker rake yielded a \$5.63 increase in win, i.e. revenue, accounting for 0.075 par value on slot machines, which he considered to be a minor effect, and encouraged casino operations management to consider alternative gambling amenities in order to maximize the cash flows from the valuable casino floor space. While there has been analysis on many different potential drivers of slot revenues, sports book performance has not been investigated. This study will add yet another important dimension to casino operations literature.

Restaurants

There is not an extensive list of previous published research on the topic of sports book operations, but as we have seen above there is some research specific to other gaming operations. In addition, there is also research estimating the indirect gaming contribution of other non-gaming casino amenities. Similar to the loss-leader role of bingo and the borderline profitability of poker rooms, non-gaming amenities like restaurants can serve as an attraction to gamblers to keep them on the property for longer periods of time. Lucas and Santos (2003) tested the assumption that considerable food department losses are justified by operations executives in that they believe the food offers drive incremental slot play. Lucas and Brewer (2001) had previously found that food covers did not significantly increase slot coin-in. Lucas and Santos (2003) found that casino-operated restaurant business volume had a significant effect on slot coin-in –

though they noted cash and complimentary (comp) food covers had been included in their model and postulated that the inclusion could have inflated the correlation between restaurant and gaming volumes.

Roehl (1996) surveyed Las Vegas residents and compared their self-reported gaming volumes with their restaurant and entertainment patronage. The study provided support of the theory that different types of amenities attract a more valuable type of gambler – there were significant differences found between the gaming practices of coffee shop and gourmet restaurant patrons and those patrons who did not dine in the casino restaurants. Further significant differences were found between large- and small-scale show patrons and those patrons who did not attend any of the casino show offerings. Roehl (1996) concluded that although some amenities failed to demonstrate a contribution to gaming revenues, this may not be justification for their removal. If the amenity still generates revenues greater than the operating costs, it still could be a valuable addition to the property as long as more profitable use of space is not available. Insufficient profit levels may not appeal to casino operators, particularly in the absence of evidence of an amenity's indirect contribution to other revenues. It is through this logic that the analysis of a sports book amenity on the casino property progresses.

Theoretical Model

The theoretical model depicted in Figure 1 is derived from the literature review of models proposed in an attempt to describe the variations in daily gaming volumes (Lucas, 2004; Lucas & Bowen, 2002; Lucas & Brewer, 2001; Lucas et al., 2006; Lucas & Santos, 2003). Lucas and Santos (2003) used a very similar theoretical model to investigate the

effect of match-play promotions on the daily cash drop of blackjack games in a Las Vegas Strip casino property. Lucas and Brewer (2001) and Lucas and Bowen (2002) both successfully account for variations in slot volume; both models explain 87% of the variations in slot volume, with very similar models. Most research designed to explain variations in gaming volume uses time series analysis and includes seasonality variables like day of the week and holiday periods. Variables which are known to contribute to multicollinearity in accordance with day of the week, such as hotel occupancy and restaurant headcount, are not included in the model. Such variables are related to associated business volumes and may exhibit collinear behaviors (Lucas & Kilby, 2002).

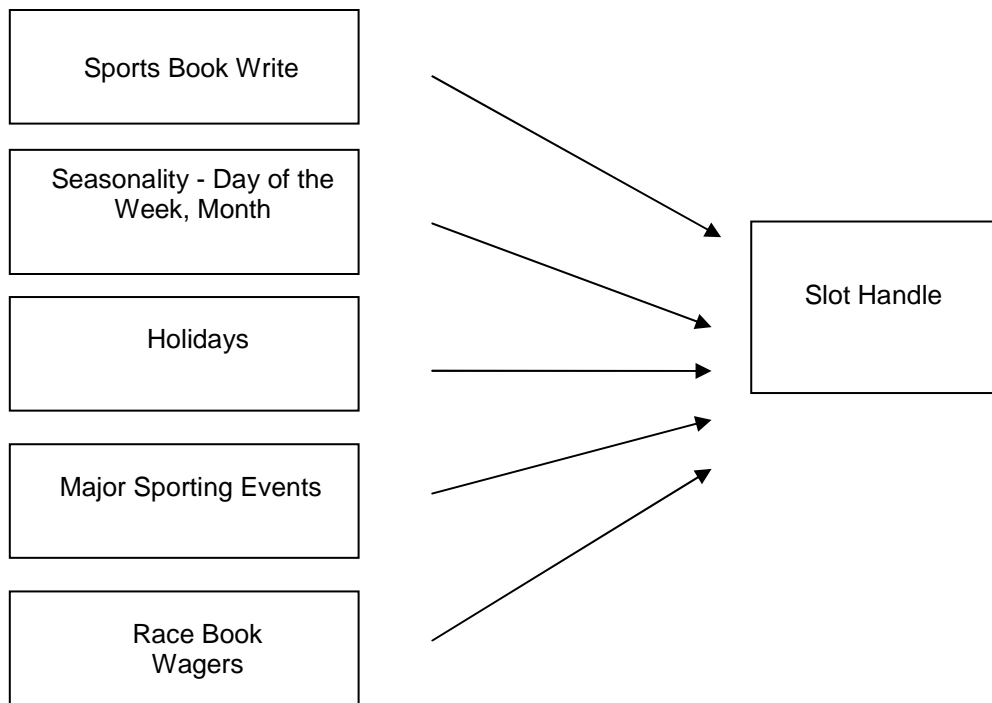


Figure 1. General theoretical model for analysis.

Aggregate daily wagers placed at the sports book, represented by Sports Book Write, describes daily sports book wagering volume. Estimating the effect of this variable on the model is the primary purpose of the study. In order to account for other factors that may influence the dynamic environment in which variations in slot gaming volume may occur, other variables are included in the theoretical model. All variables are described in further detail in the methodology section. Seasonality is described by day of the week, monthly, and holiday period binary variables. The day of the week and holiday variables were found to be powerful contributors to the analytic models used in Lucas and Brewer (2001), Lucas and Bowen (2002), Lucas and Santos (2003), and Lucas (2004). Major sporting events are also represented in binary format, to account for volume changes that occur based on promotions and extra leisure days.

Race book wagers are included in the theoretical model separate from sports books wagers as the type of bet and therefore the house edge in a race wager is very different from a sports wager. As sports and race wagers are placed at the same location, the author posits that variations in sports wagering will mirror large differences in race wagers. This is described further in the methodology section, chapter 3.

Hypothesis

Based on analysis of the literature, the null hypothesis is described as the following:

$$H_0 : \beta_{SportsBookDailyWagers} = 0$$

Null Hypothesis: There is no relationship between the dollar value of aggregate daily wagers for the sports book and aggregate daily slot handle.

CHAPTER 3

METHODOLOGY

Data Sources

One Las Vegas repeater market hotel casino provided the secondary data applied to the theoretical model described in Chapter 2. The hotel casino operates a sports book but relies on slot machines as the primary source of their revenues. All variables presented in the data set were subject to both internal and external audits. The data set includes daily results across a 250-day period, beginning on January 1, 2009, and ending on September 7, 2009.

The casino property described its sports book as a profitable operation – the Sports/Race Book Department has a profit margin near 35%. The actual dollar amount of sports book profit, however, is miniscule when compared to that of slots; it totals approximately 2% of slot profit.

Data Analysis

The data were screened in R, an open source statistical software package, to ensure accuracy of data entry, missing values, normality of the distribution, and goodness-of-fit between distributions. Line graphs of aggregate daily sports book wagers were evaluated for occurrences of seasonality. The formal data analysis was also conducted using R, which allows for the user to address the serial correlation of error terms that is often present in time series data analysis. The hypothesis was initially tested via simultaneous multiple regression analysis at the 0.05 alpha level. The simultaneous multiple regression analysis allows the null hypothesis to be tested while permitting for

the potential influence of variables with a theorized or actual impact on slot machine revenues. Following the hypothesis testing, the model was tested for multiple regression assumptions via assessments of diagnostics and error-term scatter plots. Because these diagnostic tests determined the standard regression model was unfit for the data, an ARIMA analysis was run on the data set, and further diagnostic tests were administered to ensure the new model was appropriate for the data set.

Expression of the Criterion Variable

Aggregate Daily Slot Coin-in

Aggregate daily slot coin-in (ADSC) represents the dependent variable in the model data set, identified as “Daily Slot Handle,” and is defined as the dollar amount of wagers made on all coin- or voucher-operated gaming devices currently active on the casino floor. The casino property analyzed offered a number of different slot machine systems at the time of data capture, including video keno, video poker, video blackjack, reel slots, and progressive systems.

Expression of Predictor Variables

Aggregate Daily Wagers Placed at the Sports Book

Aggregate daily wagers placed at the sports book is represented by the “Daily Sports Book Write” variable. Unlike in most casino games, the casino is not betting against the patron in sports bets. In sports betting, the house isn’t interested in the actual odds of the game. Rather, they are interested in offering a betting line that attracts an equal dollar amount of wagers to each side of the match, also known as the proposition.

The casino's profit comes from the commission, usually referred to as the "juice" or "vigorous," which is charged on each bet made. If the casino fails to properly set the betting line, and a larger amount of wagers is placed on the winning side, the house will take a loss. Because of this, the casino will move the line as game time approaches to induce wagering on the under-bet side.

