Estimating the Short-term Effects of an Increase in Par on Reel Slot Performance

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Abstract

Data from a US hotel casino are analyzed to examine the validity of a controversial theory holding that reel slot players are unable to perceive substantial increases in par (i.e., a hidden price). The results of a multiple regression analysis support this theory. A 50% increase in the pars of a $5.00 reel sample, failed to significantly affect the performance of these games. The control-group games featured 5.0% pars, while the experiment-group pars were set at 7.5%. Descriptive statistics show that the theoretical win per unit actually increased at the 7.5% par. The strategy behind the theory is to obtain bankrolls before players decide to gamble elsewhere. As player acquisition costs are rapidly growing, casino executives wish to maximize their return on this investment and increase their share of wallet. For those operating casinos in markets with easily accessible competitors, this study is rich with managerial and strategic implications.

Key Words: Slot management, slot operations analysis, casino management, casino operations analysis, casino management strategy, casino advantage

Introduction

Plume (2001) noted that the success of many US casinos depends on the state of the slot operation. Slot revenues remain crucial to the success of Nevada casinos, as 67% of gross gaming win originated from slots in fiscal-year-end 2004 (Nevada Gaming Control Board, 2004). Outside of Nevada, the reliance on slots is more pronounced. New Jersey produced 74% of its 2004 gaming win via slot machines (New Jersey Casino Control Commission, 2004). In 2004, Illinois received 86% of its gross gaming win from slot machines, while Indiana generated 85% of the fiscal 2004 gaming revenues from slots (Illinois Gaming Board, 2004; Indiana Gaming Commission, 2004). Iowa topped the major US markets, producing 88% of its gross gaming revenue from slots, in fiscal 2004 (Iowa Racing & Gaming Commission, 2004).

Though the revenue contribution from slots is more than notable, the profit contribution is even greater. Kilby, Fox, and Lucas (2004) conservatively estimated the slot department's profit margin at 60% to 70%, noting that margins vary across casinos. Despite this variation, it is not unusual for the profit margin of a slot department to be 4 times as great as a table game department's bottom line, in a US casino. According to MacDonald (2001), Harrah's executives claimed that more than 80% of the company's operating profits were produced by slot operations.

Given the substantial contribution of slot operations to casino profits, few empirical studies have examined critical theories central to the management of the slot machine offering. Specifically, little is known about the effects of variables such as par, standard

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deviation, and hit frequency on the customer's slot experience. Any research leading to a better understanding of these effects would help casino executives maximize profits. The aim of this study is to examine the effect of changes in par on slot machine performance, providing a critical start position for further research in this area. Par is the casino's expected value associated with each slot machine's pay table.

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Specifically, this research analyzes the change in reel slot performance, resulting from a substantial increase in par. Unlike video poker machines, where all possible card values are known to the player, the outcome universe is not known to reel slot players. Due to this condition, the player cannot calculate or reasonably estimate his or her disadvantage. It is similar to purchasing a product or service without knowing the price. However, the player will perceive some cost of the entertainment. The basis of this cost perception is left to abstractions such as the player's actual win/loss outcome (as opposed to the casino's theoretical win) or the amount of time the player was able to play on his or her bankroll.

For those operating casinos in markets where customers can easily access competitors, it is important to know how changes in par are perceived by slot players, if at all. If players are insensitive to par/price increases, operators may wish to increase their game pars. These possibly undetected increases would allow them to capture the player's bankroll before he or she is able to walk across the street to a competitor's casino. However, if these increases are negatively perceived, the damage to brand and slot revenues could be costly. Given the industry's increasing competition and rising acquisition costs, retaining or increasing a casino's share of the customer's wallet is becoming crucial to the survival of casinos operating in competitive markets.

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One successful casino company is challenging the preconceived notion, and widely held view, that slot players are able to determine differences in the pars of reel games. The premise is that the substantial variance associated with a typical player's trip bankroll of $300 will mask the effects of the increased par. On average, or in the aggregate, this strategy allows them to obtain player bankrolls faster than their competitors. For those that believe the popular theory that hotel guests first gamble in the property at which they are residing, the increased par helps insure that the first shot at their bankroll is the last shot. The goal of this strategy is to maximize the return on acquisition costs, by decreasing the bankroll walk-out rate. However, there may be long-term market share consequences if the increased par effects are perceived by slot players. The sooner operators understand this par-performance relationship, the sooner they can move toward optimizing casino revenues, increasing return on acquisition cost, and increasing their share of the customer's gaming wallet. This study empirically examines the effectiveness and validity of this emerging and controversial slot management strategy.

