PLAYER ERROR FACTORS IN BLACKJACK:

HOW POOR ARE POOR PLAYERS?

By Bill Zender

Determining the house's mathematical edge in a game like roulette is quite easy. First, you determine the amount paid to the customer for every positive player outcome and the amount taken by the house for every casino positive outcome. Next, you take the difference between the two and divide it by the total number of possible outcomes. This gives you the house edge, also known as the "house advantage" in percentages (35-37 = -2/38 = -0.0526 = -5.26 percent). The 5.26 percent house advantage means that the casino expects to win, in theory, $5.26 for every $100 wagered on the roulette wheel. Knowing a game's house advantage establishes a basis for why a table game wins money, which is how the casino generates revenue. All casino games have a mathematical edge that can be calculated using the same principles we used to determine the house advantage in roulette. That is, every game except one: blackjack.

The popularity of blackjack makes it the queen of the casino. Blackjack tables in Nevada make up roughly 65 percent of all live casino table games. Blackjack produced more than $1.3 billion during the 2007–2008 fiscal period ending June 30 (State of Nevada). However, the mathematicians have a problem capturing the exact edge the casinos enjoy with this card game. Blackjack has a number of variables that alter the game's house advantage. First, there are the numbers of decks used to deal the game. Casino management throughout the gaming industry can offer anywhere from eight decks of cards dealt from a dealing shoe to a single lonesome deck of 52 cards dealt from the hand. The total number of decks in play shifts the mathematical edge of the game, increasing the percentage for the house as the number of decks increases.

Second, management has the ability to offer a host of blackjack rules. Management can offer doubling on split pairs, which slightly decreases the house's advantage but is used to attract players to the game. They can also restrict a payoff of a two-card blackjack (6:5 on blackjacks), which greatly increases the game's edge. This wide variety of rules and their combination of uses may swing the mathematical house advantage from a small negative advantage

Griffin's Player Error Factor, Spring 1987

Location	Number of Observations	Number of Errors	Variance +/-	Error Factor
Atlantic City	4,399	655	0.12	1.13%
Las Vegas	3,958	657	0.17	1.67%
Reno	2,335	364	0.19	1.48%
Lake Tahoe	332	42	0.54	1.39%
Total	**11,024**	**1,718**	**0.10**	**1.41%**

Table 1

(Caesars Palace once offered a game that had a mathematical edge of -0.2 percent) to a huge positive advantage (Harrah's Las Vegas now offers a game with a house advantage of +2.02 percent). It's obvious that the mathematician can determine the game of blackjack's "basic" house edge; however, there is still one variable that needs to be mentioned: player strategy errors. These are errors players make when deciding how to play their cards, with the cost of these errors increasing blackjack's true house advantage.

This factor leads to several important questions. How much do the players themselves contribute to the coffer of the casino through bad play? How much money does the casino earn because the players fail to use an optimal hand playing strategy? Is there some method that can be employed to determine how much this player error factor contributes to the casino's overall win in blackjack?

To begin with, mathematical calculations of the value of the number of decks and rules automatically take into consideration that the game is played with optimal efficiency known as basic strategy. What most casino operators may wish to know is how each player's departure from basic strategy affects the monetary return for the house. The problem is that there haven't been many past studies addressing this situation. In years past, most casino operators didn't care. They knew the game held an edge over the players, and as long as they held a certain percentage of the drop, why should they spend the time and effort determining something that wasn't really necessary to know? Just "dummy up" and deal the cards.

Today, casino executives are saddled with a new concern: the percentage of theoretical win that is used to determine player reinvestment. In other words, they need an accurate tool to gauge the amount of comps they can offer effectively and efficiently to their live game customers. Finally, the player error factor has gained some long-awaited importance. How much do my players actually give back per hand above and beyond the game's mathematical edge based on number of decks and rules?