It is proper to use the incoming wagers as a measure of sports book betting activity rather than the aggregate of paid out win tickets for all cases, because win tickets paid out to patrons are dependent on game outcome and on the casino's payoff odds, which vary as the line moves. In addition, the book will take many variants on the standard win/loss line bet, including but certainly not limited to point spreads, parlays, teasers, and futures.

Seasonality

Seasonality is described by day and month binary variables. Seasonality is innately present in sports book wagering, because unlike most casino game wagers, which do not change as time passes, sports wagering options are different not only by month, but by day. Day of the week indicator variables have been found to produce significant effects on casino volumes in several studies (Lucas & Brewer, 2001; Lucas & Bowen, 2002; Lucas & Santos, 2003). Many special events often occur on weekends, when most of the population has more leisure time, than during the week. Moreover, due to the varying line up of sports games available for wagering by day and by month, aggregate sports book wagering could fluctuate over time.

Holiday Periods

Holiday periods are expressed in binary format, to account for gaming volume changes that occur during holiday periods that transpire throughout the data gathering period. Each holiday variable is expressed as a series of one or more days, as the day of the week on which the actual holiday falls can affect the gaming volume on days prior to or following the holiday itself. Holiday periods are theoretically tied to an increase in patron leisure time and as such to an increase in gaming volume. In past studies, holiday variables such as these have been found to produce significant effects on gaming volume (Lucas et. al., 2006).

Major Sporting Events

Major sporting events are also expressed in a binary format. They serve as indicator variables to explain variations in gaming volume that occur when major sporting events draw in a crowd that may temporarily inflate that day's or set of day's sports wagers. Each variable recorded a binary success for the specific day or days on which the sporting event occurred, and a binary failure for all other days. Because a sporting event could conceivably elevate gaming volume levels beyond the scope of a single day, some major sporting events were depicted within the indicator variable over a period of days, rather than just the day on which the event took place. Major horse racing days were also included in the sports book model, even though race wagers are taken separately from sports wagers. The wagers can still be made in the same physical location and their inclusion may account for any increases in sports wagering volume that may have occurred due to the effect of additional wagering options available to the patron

whose attendance is based primarily on the racing event. A compilation of the sporting event indicator variables included in this model can be found in Table 1.

Table 1

Major Sporting Events Included in the Model as Indicator Variables

Event	Date(s)
Super Bowl – National Football League	February 1, 2009
National Basketball Association All Star Game	February 15, 2009
March Madness – NCAA Championships, Basketball	March 26 – March 29, April 4, April 6, 2009
The Masters Golf Tournament	April 6 – April 12, 2009
Kentucky Derby – Horse Racing	May 2, 2009
Preakness Stakes – Horse Racing	May 16, 2009
Indianapolis 500 – Motor Sport	May 24, 2009
National Basketball Association Championships	June 4, June 7, June 9, June 11, June 14, 2009
Belmont Stakes – Horse Racing	June 6, 2009
US Open – Professional Golfers Association Tour	June 15 – June 21, 2009
Wimbledon Championships – Tennis	July 4 – July 5, 2009
Major League Baseball All Star Game	July 14, 2009

Aggregate Race Book Win

Aggregate race book win represents the revenue earned by the casino on race book wagers. The type of bet, and therefore the house advantage, in a race wager is very different from a sports wager. A race wager is a pari-mutuel wager, wherein all wagered money goes into a pool, and the proportion of money in the pool that is wagered on each entrant in the race determine its odds. After the race, all money is paid out from the pool to winning tickets, after a cut is taken by the house. In essence, a race bettor is wagering against other race bettors. In a sports bet, the bettor is wagering against the house, and pays for their wager plus a vigorish, which is essentially a payment to the house for the privilege of placing the bet. A winning sports wager is paid by the house according to the odds at the time the wager was placed.

CHAPTER 4

RESULTS

Data Screening

Many preliminary diagnostic tests were run on the data set before performing the initial regression analyses, in order to test the basic assumptions of a general regression model. First, a plot was constructed to investigate the existence of a linear relationship between slot handle and sports write, as seen in Figure 2. An inspection of Figure 2 shows evidence of a possible linear relationship that is made rather unclear due to one extreme outlier. It is important to acknowledge this outlier, which happens to be the day of the Super Bowl. As noted in the methodology section, the Super Bowl is taken into account in the model with an indicator variable.

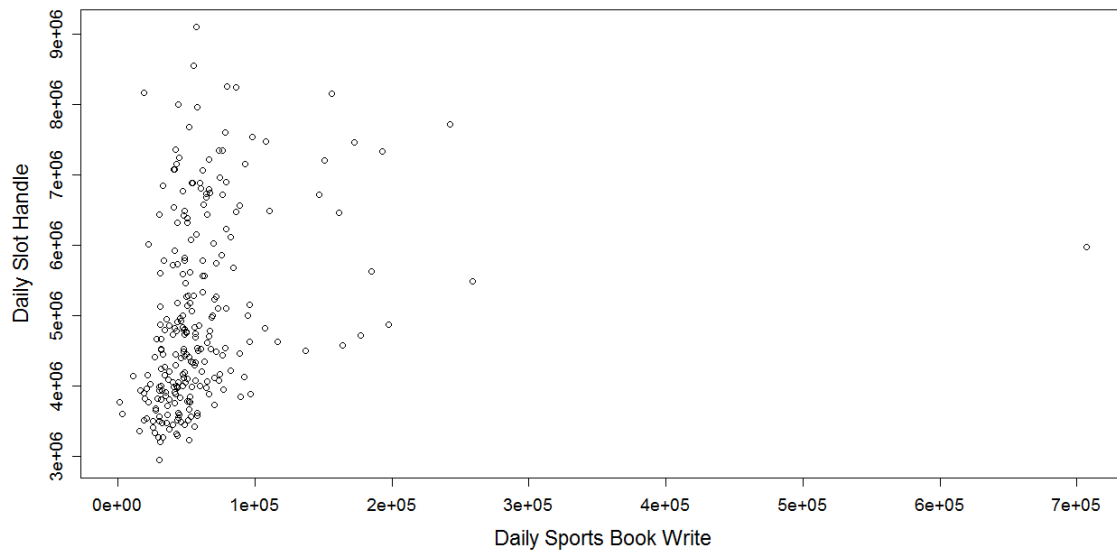


Figure 2. Scatterplot of Daily Slot Handle and Daily Sports Book Write.

The plot of Slot Handle and Sports Write was also inspected after the outlier had been removed, as seen in Figure 3. Figure 3 shows a clearer picture of the relationship between Slot Handle and Sports Write, and there is evidence that while a linear relationship exists between the two variables, there is concern over a number of outliers which appear to be skewed in a highly positive direction. As a result, the indicator variables are included in the model in an attempt to address these outlier occurrences. Table 2 below shows a frequency count of the indicator variables that were ultimately used in the model to account for noise in the data set, including month, day, holiday periods, and major sporting events.

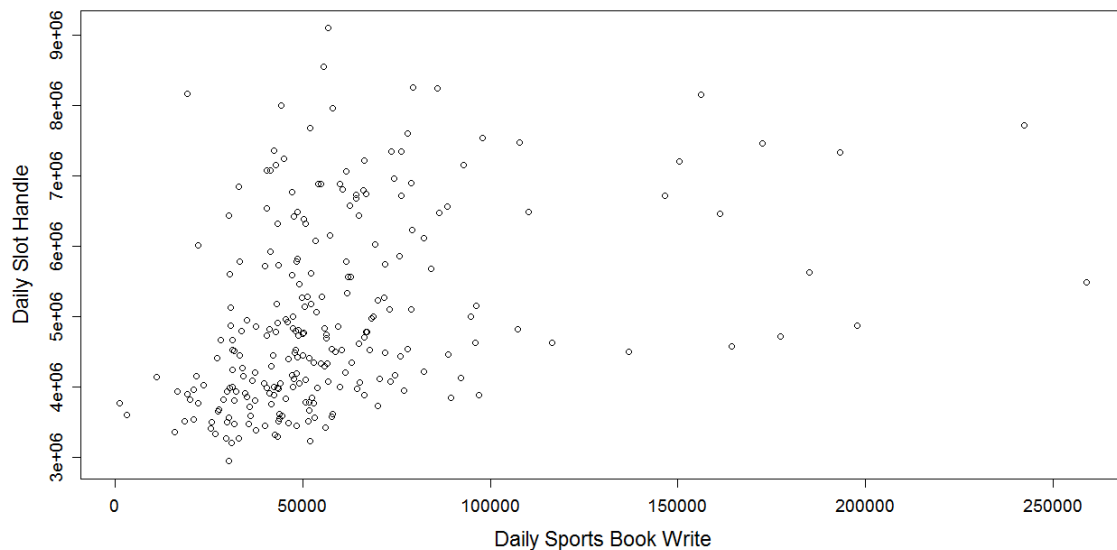


Figure 3. Scatterplot of Daily Slot Handle and Daily Sports Book Write with outlier removed.