Literature Review

With regard to casino management, par is most often discussed in long-term language. For example, if a player wagers X, the casino can expect to win Y, in the long-term. However, in the short-term, normal variance causes material swings in the actual outcome of a player's wagering activity (Lucas, Kilby & Santos, 2002; Salmon, Lucas, Kilby & Dalbor, 2004). Hence the anecdote, "There is no accounting for probability in the short-term." This is why a player's value is most accurately described in terms of theoretical win (Kilby, Fox & Lucas, 2004; Salmon et al., 2004). Theoretical win is the product of the dollar-amount wagered and the par or expected value associated with the wagers. Theoretical win cancels the aberrations associated with normal short-term outcome variance.

Slot manufacturers do not use general terms such as short-term and long-term to describe wagering activity. They compute confidence intervals, based on a specific number of spins (Kilby and Fox, 1998). At 100 spins, the distance between the confidence interval's end-points is much greater than it is at 10,000,000 spins. At 10,000,000 spins, the confidence interval end-points collapse around the game's par. At this point, differences between par and the actual hold percentage are very likely to be minute. This fact is central to this study. That is, the ability of the player, with a $300 bankroll, to perceive the difference between a 5% game and 7.5% game, will certainly affect the manner in which par is managed. In the long-term, all else held constant, there is no question that less coin-in will be recorded as par increases. Coin-in represents the amount of money or the number of coins wagered, over a specified period of time or number of spins. However, it is not known how the slot patron will perceive or react to the increase in par. Will the casino be able to acquire the player's bankroll faster, without detection? Or will future revenues and market share decline from lost business, related to the detection of par/price increases?

Performance-Potential Research

Three studies were recently conducted using performance data obtained from Las Vegas casinos (Lucas et al., 2004; Lucas & Roehl, 2002; Lucas & Dunn, in press). The aim of these studies was to predict the volume level, or potential, of slot machines, given each game's unique characteristics. These characteristics included variables such as par and standard deviation of the pay table, as well as several other variables describing each game's location. However, the par and standard deviation variables were not experimentally manipulated in these studies. The effects of these random variables on unit-level gaming volume were derived via multiple regression analysis. The ultimate goal of these researchers was to produce an equation that embodied the major influences on unit-level performance, for use as an objective performance evaluation tool. Although the primary objective of these three studies was not to measure the specific effect of changes in par on slot performance, this research stream provides valuable empirical results to such an end. Table 1 summarizes the results of this work that apply to the current study.

Table 1
Results of Performance-Potential Research Related to the Effects of Par and Standard Deviation on Slot Machine Performance

	Effect on Machine Performance Level		
Predictor Variables	Lucas & Roehl (2002) n = 418	Lucas et al. (2004) n = 250	Lucas & Dunn (in press) n = 166
Par	Decrease	No effect	N/A
Standard Deviation	N/A	Decrease	Decrease

Notes: All hypothesis testing was conducted at the 0.05 alpha level. "Decrease" indicates a statistically significant model effect. "N/A" indicates that the variable was not available or not included in the study.

Lucas and Roehl's (2002) result was intuitive, given the video poker machine sample from a Las Vegas casino that relied heavily on a repeater clientele. In their study, as par increased, the unit-level wagering volume decreased. This result was expected, as the experienced repeater clientele of this property was thought to be discriminating with regard to video poker par/price. Repeater clientele such as the one studied by Lucas and Roehl are inclined to be aware of and attracted to specific pay tables (Ramdeen, 1999).

Experienced video poker players can use pay tables as a proxy for price. Hence, the result of Lucas and Roehl was most likely a case of decreasing demand, resulting from an increasing price/par.