Player tracking systems require a number of input variables to determine a player's theoretical win. The casino also needs a correct house advantage number before it can expect to calculate the correct percentage of theoretical win. Why is theoretical win so important? The marketing department uses this figure to calculate the amount of money it reserves for player reinvestment. This reinvestment figure is not a trivial amount, either. In 2007–2008, casinos throughout Nevada spent more than 20 percent of their total gaming revenue on comping rooms, food, airfare and cash back—an amount of approximately $2.5 billion (State of Nevada). As a casino executive, you should be asking yourself this important question: What is my blackjack customer's "player error" factor, and where can I find information about it? This article may just have that solution.

Past Blackjack Player Evaluations

In the mid-'80s, mathematician and blackjack expert Peter Griffin examined the effect that players' bad strategy decisions had on the house's edge at blackjack. Up to this time, common casino wisdom estimated that the players gave back approximately 2 to 3 percent of every dollar they wagered. Even Griffin agreed that the "uniformed tourist" contributed 3 percent to the casinos above and beyond the basic house advantage based on the game rules and numbers of decks (Griffin 1991).

Using multiple observations of actual casino customers playing blackjack, Griffin was able to construct a database that could be used with a statistical treatment to calculate variance and accurately determine the player's basic strategy error factor, in percentages, for the average casino player. Griffin also conducted his observation in different locations of the country, calculating player error percentages for Atlantic City, Las Vegas, Reno and Lake Tahoe. His experiment revealed the player error information shown in Table 1.

Griffin's observations and analysis placed the standard blackjack customer at an average playing error factor 1.41 percent higher than the blackjack game's house advantage using perfect basic strategy. Griffin also concluded that the average player more than likely was contributing close to 2 percent of every dollar he or she was wagering, because the average basic house advantage of 0.5 percent (Griffin 1991) is automatically added to the average error factor penalty.

More recently, advantage player and astrophysicist James Grosjean took an educated guess at the average player error factor in blackjack. Grosjean estimated that players he observed only contributed 1 percent of everything they wagered to bad play (Grosjean 2000). Grosjean developed this conclusion based on a strategy he constructed that reflected common errors that he observed common "civilians" making.

Why the big difference in player error percentage between his and Griffin's assessments? Grosjean concluded that the players he

Scope of Observation and Analysis

The following casinos contributed to the observation to gain blackjack player strategy data:

- **Casino A:** Downtown Las Vegas, 8 decks, hit soft 17 and double after split
- **Casino B:** Downtown Las Vegas, 6 decks, hit soft 17, double after split, re-split aces, and surrender
- **Casino C1:** Las Vegas Strip, 6 decks, hit soft 17, double after split, re-split aces, and surrender
- **Casino C2:** Las Vegas Strip, 6 decks, stand soft 17, double after split, re-split aces, and surrender
- **Casino D:** Detroit, Mich., 6 decks, hit soft 17, double after split, and re-split aces
- **Casino E:** Oregon, 6 decks, hit soft 17 and double after split
- **Casino F:** Atlantic City, 6 decks, stand soft 17, and double after split

Basic data analysis to determine average error, actual house advantage, 95 percent variance and upper and lower intervals:

I. Total observations, total errors, sum of errors and sum squared of errors

Total Obs	Errors	Sum	Sum Sq
7585	899	6287.12	86914.46

II. Average error in total observations, basic house advantage (rules, decks, etc.) and total house advantage (avg. error plus basic H/A)

Avg. Error	Basic H/A	Actual H/A
0.83	0.48	1.30

III. Sum of sum squared/observations, variance based on observation minus one degree of freedom, and standard deviation

Sum	Variance	Standard Deviation
81703.1	10.8	3.3

IV. 95 percent confidence variance, 95 percent upper H/A confidence interval and 95 percent lower H/A confidence interval

95% Confidence	Upper Interval H/A	Lower Interval H/A
0.07	1.38	1.23

observed played better blackjack because they were "local" players who frequented the casino more often than the strictly "tourist" players Griffin had watched and analyzed. Second, the game of blackjack had changed since 1987. By 1999, the date of Grosjean's observations, blackjack was dealt primarily face up. The face up game gives all customers at the table a chance to see everyone's cards, thus allowing everyone the chance to criticize players who are attempting to make bad hand decisions (Grosjean 2000). Although the players who criticize and instruct the other players do not possess perfect basic strategy knowledge, they limit the serious bad plays that Griffin probably watched.