Table 2

Frequency Statistics of Significant Indicator Variables

Variable	f^a
February	28
April	30
May	31
August	31
Wednesday	35
Thursday	36
Friday	36
Saturday	36
Sunday	36
New Years Weekend	4
Martin Luther King, Jr. Weekend	3
President's Day Weekend	3
Memorial Day Weekend	4
Labor Day Weekend	3
Indianapolis 500	1

Note. ^a Frequency of indicator variables. Each day of occurrence was assigned a value of one.

Once a linear relationship has been established, the next step taken is to run histograms in order to establish the data's normality. Figure 4 exhibits the histogram of slot coin-in, and demonstrates a positively skewed distribution. This finding is typical of

gaming data, and is not a cause for concern. There are a few outliers identified, to be kept a careful eye on when processing the model. The histogram of daily sports book write, Figure 5, also indicates a positively skewed distribution. Once again, this finding is not unusual for gaming data and does not indicate a serious departure from normality. In Figure 5, however, it is very easy to see the outlier that had so seriously distorted the plot of slot handle against sports write. When this outlier is removed, the histogram of daily sports book write shows a more apparent view of the positively skewed distribution, as well as identifying several other outliers (see Figure 6).

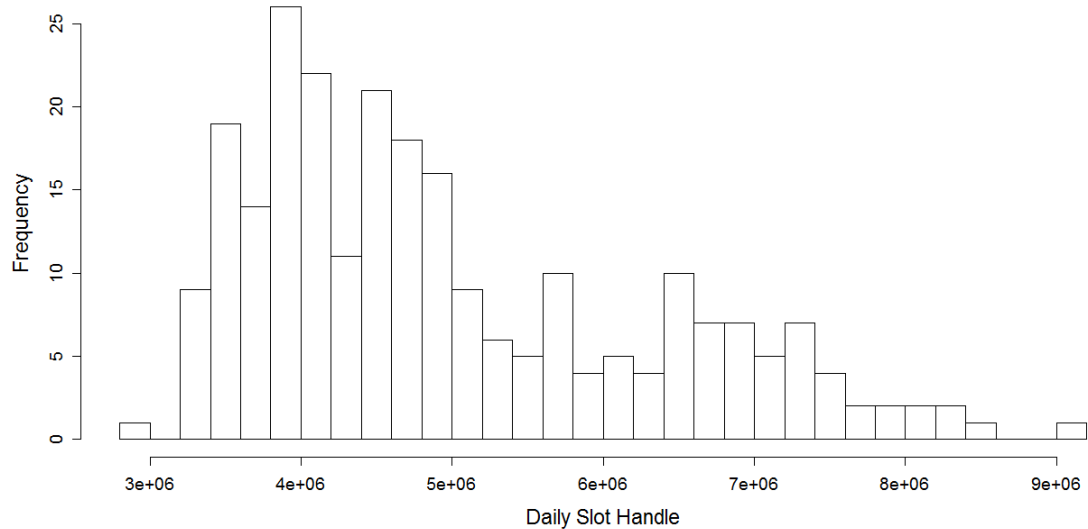


Figure 4. Histogram of Daily Slot Handle.

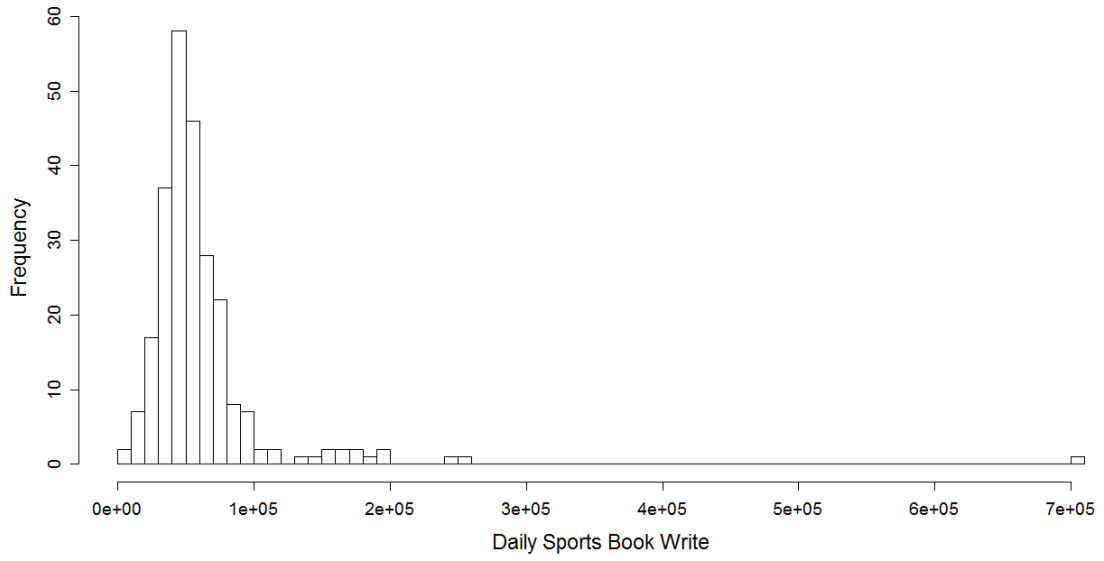


Figure 5. Histogram of Daily Sports Book Write.

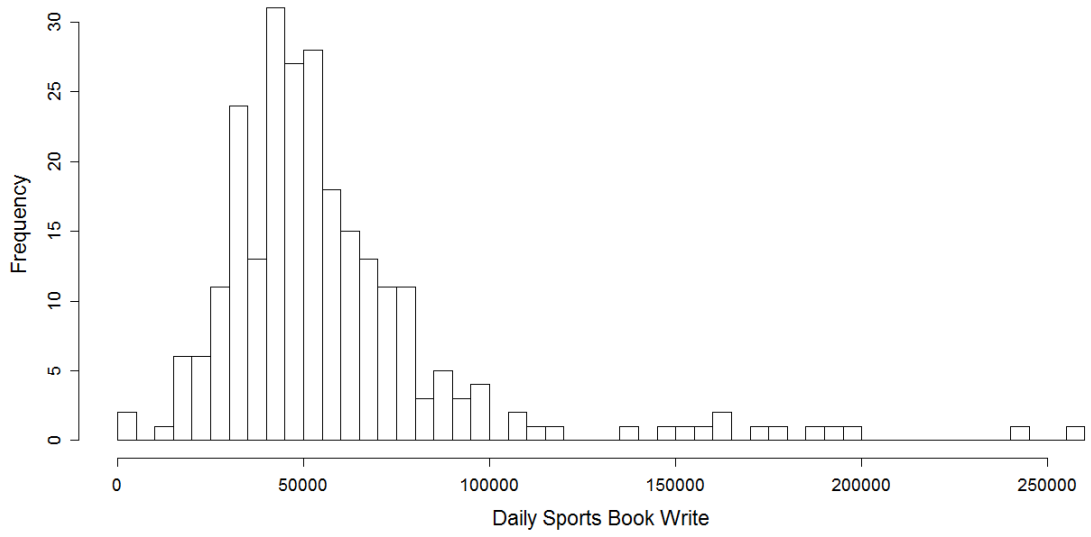


Figure 6. Histogram of Daily Sports Book Write with outlier removed.

After the plots and histograms have been examined for linearity and normality and outliers have been acknowledged, descriptive statistics of the data were assessed for further analysis. Table 3 is comprised of a summary of the descriptive statistics for daily slot handle, the dependent variable, and daily sports book write, the independent variable.

Table 3

Descriptive Statistics for Major Dependent and Independent Variables

Variable	Minimum	Maximum	Mean	Median	Standard Deviation
Daily Slot Handle	2,944,266	9,093,829	4,989,531	4,629,077	1,324,044
Daily Sports Book Write	1,221	707,252	60,867	50,474	54,284

Note. All values are measured in U.S. Dollars (\$).

A line plot of Daily Slot Handle against time (see Figure 7) was examined to search for seasonality trends across the time period of the data. Within Figure 7 can be seen a nearly constant pattern of slot handle, which incurs a small but continual downward slope starting at around day 150, which is approximately the beginning of June. A trend variable was added to the model to account for this finding. The trend variable was specified by categorizing the first day of the data, January 1, 2009, with a value of one and increasing the value of “trend” by one unit for each day through September 7, 2009. For this data set, therefore, “trend” ran sequentially across the range from one to 250. This will help to eliminate some of the noise that is inherent in the time series model.