In Lucas et al. (2004), par failed to produce a statistically significant effect on unit-level wagering volume. The authors cited the reel slot sample as a possible explanation for this result. Specifically, that price or par is masked, or unknown to players, in reel slot machines. Additionally, other factors such as increased demand for a specific program or theme could have masked the inescapable effects of par. For example, despite the greater par, a strong attraction to certain game themes or programs may have driven wagering volume. Further, low-par reels with unattractive games themes could have also contributed to the no-effect result. All else held constant, an increase in par will eventually produce a decrease in wagering volume (i.e., coin-in).

Lucas and Dunn (in press) did not examine the effect of par on the wagering volume of their reel slot sample, due to multicollinearity issues. The par variable was highly correlated with other predictor variables and had to be eliminated from the model to remove bias from the remaining regression coefficients. Par was omitted largely because its removal did not affect the primary goal of the research.

Lucas and Dunn also noted the measurement error associated with the par variable. Specifically, that slot systems have only one par field, and multiplier slot machines frequently have multiple pars or house advantages. For multipliers, par is usually lowest at the maximum allowable wager, and increases for wagers less than the maximum bet. Because slot systems do not compute a weighted average par for multipliers, any analysis is forced to include the assumption that all wagers are maximum coin wagers. An assumption that is almost undoubtedly false. Lucas, Dunn and Singh (in press) also acknowledge and discuss this limitation.

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With regard to the standard deviation results from Table 1, Lucas et al. (2004) and Lucas and Dunn (in press) produced similar results. Both of these studies employed a double-log data transformation. Hence, a one-percent increase the pay table's standard deviation produced a 27-percent and a 16-percent decrease in unit-level wagering volume, respectively. The Lucas et al. sample was comprised of $1.00 reels, while Lucas and Dunn studied $0.25 reels. Standard deviation was not analyzed as part of Lucas and Roehl's (2002) study of $0.25 video poker machines. These results are closely connected to the current study, as changes in the standard deviation of the outcome distribution must be simultaneously considered along with changes in the par.

Player-level Research

Lucas, Dunn and Singh (in press) examined the effects of par on slot machine wagering volume from a different perspective than that of the performance-potential researchers. Specifically, they sought to measure the effects of direct mail incentives on the trip wagering volume of individual players (slot play only). The effects of par were considered in their analysis, as a player's slot volume could vary from trip to trip, based on differences in the pars of the slots that were played on each trip.

Because the cases were measured at the player level, wagers from both video-pokers and reels could be included in the trip wagering volume of the cases. Despite the dismal results associated with the direct mail variable, the par results were intuitive. That is, increases in par produced significant ($p < .01$) decreases in the average trip wagering volume. In fact, this result held across two different levels of the analysis. There were 362 cases in the $50-incentive study and 209 cases in the $100-incentive group. However, it was not known whether the players perceived the difference in the pars, despite the variable's significant effect on trip slot volume. A weighted standard deviation variable was not available to Lucas and Dunn, due to system and data warehousing limitations.

As this section of the literature review examines sources of influence on individual wagering volumes, it is important to address the effect of hit frequency on slot play. Hit frequency represents the percentage of spins/trials that produce a payout of at least one coin (Kilby, Fox, Lucas, 2004). There are casino executives that believe there is an inverse relationship between hit frequency and coin-in, a reasonable hypothesis, on its face. However, Kilby, Fox, and Lucas discuss the results of a simulation that failed to support this general hypothesis. The simulation featured ten IGT games with 10% pars, and hit frequencies ranging from 6.7% to 29.6%. Three versions of the simulation were run. The starting bankrolls were $100, $100, and $200, in each of the three versions. In the first and third versions, the stop criteria were as follows: Play ended with bankruptcy or a doubling of the original bankroll. The second version of the simulation was the exception, as play terminated after the original bankroll was either lost or tripled, as opposed to, lost or doubled.

The results failed to demonstrate an inverse or linear relationship between hit frequency and pulls per losing player. Pulls per losing player was examined, as losing or bankrupt players were likely to employ time-on-device as a proxy for satisfaction with their gaming experience. It was assumed that the winning players were satisfied with their encounter. In any case, no less than 86% of all virtual players experienced bankruptcy in all versions of the simulation.