How Badly Do They Play?

Over the last several years, I collected player error data from a number of casinos in North America. Observations conducted in a total of seven different locations allowed me to establish these points, which will provide a good overall understanding of how badly the average blackjack customer plays and how those playing errors affect the game's mathematical house advantage.

- The average blackjack players at all locations gives back approximately 0.83 percent of every dollar wagered (95 percent variance of +/- 0.06)
- Total hands observed: 7,584
- Total playing errors recorded: 901, or 11.9 percent of total hands observed (including insurance and surrender)
- Based on the previous assumption, the average player misplays 1 in 8.5 hands
- The average cost of playing mistakes per hand is 7 percent of the original dollars wager on that hand, or $7 for every $100 wagered, when a playing error is made

In the first bullet point, the possible error variance has been calculated as +/- 0.06 percent. Under the 95 percent confidence level used to calculate the possible error, the average blackjack player error percentage of 0.83 percent is within a standard error of 0.06 percent, indicating the true error percentage is safely within a range that is as low as 0.77 percent and as high as 0.89 percent.

It's also important to understand that error percentages differ from location to location. This can be attributed to the average local customer's gambling exposure and playing experience level, and the percentage of uneducated tourists that also frequent the casino. The following information reflects the different player error percentage for the different observation locations.

- Average blackjack players in downtown Las Vegas give back approximately 0.94 percent of every dollar wagered (95 percent variance of +/- 0.15)
- Average blackjack players on the Las Vegas Strip give back approximately 0.93 percent of every dollar wagered (95 percent variance of +/- 0.15)
- Average blackjack players in Atlantic City give back approximately 0.55 percent of every dollar wagered (95 percent variance of +/- 0.17)
- Average blackjack players in Detroit give back approximately 0.54 percent of every dollar wagered (95 percent variance of +/- 0.12)
- Average blackjack players in Oregon give back approximately 1.28 percent of every dollar wagered (95 percent variance of +/- 0.29)

The Nevada casinos in this observation rely heavily on tourists. Tourists, for the most part, travel from areas of the country where they are not exposed to blackjack or casino gambling on a regular basis. They tend to gamble less seriously than customers who live close to the casino and play blackjack on a more regular basis. The tourist affect is noted when examining the player error percentages for both downtown Las Vegas and the Las Vegas Strip.

Atlantic City and Detroit cater to a slightly different crowd. They primarily attract casino customers from their general location. When examining the results from these two locations, it is noted that the player error percentage is much lower than the tourist-driven market in downtown Las Vegas and the Las Vegas Strip. Even Griffin noted the difference between Atlantic City and Las Vegas during his observation and analysis in 1987 (see Table 1).

Although Oregon is not considered a destination-resort location, the locals they do attract are spread out over a large rural area. Because Oregon casinos are viewed as an alternative entertainment venue, blackjack players do not possess the serious attitude of serious urban gamblers. These players reflect more of the "tourist" attitude and play as a social interaction event. This situation is

indicated by the Oregon casino's player error percentage, which is approximately 1.3 times higher than Atlantic City's and Detroit's.