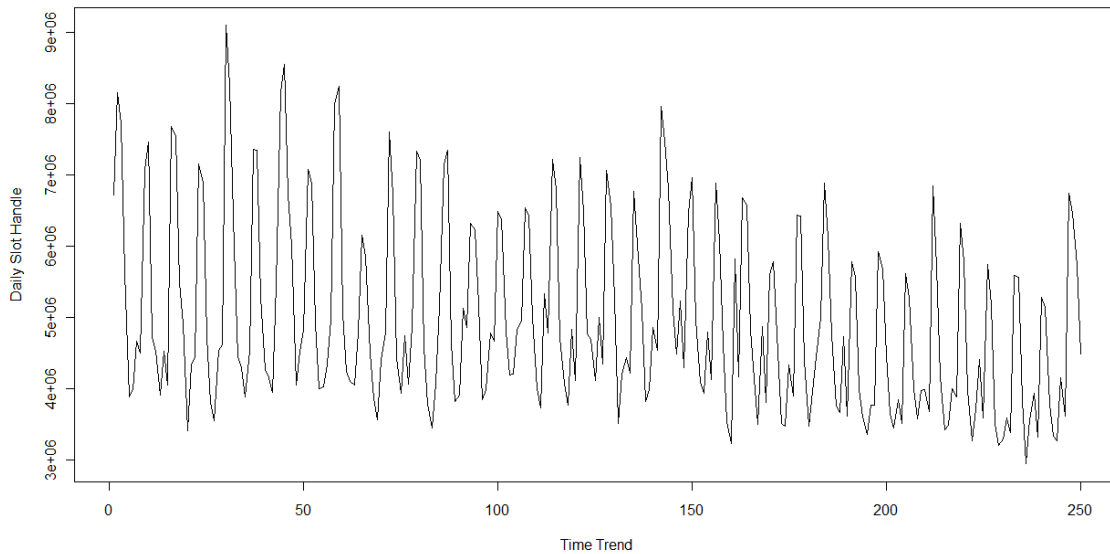


Figure 7. Line plot of Daily Slot Handle over time.

Regression Analysis

The regression model produced a multiple R^2 value of 0.896, and an adjusted R^2 value of 0.889, both very high and indicating the model is substantial. The model F statistic of 117.8 is significant ($df = 17, 232$, $p\text{-value} < 0.00001$). The results of the initial linear regression analysis are summarized below in Table 4. All variables shown in Table 4 mark significant effects on the dependent variable, Daily Slot Handle, with the notable exception of Daily Sports Write, which was significant at the 0.10 alpha level but not at the 0.05 alpha level. Because this is exploratory research, there is more concern with not detecting a true relationship than falsely rejecting a true null hypothesis. As such, Daily Sports Write stays in the model at this point as the p-value of its coefficient is less than 0.10. The β coefficient values for the month of August and the trend variable indicate a negative effect on the model. The negative effect suggested by the trend

variable does not come as a surprise, as this variable was included in the model to accommodate for the downward slope noted in Figure 7. It is important to note that Daily Race Win did not have a significant effect on Daily Slot Handle in this model and was removed from the regression analysis at an early stage. Following this point, Daily Race Win was not given specific consideration in analysis due to its very low levels of significance. All coefficients for indicator variables in Table 3 are significant at the 0.05 alpha level, and most are significant at least at the 0.001 alpha level. For all other independent variables, the β coefficients suggest a positive effect on Daily Slot Handle.

Table 4

Summary of Regression Analysis for Independent Variables Predicting Daily Slot Handle

Variable	β Estimate	β Standard Error	P-Value	
Intercept	4,188,000	96,630	$< 2 \times 10^{-16}$	***
Daily Sports Write	1.155	0.5957	0.05385	
February	242,300	106,500	0.0238	*
April	182,700	90,880	0.0455	*
May	294,900	94,540	0.0020	**
August	-286,600	106,200	0.0075	**
Wednesday	621,700	91,770	1.02×10^{-10}	***
Thursday	489,100	91,490	2.15×10^{-07}	***
Friday	2,922,000	91,380	$< 2 \times 10^{-16}$	***
Saturday	2,545,000	93,440	$< 2 \times 10^{-16}$	***
Sunday	760,600	96,330	1.15×10^{-13}	***
Trend	-3,574	560.50	9.66×10^{-10}	***
New Years Weekend	983,000	243,600	6.94×10^{-5}	***
Martin Luther King, Jr. Weekend	598,900	268,000	0.0264	*
President's Day Weekend	1,674,000	273,000	3.68×10^{-9}	***
Memorial Day Weekend	953,700	270,700	0.0005	***
Labor Day Weekend	1,064,000	270,100	0.0001	***
Indianapolis 500	1,056,000	518,300	0.0427	*

Note. *** < 0.001, ** < 0.01, * < 0.05

Diagnostic Tests on Multiple Regression Analysis Assumptions

Once the model had been run, the results were examined for violations of the regression assumptions employed when performing this type of analysis. Table 5 below summarizes the variable inflation factors (VIFs) associated with each independent variable in the model. VIF values for all independent variables are low, which indicates there is no problematic multicollinearity in the model.

Table 5

Summary of Variable Inflation Factors for Independent Variables Utilized in the Final Regression Model

Variable	VIF
Intercept	--
Daily Sports Write	1.3330
February	1.4441
April	1.1162
May	1.2425
August	1.5685
Wednesday	1.2977
Thursday	1.3204
Friday	1.3173
Saturday	1.3774
Sunday	1.4638
Trend	2.0937
New Years Weekend	1.1860
Martin Luther King, Jr. Weekend	1.0900
President's Day Weekend	1.1306
Memorial Day Weekend	1.4764
Labor Day Weekend	1.1069
Indianapolis 500	1.3696

The model residuals were tested for normality using a normal Q-Q plot, as seen in Figure 8. Because the line of residuals is approximately linear with few outliers, the plot fails to indicate a significant departure from a normal distribution. These outliers occur on the day of and days surrounding the Super Bowl, and the NBA Finals from mid-June.

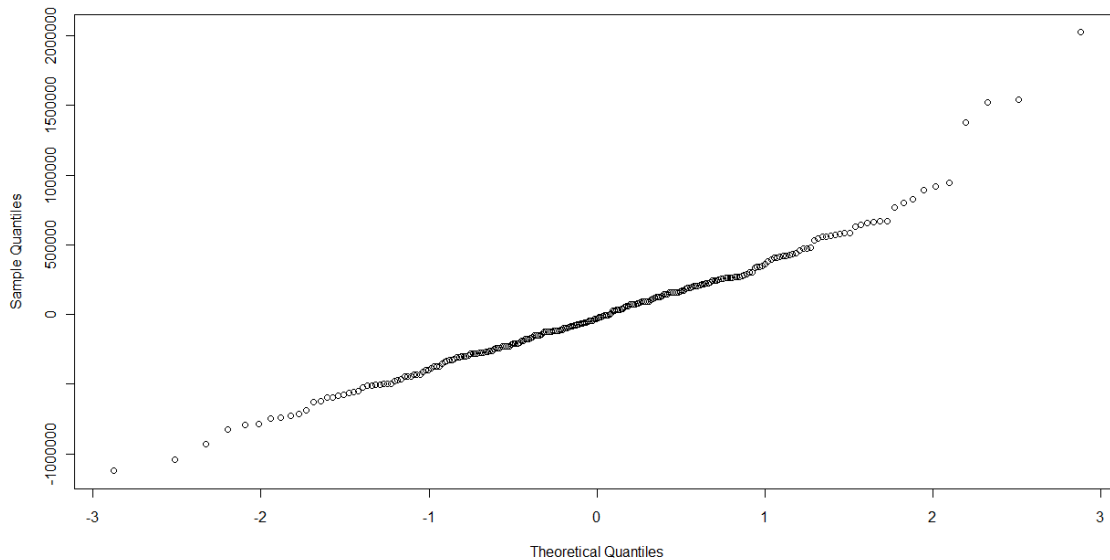


Figure 8. Normal Q-Q plot on regression model residuals.

Finally, the autocorrelation function (ACF) and partial autocorrelation function (PACF) were graphed to look for serial correlation within the data set, a typical problem with time series models. Because the value of Daily Slot Handle observed at any given time t_i may depend on values observed at other points in time, time series data tends to violate independence assumptions of a linear regression model. Figures 9 and 10 exhibit the ACF and PACF plots. Because these plots indicate serial correlation, an Autoregressive Integrated Moving Average (ARIMA) analysis was run on the model.

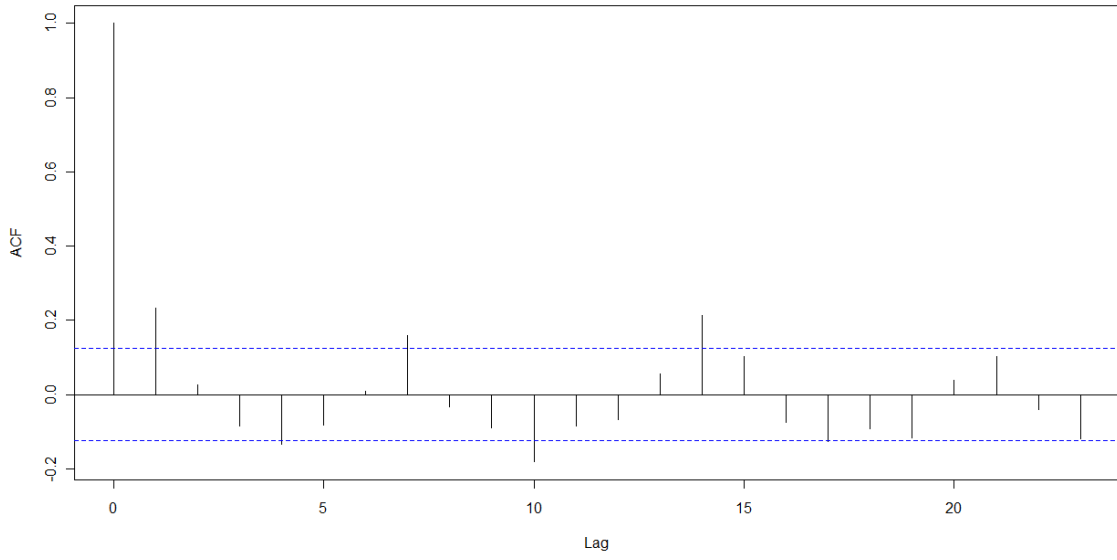


Figure 9. Autocorrelation plot of residuals from final regression model.