It is also helpful to consider the extreme cases of this hypothesized relationship. For example, a slot machine could have a 100% hit frequency and 50% par, where every spin is characterized by two coins in and one coin out. Such a game would devour a player's bankroll in no time at all, claiming 50% of the wagers on each iteration. Based on the results of the simulation and the fact that the effect of hit frequency is already incorporated in the game's standard deviation, hit frequency was not included as a predictor variable in the current study.

Hypotheses

With regard to the effect of par on wagering volume, the results of the reviewed literature would suggest a negative relationship (Lucas & Roehl, 2002; Lucas, Dunn & Singh, in press). Aside from the reel slot sample analyzed by Lucas et al. (2004), par variables have produced significant and negative effects on gaming volume variables, in three different analyses. However, this study is not concerned with the effects of par on wagering volume (e.g., coin-in), but rather, the effect of par on theoretical win. Wagering volume would be expected to decline, with an increase in par, even in a sample of reel slots. However, the percentage of its decline must exceed the percentage increase in par, to produce a decline in theoretical win. Unfortunately, no published research has addressed the specific question of how increases in par will affect theoretical win, if at all. Given the void in the literature, no directional hypothesis could be supported. Hence, the following null hypothesis was advanced:

$H_0 1$: The increase in par will not affect unit-level theoretical win

Both Lucas et al. (2004) and Lucas & Dunn (in press) found increases in a reel game's standard deviation to decrease its wagering volume. Despite these results, the same void in the literature exists regarding the effect of changes in the game's standard deviation on its theoretical win production. However, this variable differs from par in that it is a measure of dispersion rather than central tendency.

After accounting for the effects of par changes, increases in the game's standard deviation would also be expected to increase the speed at which a player's bankroll is lost. The rationale behind this position is that outcome distribution variance is increased by decreasing the frequency of low-end payouts, which occur more frequently than high-end jackpots. It is the low-end payouts that are most likely to partially refund the player's bankroll as it is iterated through the machine. Whereas, obtaining a high-end jackpot is listed as one the three most common reasons player's stop wagering (Kilby & Fox, 1998). Halting play would certainly not increase theoretical win.

However, winning money quickly does not necessarily equate to winning more or less of it. That depends largely on the player's perception and reaction to the changes in these stimuli. Due to the void in the literature and a lack of knowledge regarding player reactions to changes in the standard deviation, a directional hypothesis was not advanced.

$H_0$2: Increases in a game's standard deviation will not affect its t-win production

P-P researchers have found many influences on unit-level slot performance including: Aisle locations, ceiling height, game position within a bank, cabinet design, bonus features, top-award magnitude, and specific programs (Lucas & Roehl, 2002; Lucas et al., 2004; Lucas & Dunn, in press). Despite the abundance of identified sources of influence on game performance, these variables have been held constant in this study, through experimental design. The Methodology section describes the design in detail. The current study attempts to isolate the effects of par on game performance. However, it was not possible to hold standard deviation constant, as changes in the par produced changes in the standard deviation.

Strategic Risks

The potential gains associated with even a one-percent increase in the existing share of wallet would be tremendous for many casino companies. However, there are some long-term risks associated with aggressive increases in the reel pars. That is, if these risks are detectable and felt by the existing clientele, repatronage and other loyalty behavior may suffer as a result. A loss of market share, resulting from price gouging, could be equally devastating to a casino company's profits.

Many researchers have found various forms of the price-value perception to weigh heavily in the repatronage intentions and satisfaction with the gaming experience. In a survey of Illinois riverboat patrons, Turco and Riley (1996) found "Favorite place to play" as the most frequently stated choice/visitation factor. "Lucky/won there before" was fourth most frequently given choice factor. In a survey of Las Vegas Strip slot players, Lucas (2003) found a gaming value construct to produce the greatest influence on satisfaction with the gaming (slot) experience. Shoemaker and Zemke (in press) surveyed Las Vegas Valley residents to find that "Past experience at the casino" and "Machines pay off better" were important features in casino patronage decisions. Specifically, 41.40% and 41.60% of the 618 respondents assigned these features top-box ratings, respectively. Top-box ratings were defined as a score of 9 or 10, on a 10-point scale designed to determine the relative importance of 24 listed casino features. These two characteristics were the 8th- and 9th-highest rated features. Finally, 440 respondents from two Indian casinos and two riverboat casinos reported "Chance to win" and "Better odds" as the 4th- and 6th-highest rated choice factors (Pfaffenberg & Costello, 2001). There were 25 listed items, but the authors noted that the items were sorted according to mean score, with only the top and bottom 20% listed in the article.