There is one problem with the Oregon error percentage figure. Because the number of observations used to calculate this percentage was lower than desired, the standard error variance of 0.29 percent was larger than the other observations. The range for this location indicates the true player error percentage could be as low as 0.99 percent, which would make it relatively close to the tourist intense percentages in Nevada. *[Note: In order to keep player error variance below 0.2 percent, 1,000 observations or more were requested. Some of the observation errors and percentages were corrupted, and only 660 observations could be used.]*

High Limit vs. Low Limit

The study also revealed facts and information I never planned to receive. One of the areas of surprising notability is the difference between lower-limit players and higher-limit players. It appears the more money a blackjack gambler places in action, the more attention he pays to learning the correct strategy. Observations were conducted on lower- and higher-limit players at the same casino on the Las Vegas Strip. These observations revealed the following facts:

- Higher-limit blackjack players on the Las Vegas Strip give back approximately 0.68 percent of every dollar wagered (95 percent variance of +/- 0.16).
- Lower limit blackjack players at the same location give back approximately 1.18 percent of every dollar wagered (95 percent variance of +/- 0.25).

Based on these observations, the contrast is striking. The higher-limit gambler gives back approximately half of what the lower-limit gambler contributes. This example is based only on a single property, but what if there is a parallel effect at other gaming locations across the country? This nugget of information may make the more learned and curious casino executive rethink his player tracking game plan for higher-limit players. Maybe higher-limit players should be rated based on an entirely different set of theoretical win metrics than those of the average player.

Surrender

In blackjack, there is one rule that is starting to receive more consideration as a standard, and that's the use of late surrender. Late surrender is given that label because this playing option can only be used after the dealer peeks at the hole card to make sure they do not hold an automatic winning two card blackjack. Surrender allows players to "surrender" their first two cards if they feel their chances of winning the hand are slight. For this forfeiture, players are allowed to retain half their original wager. Surrender was offered sparingly until the 1990s, but was quickly accepted by my casino executive because it provided the players with an additional playing option at a very low price. Late surrender reduces the basic house advantage by 0.06 percent (in multiple deck games). That is, it reduces the house's advantage only if the player takes advantage of the option. It was always my opinion that surrender didn't cost the house very much because most players fail to take the option, while other seemed to gain great enjoyment from abusing it. In my estimation, the surrender option was a break-even proposition at the very worst.

- Total playing errors recorded regarding surrender (based on 3,284 observations at casino's offering the surrender option): 144, or 4.4 percent of hands observed.

Based on these observations, the players seldom took insurance because the number of basic strategy acceptable situations is around 170 hand possibilities out of 3,284 hands observed at casinos that offered the option (both high- and low-limit players). Without going into great detail, it appears that a large number of players ignore the surrender option, missing out on any gains, and surrender hands that they shouldn't, thus costing the players more than if the option wasn't offered (two examples are surrendering a 12 vs. T, and 14 vs. 7). It's fairly safe to say that offering late surrender only costs pennies on the dollar but provides the players with an interesting option when playing blackjack.

The Overall Effect of Bad Play

Once you have determined what the players' error factor is in percentages, you need to add that cost to your blackjack game's house advantage. In most situations, a six-deck shoe with standard rules has a basic house advantage of approximately 0.60 percent. This percentage is then added to the player error percentage to calculate a true blackjack house advantage. Some of the Las Vegas Strip casinos presently offer very low house advantage six-deck games in their higher-limit areas. These games are designed to attract the higher-limit customer and are subject to a basic house advantage of only 0.28 percent.

- Based on a basic house advantage on a six-deck game of 0.60 percent (hit soft 17, double after splitting), the average blackjack player will lose 1.43 percent of the original wager, or $1.43 for every $100 wagered.
- Based on a basic house advantage on a high limit six-deck game of 0.28 percent (stand on soft 17, double after splitting, re-split aces, and surrender) the high limit blackjack player will lose 0.96 percent of the original wager, or $0.96 for every $100 wagered.

The true house advantage for blackjack varies greatly when everything is considered; however, we now have a more accurate and useable figure. These numbers should be especially interesting to executives in casino marketing. Many of the current player rating systems rate every blackjack player the same and still operate off the rating system's default advantage number of 2.0 percent. Adjustments in the player tracking system will help calculate a player's true theoretical win, which will give the casino a correct player reinvestment number that marketing can use to better service its players. In some cases, a correct house advantage number for blackjack could save the casino thousands annually by reducing inappropriate comp expenses.

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