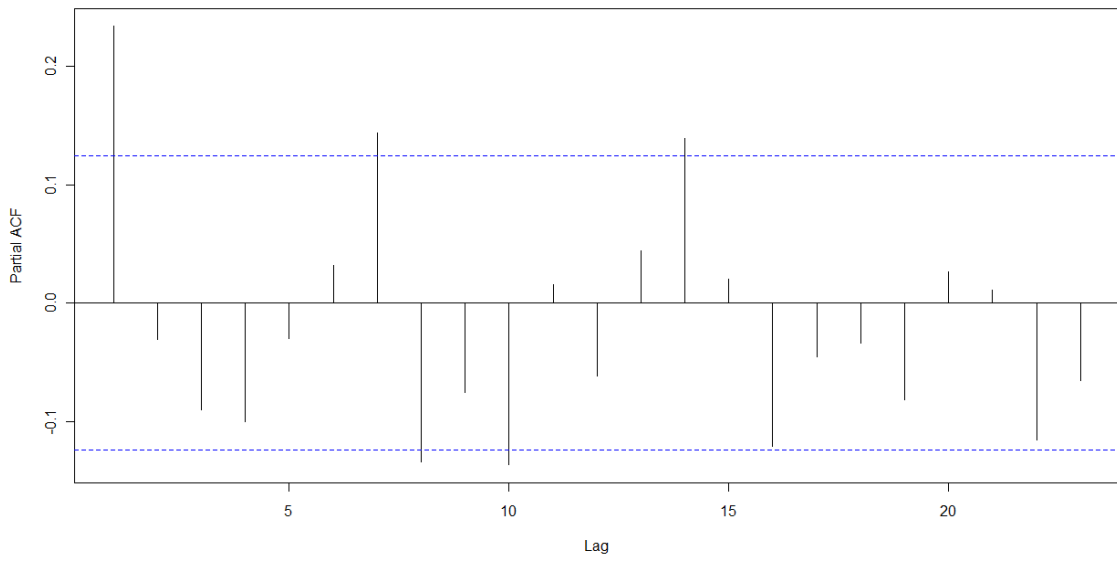


Figure 10. Partial autocorrelation plot of residuals from final regression model.

ARIMA Time Series Analysis

The ARIMA model is used to uncover lags and shifts in the data that occur over time, and uses patterns like moving averages and seasonality to generate a prediction model. The ARIMA model accounts for temporal dependence found in seasonal and systematic trends in several ways, as described by Grimmer's research in R (as cited in Imai, King, & Lau, 2007). Within the R statistical program, a time series data set is differenced to render it stationary, then the time dependence of the stationary process is modeled, including autoregressive and moving average terms, as well as any other time-dependent covariates. When utilizing an ARIMA model, the trend variable is dropped and thus will not appear in tables below. This is because the "integrated" ARIMA already accounts for trend found in time series during its formulations. An examination of Figures 9 and 10 indicate the presence of a moving average component of 2, due to significant spikes at early lag periods. The ARIMA model notation takes the form of ARIMA (p, d, q), in which p represents the order of the autoregressive (AR) part, d represents the order of the integrated differencing (I), and q represents the order of the moving average (MA) process. When the trend variable is incorporated in the model, d will equal zero. To simplify the process, attempts are made to select a model in which the ARIMA component orders of a degree less than or equal to two.

An ARIMA(0,1,2) model was fitted on the data set, and included all independent variables that had been found significant in multiple regression. ARIMA (0,0,1) and ARIMA (0,0,2) models were also fitted to the data, but after analyzing the Akaike Information Criterion (AIC) for those models, the ARIMA (0,1,2) model was selected for use. When using the AIC as a selection criterion, the lowest value is considered the most

ideal, as the AIC is a measure of the information lost when a model is used to simulate reality. The first ARIMA (0,1,2) model run included all significant independent variables, including Daily Sports Write. The trend variable was not included in the ARIMA model for the reasons specified above. When it was found that Daily Sports Write was not significant in the model (as specified in Table 6), the final model was run to ensure goodness of fit without the author's primary investigative independent variable. In addition, the indicator variables that had been found significant in the initial linear regression – April and May – were found to be insignificant in the ARIMA (0,1,2) analysis and were removed from the final model.

Table 6

Summary of ARIMA Time Series Analysis for Variables Predicting Daily Slot Handle

Variable	β Estimate	β Standard Error	P-value	
MA(1)	-0.6997	0.0592	$< 2 \times 10^{-16}$	***
MA(2)	-0.2399	0.0584	3.95×10^{-5}	***
Daily Sports Write	0.5883	0.5592	0.2927	
February	281,639.9	139,613.3	0.0436	*
April	116,971.0	143,283.3	0.4143	
May	234,942.9	145,310.0	0.1059	
August	-322,927.9	155,854.6	0.0382	*
Wednesday	640,385.1	83,971.2	2.41×10^{-14}	***
Thursday	495,051.9	91,981.0	7.36×10^{-8}	***
Friday	2,926,593.7	91,919.1	$< 2 \times 10^{-16}$	***
Saturday	2,565,578.2	93,707.8	$< 2 \times 10^{-16}$	***
Sunday	777,911.3	88,407.4	$< 2 \times 10^{-16}$	***
New Years Weekend	1,222,242.4	278,403.1	1.13×10^{-5}	***
Martin Luther King, Jr. Weekend	743,465.1	290,725.4	0.0105	*
President's Day Weekend	1,599,555.5	292,866.5	4.72×10^{-8}	***
Memorial Day Weekend	935,408.3	276,636.9	0.0007	***
Labor Day Weekend	872,329.3	322,928.1	0.0069	**
Indianapolis 500	1,070,388.2	433,307.4	0.0135	*

Note. *** < 0.001 , ** < 0.01 , * < 0.05 . Maximum Likelihood Error (MLE) of the innovations variance is estimated at 1.799×10^{11} . Maximized log-likelihood = -3,580.8. AIC = 7,199.59.

Diagnostic Tests of ARIMA Analysis

ACF (see Figure 11) and PACF (see Figure 12) residual plots for the final ARIMA model – without Daily Sports Write included – were reviewed, and show the elimination of a significant peak at lags 1 and 4, although the ACF plot shows significant peaks still remain in the model at lags 7, 10, and 14. A review of the PACF also indicates significant peaks at lags 7, 10, and 14. Because these peaks are not extremely far outside the cutoff region, they do not take away significant value from the model, but it is important to note that there could be issues with correlation between day of the week in the data set.

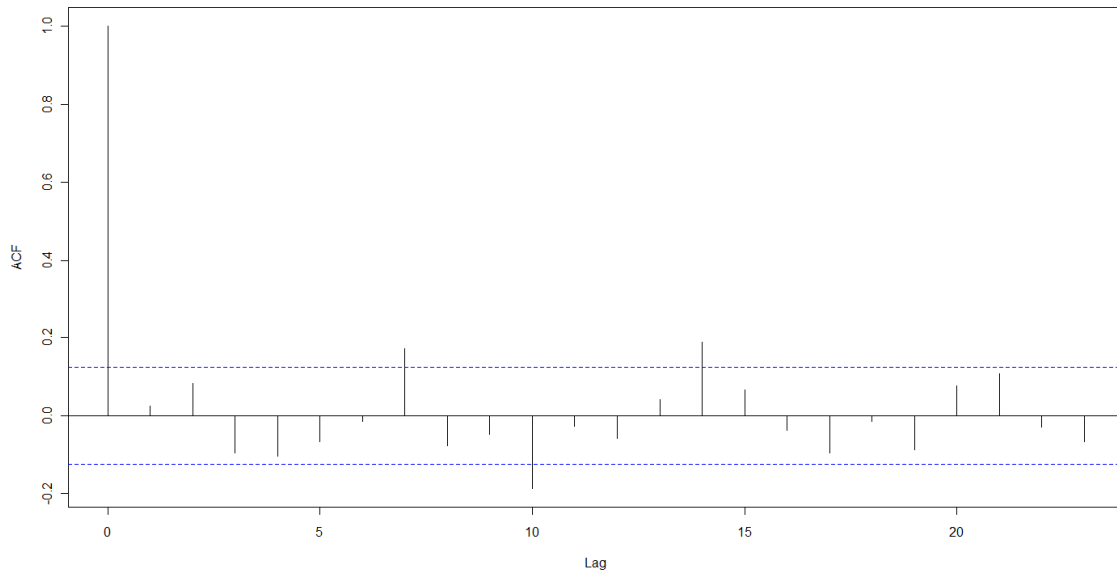


Figure 11. Autocorrelation function residual plot of ARIMA (0,1,2) model.