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All of these findings support the importance of perceived gaming value. Existing research supports the notion that customers would be less inclined to visit a casino that they perceived to offer an undesirable gaming value. If they were indeed less inclined to visit such a casino, it is quite possible that they would also be disinclined to recommend it to others. Although it is difficult, if not impossible, to predict the damage of changes in customer perceptions related to gaming value, there are sufficient findings to warrant concern for such changes. This is a considerable risk associated with aggressive increases in pars that should be acknowledged in the interpretation of this study's result.

Methodology

Data Source

The data donor wishes to remain anonymous. As a result of this request, only a limited amount of information describing this hotel casino is available for publication. All secondary data were collected from the online slot system of a US destination resort (hotel casino). This property's performance data were subject to periodic audits by gaming regulators. The donor casino is owned and operated by one of the four largest US gaming companies, with respect to both market capitalization and number of properties.

Slot Performance Variable

The dependent variable was theoretical win per unit per day (TWPU). TWPU represented the slot machine's performance, in terms of theoretical dollars won by the casino. Actual win dollars could not be used, due to obvious bias resulting from short-term performance variation. That is, in the short-term, some games produce revenue beyond the expected value and some produce less than the expected value. Eventually the two win numbers (actual and theoretical) will become inconsequentially different, but this usually takes about 10M trials/spins, or about five years for most popular games. Of course this estimate varies according to the game's par, standard deviation and exact number of trials per day. If the total amount wagered (i.e., coin-in) were used as a criterion variable, the change in this value would have to be restated in terms of t-win, after the regression analysis. TWPU was the most economical, meaningful and accurate expression of performance, for this study.

As described in the Data & Design section, not all of the games had an equal number of days in their respective year-over-year comparison periods. The minimum comparison period was equal to 153 days, while the maximum was equal to 245 days. For example, games that received par increases in August of 2003 produced a comparative period of September 2003 through January 2004, or 153 days. Play from this period was compared to the same 5-month period (or 153 days) in 2002. Continuing this example, the total dollar-amount of wagers (coin-in) for both of these periods were each multiplied by the respective pars (5.0% for 2002 and 7.5% for 2003), and subsequently divided by 153. The result represented the game's TWPU. This process was repeated for each game/case.

However, some game pars were increased as early as May 2003, creating a 245-day comparative period for these units. Despite the increased comparison period, the process was identical to that described in the preceding example. Regardless of the number of days in the comparison period, all performance data were ultimately expressed in terms of theoretical win per unit per day, allowing for direct performance comparisons across the units while attempting to hold seasonality (by month) constant.

Predictor Variables

The par variable (PAR) was expressed as a categorical variable due to its distribution. That is, only two pars existed, 5.0%, in the 2002-period, and 7.5%, in the 2003-period. These percentages represented the portion of each coin wagered that the casino can expect to win or retain (i.e., the expected value). As a result of the dichotomous distribution of the par variable, the 2002-period cases were assigned a value of zero, while the 2003-period cases were assigned a value of one.

The standard deviation (SD) of the pay table was a continuous-like variable that represented the dispersion of each game's outcome distribution. Alternatively stated, it represented the average distance of all possible outcomes from the mean or par. This variable was computed from the par sheets provided by the slot manufacturer. Each game analyzed in this sample had a corresponding par sheet that contained information such as its volatility index. The volatility index is computed by multiplying the game's standard deviation by a selected z-score. The z-score is used to construct a confidence interval, or a range of pars or payback percentages, by which the reasonableness of actual outcomes (e.g., hold percentage) can be judged by casino operators. Each par sheet in this sample computed a 90% confidence interval, for selected numbers of trials (e.g., 100,000 spins). To compute each game's standard deviation, the game's volatility index was divided by 1.65, the z-score needed to create a 90% confidence interval. This transformation was necessary, as the breadth of the confidence interval varies by manufacturer (i.e., 90% vs. 95%), which could hinder the future applicability of this result. Further, in the interest of consistency, extant literature examines the effects of the pay table's standard deviation in lieu of its volatility index. The volatility index is a less pure expression of the dispersion effect.