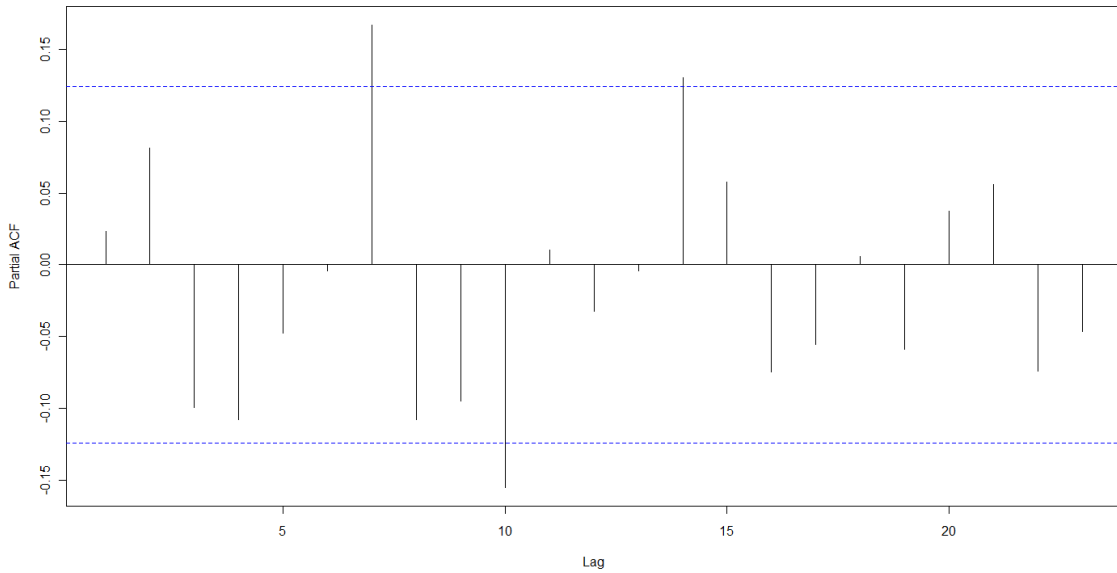


Figure 12. Partial autocorrelation function residual plot of ARIMA (0,1,2) model.

As before with the multiple regression model, a normal Q-Q plot (see Figure 13) was examined to ensure the model residuals adhere to a normal distribution, a requirement of a sound goodness of fit. Figure 13 indicates that the residual errors of the ARIMA model follow a normal distribution, as the residuals follow an approximately linear pattern with only a few outliers towards higher positive quantiles. Once again, the outliers that appear occur on the day of and days surrounding the Super Bowl and the NBA Finals.

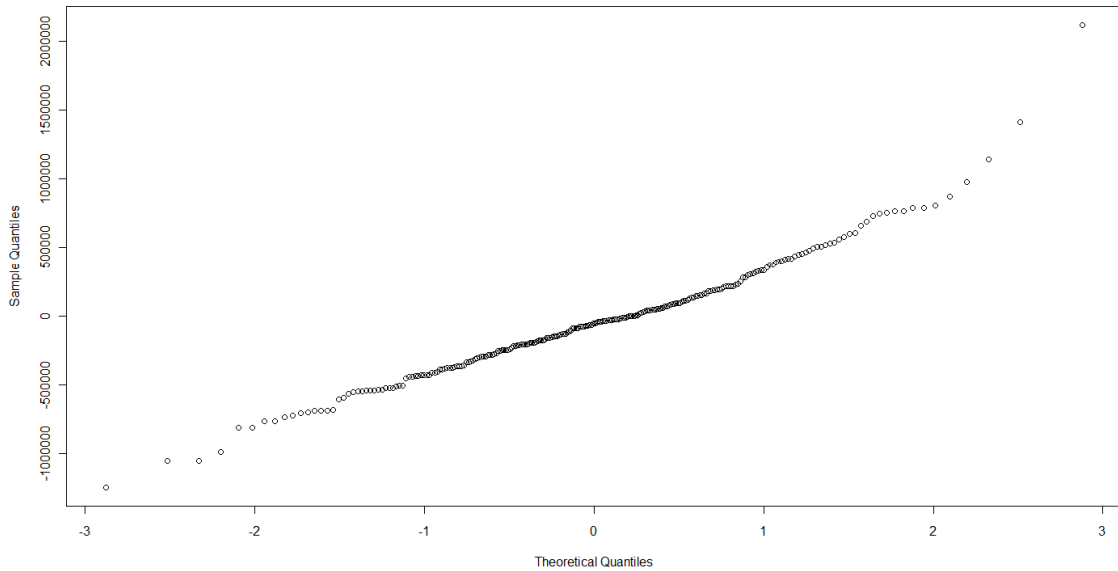


Figure 13. Normal Q-Q plot of residuals for ARIMA analysis.

In addition to the normal Q-Q plot, a histogram of the residuals (see Figure 14) was reviewed and failed to indicate the presence of problematic outliers in the dataset. As seen previously in the regression analysis, the distribution is skewed positively, which is typical of casino data, and once again the outliers seen represent days of and surrounding the Super Bowl and NBA Finals.

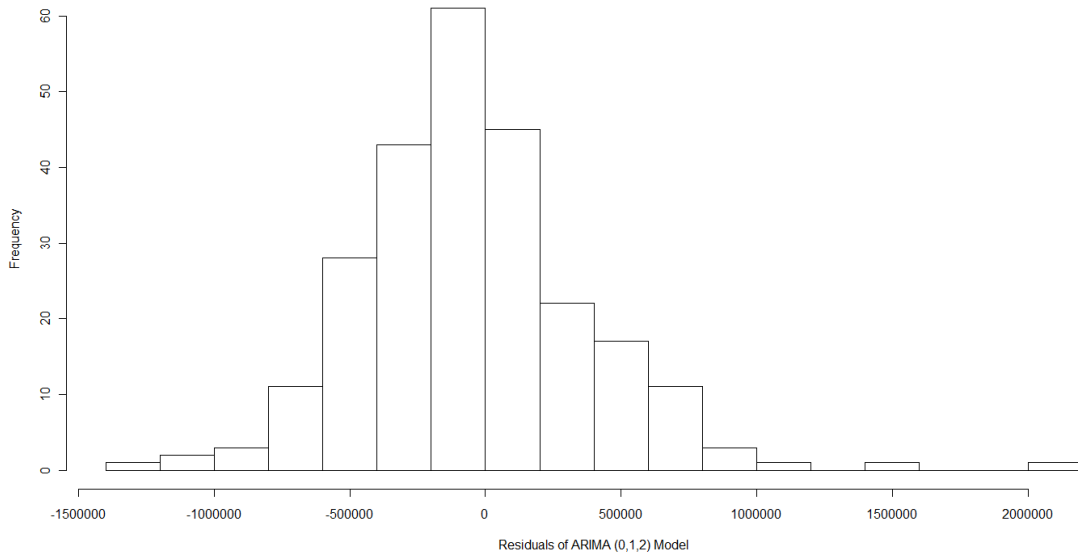


Figure 14. Histogram of ARIMA residuals.

Ljung-Box statistics were examined for the first ten lag values, as seen listed in Table 6 and plotted in Figure 15. The Ljung-Box statistical test checks the null hypothesis that the residuals of the ARIMA model are independently distributed. In order for the model to be classified as “correctly specified,” the residuals must not only be normally distributed, as demonstrated in Figures 13 and 14, but also independently distributed. If the residuals are autocorrelated, then the time series analysis can be used to improve the model. Table 7 shows significance levels above the 0.05 alpha level for the first six lags. Figure 15 shows a plot of these statistics – all p-values which fall above the dotted line indicate the results of the test show residuals are independently distributed. The significance levels of lags 7, 8, and 9 are well above the 0.01 alpha level cut off. That is, for the first nine tested lag periods, the null hypothesis is not rejected at a 0.01 alpha level – the residuals are independently distributed. When reviewing Table 7 in conjunction with Figures 11 and 12, the lag spikes seen on the ACF and PACF for the

seven-period lag become less alarming. While those spikes initially were cause from concern, we can see from Table 7 that the p-value at lag 7 at a seven-period lag is not significant at the 0.01 alpha level, and is near to the 0.05 alpha cut off.

Table 7

Ljung-Box Statistics ARIMA (0,1,2) Model

Lag Period	Ljung Box Test Statistic Value	Degrees of Freedom	P-Value
1	0.1389	1	0.7093
2	1.8198	2	0.4026
3	4.0799	3	0.2530
4	6.7891	4	0.1475
5	7.9323	5	0.1600
6	7.9912	6	0.2387
7	15.3091	7	0.0322
8	16.7894	8	0.0324
9	17.3768	9	0.0431
10	26.0667	10	0.0037

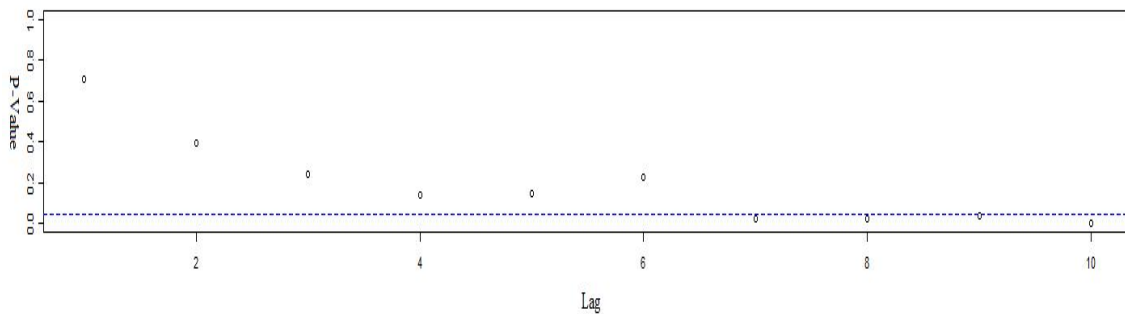


Figure 15. Plot of p-values for Ljung-Box test statistics.