Data & Design

The data provided for the analysis included results (i.e., coin-in) by game, for each of 25 consecutive months, starting with January of 2002 and ending in January 2004. Also included were data describing each game's theme, par (by month), and standard deviation (by month). In general, the study compares the performance of $5.00 reel slot machines from Fall/Winter 2002 to Fall/Winter 2003. Although each machine produced a Fall/Winter 2002 and Fall/Winter 2003 observation, a paired-sample design was not employed due to the possible effects of the covariate (pay-table standard deviation). The year-over-year design was selected, as the dominant explanatory power of seasonality on slot performance has been well-documented by gaming researchers (Lucas & Bowen, 2002; Lucas & Brewer, 2001).

To be eligible for the data analysis, a slot machine had to have recorded play in Fall/ Winter 2002, at a 5.0% par, and also in Fall/Winter 2003, at a 7.5% par. In 2003, management made the decision to increase par by 50% (from 5.0% to 7.5%) on several $5.00 reel slots. The goal of this quasi-experimental design is to measure the resulting change in theoretical win, if any. However, the pars were not all increased in the same month, causing differences the durations of the comparative periods. For example, some pars were increased in June and some in September. If the game's par were increased in June, its year-over-year performance comparison period would be July through January of the subsequent year. The comparative period would begin in July because the exact day of the June par change would be unknown. That is, the 2002 period might have included only 10 days of June, while the 2003 period would have included all 30 days of June, creating obvious measurement bias. In total, 38 games satisfied the eligibility criteria, creating a total of 76 cases for the data analysis (one performance observation in each of two performance periods).

When the game's par was increased its standard deviation changed. Although these changes were usually slight, the results of previous research have demonstrated the pronounced effect of such changes on performance (Lucas et al., 2004; Lucas & Dunn, in press). Aside from the change in the standard deviation, all game themes, game configurations (e.g., maximum wagers), floor locations, and cabinet styles remained constant. This same-game same-location control was clearly the greatest strength of this design, especially given the multitude of influences on slot volume that have been identified by performance-potential researchers.

Data Analysis

Prior to formal data analysis, all data were screened for outliers. Scatter plots were reviewed for nonlinear distributions and relationships. Histograms were also examined for evidence of problematic departures from normal distributions. Once the data were satisfactorily screened, a simultaneous entry multiple regression analysis was performed. The hypotheses were tested at a 0.10 alpha level. Given the exploratory nature of this study, it was important to detect the possibility of any significant effects on performance. As a result, the Type 1 error risk was increased from its typical 0.05 level. The regression analysis was performed on 76 cases. Upon completion, the results were thoroughly examined for violations of the regression assumptions and for cases with extreme leverage or influence on the final solution.

Results

Data Screening

Two of the original 40 units were eliminated due to excessive studentized deleted residuals, leaving the 38 units, or 76 cases in the final solution. No problematic departures from normal distributions were detected. However, as is often the case with gaming data, the performance variable was positively skewed. Attempts to transform TWPU (i.e., square root and natural log) failed to noticeably improve the distribution. Because the skewness was not judged as problematic, TWPU was left in its original metric. The SD variable was also positively skewed and handled in the same manner as TWPU, with the same result and ultimate determination. No nonlinear distributions or relationships were discovered. There were only two continuous variables, TWPU and SD, so a correlation table was not produced. TWPU and SD produced a correlation coefficient of -0.20, significant at the .05 alpha level. Table 2 lists the descriptive statistics for the model variables. Because the variable of interest, par, was in a categorical format (0/1), the descriptive statistics are reported by group.

Table 2
Descriptive Statistics by Group: 5.0% Par and 7.5% Par

	5.0% Par (2002 Period) n = 38			7.5% Par (2003 Period) n = 38		
Variable	M	Mdn	SD	M	Mdn	SD
TWPU	$528.97	$385.66	$322.97	$582.47	$410.71	$351.88
SD 8.00	7.33	2.36	7.94	7.35	2.32	

Notes: The predictor variable SD is expressed in terms of coins, not dollars. Each coin was equal to $5.00.