Having concluded that the diagnostic checks display the ARIMA model to be a good fit to the data, a plot (see Figure 16) was drawn of the ARIMA predicted values for daily slot handle and the actual values taken in by the casino. As seen in Figure 16, the actual and predicted slot handle plots appear synchronized. There are a few positive spikes within the actual slot handle plot, most specifically at the beginning of February (during which the Super Bowl occurred), and sporadically throughout the fifty to one hundred day period, which coincides with Spring, but nearly the entire plot fits within the 95% confidence interval proposed by the ARIMA model, as demonstrated in Figure 17.

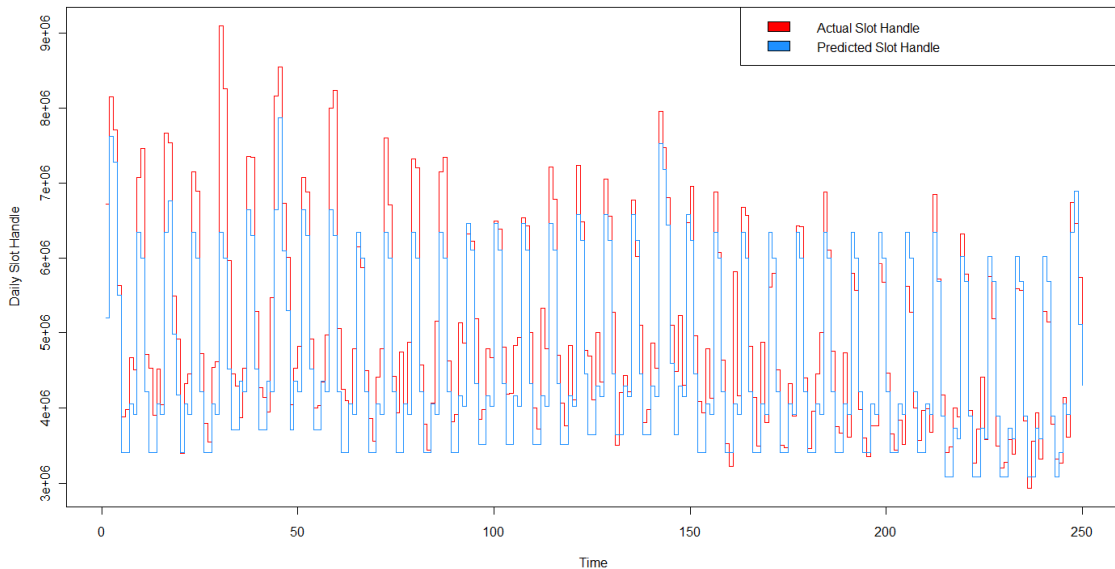


Figure 16. Slot Handle predicted values from ARIMA analysis versus actual values.

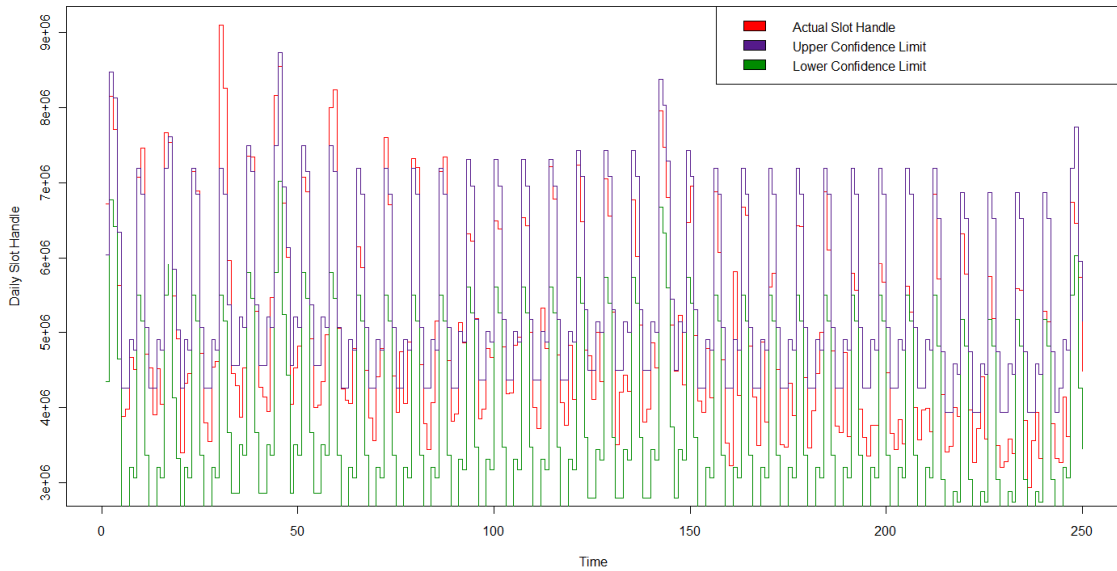


Figure 17. 95% confidence interval from ARIMA analysis versus actual values.

The final model coefficients and their standard errors can be found in Table 8. All coefficients are significant at the 0.05 alpha level, with the exception of the indicator variable for the month of August. As mentioned earlier, this is an exploratory study and since the p-value for August was well within the 0.10 alpha cut off level, and nearly within the 0.05 alpha criterion, it was kept in the model. MA(1) and MA(2) represent the first- and second-period moving average terms that were included in the model to remove serial correlation in the error process. Without these two terms included in the model, coefficients would include bias due to dependent error terms.

Table 8

Summary of ARIMA Time Series Analysis for Variables Predicting Daily Slot Handle with Daily Sports Write Dropped

Variable	β Estimate	β Standard Error	P-value	
MA(1)	-0.6831	0.0573	$< 2 \times 10^{-16}$	***
MA(2)	-0.2434	0.0563	1.53×10^{-5}	***
February	283,037.6	143,662.7	0.0488	*
August	-307,558.1	162,524.2	0.0584	
Wednesday	649,057.9	83,944.9	1.05×10^{-14}	***
Thursday	509,161.1	91,937.9	3.05×10^{-8}	***
Friday	2,941,311.0	91,987.0	$< 2 \times 10^{-16}$	***
Saturday	2,592,085.0	91,937.5	$< 2 \times 10^{-16}$	***
Sunday	812,464.8	84,136.8	$< 2 \times 10^{-16}$	***
New Years Weekend	1,265,580.0	279,747.2	6.07×10^{-6}	***
Martin Luther King, Jr. Weekend	760,431.9	292,317.0	0.0093	**
President's Day Weekend	1,576,059.0	294,272.5	8.52×10^{-8}	***
Memorial Day Weekend	1,026,654.0	273,979.6	0.0002	***
Labor Day Weekend	905,906.7	328,930.3	0.0059	**
Indianapolis 500	1,047,416.0	431,715.6	0.0153	*

Note. *** < 0.001 , ** < 0.01 , * < 0.05 . Maximum Likelihood Error (MLE) of the innovations variance is estimated at 1.82×10^{11} . Maximized log-likelihood = -3,582.53. AIC = 7,197.06.

CHAPTER 5

DISCUSSION

With regard to the primary independent variable, Daily Sports Write, the test results of both the initial regression analysis and the ARIMA analysis that followed failed to reject the null hypothesis postulated in Chapter 2. There was no support of the alternative hypothesis that daily sports write had a significant impact on daily slot coin-in. That is, the coefficients associated with daily sports write were not significantly different from zero, and therefore sports write did not have a significant impact on slot coin-in. In addition, it is important to note that race book win not only did not have a significant impact on daily slot coin-in, it was deemed a non-contributor to the model early in analysis and was removed from consideration. This finding comes in contradiction of the theories held by several casino operations managers (Eng, 2008; Lang & Roxborough, 1992; Manteris, 1991; Manteris, 1993).

Managerial Implications

The research conducted herein does not support the theory proposed by industry professionals that the floor is a full-service model, when considering the incorporation of either a sports or race book. The results of this research did not produce any evidence of a positive, significant, indirect contribution from sports nor race books to slot coin-in. At a very minimum, casino operators should give a second thought to sports and race book operations.

While the sports book does turn a profit, the actual dollar amount of this profit is minimal, as can be seen in Table 2 in Chapter 4. The maximum value of sports book write is rather large, \$707,252, and occurs the day of the Super Bowl, a major event for

American sports. This maximum value, however, is not even one third the amount of the minimum value of daily slot handle, \$2,944,266. Casino managers would certainly want to consider both the lack of evidence of an indirect relationship between sports book write and slot coin-in, as well as the absolute profit differences, when determining the allocation of valuable floor space for a sports book. In addition, because the race book was found to have no significant impact on slot coin-in, it is crucial that casino operators consider the dollar value of race book win that is coming in from that channel and the operational costs associated with the book – they may find that the race book is being incorrectly used as a loss leader.