Despite the 50% increase in par from Fall/Winter 2002 to Fall/Winter 2003, the same games, in the same locations, actually recorded a greater mean TWPU ($582.47) at the 7.5% par. Although par was substantially increased from the base period, the change in the mean value of SD was not remarkable. The SD mean decreased from its 2002-level of 8.00 to 7.94.

Formal Data Analysis

The model produced an R^2 of 0.047. The omnibus F statistic of 1.79 was not significant ($df = 2, 73$, $p = 0.174$). The results of the SMRA are summarized in Table 3, which also includes each variable's variance inflation factor (VIF). The corresponding VIF is listed immediately after each variable name.

Table 3
Summary of Simultaneous Regression Analysis for Variables Predicting Theoretical Win Per Unit (n = 76)

Variable/[VIF[a]]	B	SE B	ß
Constant	761.94 —	—	—
SD [1.00]	-29.14 *	16.56	-20.01
Par [1.00]	51.83	76.41	0.08

Notes: * $p < 0.10$, two-tailed. [a] Variance inflation factor.
$R^2 = 0.047$; Adj. $R^2 = 0.021$; $F = 1.79$ ($df = 2, 73$, $p = 0.174$).

The standard deviation variable produced a significant negative effect on the theoretical win per unit. A one-unit, or percentage-point, increase in SD produced a $29.14 decrease in TWPU. This result was consistent with the bivariate correlation coefficient (-0.20) produced by these variables. The par variable failed to produce a statistically significant effect on TWPU.

Multiple Regression Diagnostics

A scatter plot of the studentized deleted residuals and the adjusted predicted TWPU values revealed no evidence of non-constant variance in the model residuals, nor did it reveal any indication of nonlinearity in the solution. However, two cases were omitted from the formal data analysis due to excessive studentized deleted residual values. Error patterns were reviewed by examining a normal probability plot and a residual histogram, both of which failed to reveal evidence of a problematic departure from a normal distribution. Variance inflation factors and conditioning indexes failed to indicate excessive bias from multicollinearity, per Tabachnick and Fidell's (1996) guidelines. A graphical review of DF Betas and Cook's Distances provided no cause for concern or evidence of cases exerting an exaggerated influence on the solution. Lastly, no significant serial correlation was detected in the residuals.

Discussion

Overall, the equation explained only 4.7% of the variation in TWPU. However, given the magnitude of the year-over-year change in TWPU (10.2%), much of this could have been random or normal variation. Regarding $H_0 1$, the result failed to reject the null hypothesis. That is, the change (i.e., increase) in par failed to significantly affect the production of theoretical win, at the unit-level. As for $H_0 2$, the null hypothesis was rejected. The change in SD produced a statistically significant decrease in TWPU. The effect of this variable on slot performance was consistent with the results of performance-potential researchers (Lucas et al., 2004; Lucas & Dunn, in press). The SD result adds to a growing and important research base, with game design implications, and direct linkage to the management of the customer experience.

The results of this study are as perplexing as they are helpful. For example, at what point would a percentage increase in par negatively affect performance? A 50% increase in par failed to significantly affect TWPU in this study. In fact, the mean TWPU was 10.2% greater in the 2003 (7.5% par) period. However, the results certainly do not suggest that players are losing less money, due to negative perceptions or reactions to the diminished price-value relationship. Instead, the results support the theory that players cannot perceive the considerable difference between a 5.0% game and a 7.5% game. The increase in performance from the 5.0%-par period was not statistically significant, but, more importantly, no evidence of a significant decrease in TWPU was provided. In this case, only a statistically significant decrease in performance would have supported the presence of negative customer perceptions associated with the increased par. Such a result was not produced. Only further research will help casino executives clarify the ability of players to perceive changes in pars and the resulting effects of these changes on performance.