As Lucas, Dunn, and Kharitonova (2006) describe, casino management ought to consider both the direct and indirect revenue contributions of gaming and facility amenities, and they must ultimately decide what combination of each operational element maximizes the property's profit per square foot. Sports books have the potential to draw huge crowds, particularly on days during which major sporting events occur. But once again Lucas et al. (2006) put forward the suggestion that not all patrons offer the same profit potential - the sports book may serve the needs of many patrons, but their individual value to the casino may vary greatly. The needs of the shareholders, however, are equally if not more important than the customers to the maintenance of the bottom line, and a sports book that covers prime casino floor space may not be the ideal choice for optimizing cash flows.

Because a slot machine requires very low operational cost, and because of the low variance generated by the large aggregate number of spins per hour, even an infrequently played slot may generate higher cash flows for the property than the sports book might.

It is typical of a Las Vegas casino to experience attendance and volume peaks during holidays and weekends and troughs during midweek periods. Due to the timing of sporting events, sports books have the ability to generate patronage during slower periods. The property, however, may be able to increase their profit per square foot by using some of the space allotted to the sports book for extra slot capacity during peak slot volume periods that coincide with lulls in sports book volume periods. The reality is, unfortunately, that it is difficult to quickly convert the space from sports book floor to slot floor and back again on a frequent basis. With the advent of server-based gaming and innovative concepts like Harrah's Sports Pit, detailed in Chapter 2, management should consider incorporating slot terminals into their sports book operation. Similar to the WagerVision concept described by Nover (2008), the slot machine could have a live feed of the sporting event on one screen, while a second screen permits the bettor to continue playing their slot game. Once the technology is further integrated, perhaps the bettor could make wagers from their terminal while playing their slot game, without ever needing to leave their seat. Without empirical evidence of a significant, positive, indirect contribution from sports books to slot machines, it is difficult to justify the massive amount of casino floor space that is apportioned to sports books.

Following the same line of questioning that Lucas et al. (2006) put forth in their bingo analysis, managers must ask themselves a series of questions when determining the value and size of a sports book on their property. What would the impact be on slot revenue if a casino severely downsized or even removed the sports book from their property? Would patrons whose primary reason for coming to the property still patronize the establishment? Would the casino lose slot revenues due to the loss of the niche

clientele? If so, how much revenue would be lost? What gains may occur if the space is used for an expansion of the slot floor? All these questions are certainly dependent on local competition. Several studies have been conducted on various United States casino markets, and have found that ease of access of location is a primary reason for a customer's choice to patronize a casino establishment (Pfaffenburg & Costello, 2001; Richard & Adrian, 1996; Shoemaker & Zemke, 2005; Turco & Riley, 1996). In a highly saturated market like Las Vegas, both on the Strip and in locals casinos, in which nearly all casinos have a sports book amenity, one might expect a decrease in patronage following the closing of an on-property sports book. Players who wager at both slot machines and at the sports book may still continue to patronize the casino, as the property is still at least partially meeting their needs.

It is especially crucial that managers take heed of the results of this study, as literature shows they are currently adhering to conjecture without evidence – Eng (2008) writes of several race and sports directors from Las Vegas repeater market casinos, who state that sports books must offer state-of-the-art technology and customer service, for fear of losing their patrons. While these are certainly beneficial to any service-based product, it may not be necessary to continue infusing a large cash flow into the sports book, but rather to consider a redistribution of space, to permit for more of an allocation for slot machines. As in any situation, casino management will have to weigh all options on a case-by-case basis, and cannot use the research provided here as an etched-in-stone truth.

Profit per Square Foot

Casino management teams who put an emphasis on profit per square foot may consider the research presented here to provide valuable insight as to their distribution of floor space among the various gaming amenities. The results demonstrated here fail to provide any empirical evidence that the sports book serves as a driver of slot revenues on the property. While further study is certainly recommended, such as longer-term time series analysis, casino management may want to begin considering a reallocation of the space currently used for the sports book. It seems likely that even a slot machine and sports book combination configuration would be preferable to the current sports-book-only set up, when considering the bottom line. Ultimately, the decision must be made based on empirical proof and dedication to optimizing profit per square foot, rather than blindly following the declarations of unsupported theory.

Limitations

The first and most evident limitation of the study is that the data come from a single Las Vegas repeater market property. Because of this, the results will not necessarily be generalizable to casinos in other cities, Las Vegas Strip casinos, and not to other Las Vegas repeater market casinos. The information derived from the study, however, will help the host property in the casino marketing decision-making processes and provide a model and process for others to follow.

Within the scope of data limitations, the author recognizes one immediate shortcoming – the data set used for the thesis does not include any information on promotional events that occurred at the host property. In addition, there are major

sporting event dates missing from the data set (Major League Baseball's World Series, for example), simply because these events did not occur within the time period of the data.

The very nature of sports book wagers provides an additional limitation. In casino betting scenarios other than sports books, the patron places a wager and immediately, or at the very least within a minute, participates in the casino game. With a slot machine, for example, the game is played at the push of a button, and with roulette, wagers are placed just prior to and even during the spinning of the wheel. With sports books, however, bets are made not just moments before the game is played, but can be completed earlier in the day, week, or at any length of time before the event actually occurs, based on the house's willingness to accept the wager. Sports books take a lot of action with futures bets, in which a wager is placed long before the sporting event takes place, often before the sports season even begins. Because of this, futures wagers on an event that occurs on a certain day in the time frame will not be counted on that day, regardless of the result. Rather, the wager is counted as sports book write on the day it was placed, and it will not be incorporated in the indicator variables used for the major sporting events.

Furthermore, the research conducted here only delves into the seasonality variation that transpires by day of the week and month of the year. Within the sports book, however, there are natural fluctuations that occur within a single day period due to the timing of sporting events. It is possible that because the data was gathered at a daily grain, there may be an over-aggregation of actual results. Morning patrons at Las Vegas sports books tend to be race bettors, since many east coast racetracks begin the day's racing between 11AM and noon, Eastern Standard Time, which relates to 8-9AM Pacific

Standard Time, in which Las Vegas resides. Golf also is generally a daytime sport. In the afternoon, the patrons in a typical sports book are much more varied. Baseball, football, and basketball fans tend to come out later in the day, since those sports usually have late start times on weekdays. On the weekends, the timing can be different, as many sports games will take place in the afternoon for all time zones. While there is also hourly variance with slot patrons, such as early mornings when most patrons are sleeping or crowds that come towards the evening, the variance is much different from that of a sports book. Sports games often do not run as late into the evening and night, unlike slot machines, which are a 24-hours-a-day, seven-days-a-week operation. It is possible that the indirect contribution from the sports book to slot volume may be deflated due to large durations of time in which the sports book is extremely slow because there is no live feed of games.

This research also is unable to acknowledge the effects of the ever-growing population of online sports bettors, who do not have the need to come into the sports book to place their wagers.

The study also does not approach the research question from the player's point of view in any way. There may be a difference between how a player views the casino's sports book as a lure to the rest of the casino floor and the actual financial impact of their attendance. It is possible that a patron would come to the property with the sole intent of wagering at the sports book and plans to come back on a separate trip to wager at a slot machine or table game – this situation is not captured by the data currently available to the author. The study only approaches this concept from the casino's point of view, and cannot discern the human aspect of these financial interactions.

Finally, the study cannot transcend fluctuations in the economy. At this moment, in 2009, the economy is at a downturn. This poor economic situation may be influencing who sits in the sports book, how much disposable income they have, and how much of that disposable income they are willing to spend on the host property. Perhaps a bettor who might normally wager at both a sports book and at a slot machine during a boom economy feels the brunt of the poor economy and as a result opts only to wager on one of the two gaming options. Because of this, we may not be able to accurately compare these results with any past or future research.

Recommendations for Future Research

Drawing from the limitation of this study being restricted to data gathered from a single property, replication of the research at a different property would provide a stronger foundation for the claims made in this research and would become a balancing asset for industry decision-makers. It would certainly also be useful for a property to research ways to generate greater revenues from a sports book. Conversely, the casino would also want to analyze the expenses they incur for general sports book generations. An in-depth look at the net financial success of individual sports book promotions might help the casino create an interesting cost-benefit analysis.

Further allowing the limitations of this research to inspire additional study, others may want to expand the scope of their exploration by collecting data at an hourly grain, rather than the daily grain at which this data was collected. Over-aggregation of periodic results may be avoided with more sectionalized compilation of data.

Due to the limitation of the inherent nature of sports wagering, it may also be of interest to research the indirect effects of sports book win on daily slot handle. This would permit the researcher to investigate whether or not a customer who receives a sports book payout takes their winnings and wagers them at other gambling amenities on the property. This would account for hidden holes in the data, which may occur during futures wagers and other bets placed on days previous to the reported day's write.

It would also be beneficial to set up observation studies, in which researchers would discreetly follow patrons as they wagered in the sports book and record their actions after they left the amenity, in order to see how they spent the remainder of their time on the property. Qualitative studies like in-depth ZMET interviews or focus groups may also be beneficial, and would contribute greatly to the validity of the research claims.

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