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One obvious concern regarding the comparison of 2002 and 2003 performance is the 9-11 effect. The detrimental effects of 9-11 on the gaming and tourism industries are well documented. For example, the 2002-period might have represented a lesser stage of economic/business recovery from the 9-11 tragedy, characterized by lower business volumes than the 2003-period. To the contrary, when comparing the last six months of 2002 to the same period in 2003, the management of the donor casino reported that overall slot revenues were flat, actually down slightly from the 2002 period. Additionally, slot reports from the donor property indicated that the 2003 aggregate theoretical win for all $5.00 units declined by 6.0% from the same period in 2002 (i.e., July – December). These results failed to support the basic theory of 9-11 bias, bolstering the integrity of this study's results.

Managerial Implications

Overall, or on the aggregate level, the casino was winning the money at an increased rate. That is, on average, less pulls/spins by the player were required for the house to obtain the player's bankroll. This was achieved by increasing par from 5.0% to 7.5%. Given the magnitude and direction of the change in SD, this was a safe assumption. However, despite the increase in mean TWPU from the 2002 period (see Table 1), the increased pars did not affect a statistically significant increase in the TWPU of this sample. In summary, it is extremely likely that the casino had reduced the time needed for the player to lose his or her bankroll, but failed to significantly increase its share of the player's wallet.

This result raises other questions. For example, how would a more modest increase in par affect performance? Further, at what point would an increase in par lead to a significant increase in TWPU? One experimental hurdle for this study was the availability of a par less than 7.5%. Management would have liked to employ a more stepped approach to this research. However, the significant resources required by slot manufacturers to license different versions (e.g., different pars) of a slot machine, deter them from providing a multitude of par options for a game. In this case, the next available par option was 7.5% (from 5.0%). This represents a substantial increase in par, especially for a $5.00 slot machine. As gaming regulators are not likely to relax licensing requirements in this area, only further research on par changes and resulting demand for specific pars is likely to increase the number par options provided by manufacturers.

Limitations

The results of this study are not generalizable, as the data originated from a single property. Although the authors were unaware of any substantial changes that would bias the year-over-year performance comparison, these influences certainly could have existed. Additionally, other forces within the immediate market such as competitor actions could also have affected performance over the course of the study.

The long-term implications of the par change are yet to be determined. This study examined the performance-related effects of par changes that were in place for a minimum of 153 days and a maximum of 245 days. While these periods represent a considerable length of time, changes in customer perceptions could occur over a longer time horizon.

This study assumes the same amount of measurement error in the par variable across the year-over-year design. That is, a constant amount of play on multipliers occurred at less than the maximum wager. Multiplier slots often have two pars. One par for maximum coin wagers and one for less than maximum coin wagers. This study assumed that the amount of play at each level remained unchanged across the sample period. No slot system currently acknowledges this problem. That is, for purposes of performance analysis and player valuation, only one par field exists.

Lastly, multiple regression analysis does not prove cause and effect. Any references to the effects, impacts or influences of model variables were meant to describe the results of hypothesis tests. Simultaneous multiple regression analysis was merely a statistical method employed to test the tenability or plausibility of the theoretical model/ hypotheses advanced in this paper.

Future Research

Any attempt to repeat this study using a sample of $5.00 reels would help determine the external generalizability or applicability of the results. Also, research related to par changes in other denominations (e.g., $0.05), types (e.g., video poker games), or type of market (e.g., repeater vs. destination) would be valuable to casino executives.

Additionally, any research including a variation(s) on the par change would be most useful. This study featured a 50% increase in par, representing an academically useful, but rather extreme move. It would be beneficial to better understand the effects of more modest changes in par. Any study that would help identify limits, points of diminishing returns, or the general shape of the par-performance relationship would be most valuable to casino operators.

Finally, there are those that believe that players cannot determine substantial differences in the pars of otherwise identical games; however, no published research has directly examined this crucial assumption. At some point players might perceive differences. Research featuring some form of a blind design would shed light on this phenomenon. For example, wagering activity could be held constant, with the par of the reel machines unknown to the subjects. Each subject would wager the same amount, in the same fashion, against each of the different pars. Ultimately, the subjects could be asked to rank the games in terms of the pars, from greatest to least. This result would help researchers and operators better understand the ability of players to perceive par/ price. Of course there are many other useful versions of this type of design. Only the specific end goals of the researcher would limit the number and type of possible blind designs.

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