

# The Wizard of Odds Analyzes the New Casino Games

BY MICHAEL SHACKLEFORD

The insurance business has always been a gamble but actuaries haven't exactly been considered high rollers at the gaming table. Until now.

**W**HAT ARE THE ODDS? It's the question all casino gamblers ask themselves when they sit down at the gaming table, and it's a question actuaries are uniquely qualified to answer. After all, the role of an actuary is to measure risks according to probabilities of possible outcomes. Casino gambling provides the excitement of risk taking in a controlled environment—a perfect combination for an actuary.

This explains why, after five years with the Social Security Administration, I decided to give up my career as a government actuary and devote all my time to the analysis and testing of casino games.





I use three main approaches to analyze casino games:

■ **Simple math:** Many games of luck can be analyzed easily by anyone comfortable with high school mathematics. Games such as craps, roulette, and keno can be evaluated easily using only a decent calculator.

■ **Combinatorial:** Games of skill require analyzing every possible outcome after every possible decision. In card games, this may involve testing billions of possibilities or more. Every possible outcome must be weighted by its probability, then the sum taken over all possibilities. The course with the greatest average return is the best play. By measuring over all initial situations the return of the game can be evaluated. With games like blackjack, the varying card composition remaining in the deck(s) can necessitate trillions of calculations. This brute force method can take a personal computer all night or longer to complete.

■ **Random simulation:** Some games are so difficult to model that a random simulation is the only way to go. With the speed of modern computers, this method is quite reliable in games with low payoffs. For games with rare yet large jackpots, however, this method can be unreliable due to bias in random number generators. This problem continues to be one of my greatest challenges.

Figure 1. Odds

| HAND  | PAYOFF   |
|---|----------|
|  Royal flush     | 100 to 1 |
|  Straight flush  | 50 to 1  |
|  Four of a kind  | 20 to 1  |
|  Full house      | 7 to 1   |
|  Flush           | 5 to 1   |
|  Straight        | 4 to 1   |
|  Three of a kind | 3 to 1   |
|  Two pair        | 2 to 1   |
|  Pair            | 1 to 1   |
|  Ace/King        | 1 to 1   |

Four of the most successful new casino games of the 1990s are Caribbean Stud Poker, Let It Ride, Spanish 21, and Three-Card Poker. (For an analysis of the latter two, see the *Contingencies* website at [www.contingencies.org](http://www.contingencies.org).) Developing a successful casino game is like introducing a new insurance product: It's a long process, complete with a different regulatory agency in each state. There's always the possibility a new game can be lost in litigation over the allegation that it stole someone else's concept. And ironically, casinos are risk averse when it comes to trying anything new.

The odds of a new game ever making the first dollar in profit for its owner are slim. These four games beat the odds and can now be found in casinos across the United States and abroad.

### Caribbean Stud Poker

This game got its name from its origins on Caribbean cruise ships. Eventually Mikohn Gaming purchased the game and put it in casinos throughout the United States. Caribbean Stud can also be found at many online casinos under different names, such as Caribbean Poker or Cyber Stud Poker. The game is played on a blackjack-size table. The rules are based on five-card stud and are easy to learn.

### The Rules

In Caribbean Stud Poker, each player plays against the dealer, not each other. After making their ante wagers each player and the dealer are dealt five cards. The players' cards are dealt face down. Players may look at their own cards, but they're not supposed to share information with each other.

Four of the dealer's cards are dealt face down and one face up. At this point the player has two options: fold or raise. If the player folds, he loses his ante bet. If the player decides to raise, the bet must be increased by an amount equal to double the ante bet.

After all player decisions have been made, the dealer flips

Figure 2. House Edge and Strategies

| STRATEGY                     | HOUSE EDGE | RISK ELEMENT |
|------------------------------|------------|--------------|
| Optimal                      | 5.22%      | 2.56%        |
| Three rules of thumb         | 5.22%      | 2.55%        |
| Raise on a/k/j/8/3 or better | 5.32%      | 2.60%        |
| Raise with matching rank     | 5.33%      | 2.62%        |
| Raise on pair or better      | 5.47%      | 2.74%        |
| Raise on ace/king or better  | 5.68%      | 2.67%        |
| Raise on everything          | 16.61%     | 5.54%        |

over his hand. The dealer must have at least an ace and king to qualify, otherwise those players who raised will win even money on the ante bet and the raise will push. If the dealer does qualify, then the hands of the player and dealer are compared; the better one wins.

If the dealer wins, the player loses both ante and raise. If the player wins, the ante wins even money and the raise pays according to Figure 1.

In the unlikely event of an exact match, the ante and raise both push. There's also a progressive jackpot side bet available, which doesn't depend on the dealer's hand that's explained below.

### Strategy

Caribbean Stud Poker is a difficult game to analyze. It takes a very efficient program to analyze a complete cycle of almost 20 trillion hands and do so in a reasonable period of time. Fortunately, there are two absolute truths that cover 93.56 percent of the hands. First, always raise with any pair or better. Second, always fold with less than an ace and king. There are no exceptions.

Where strategy gets complicated is if the player has an ace and king. Optimal strategy depends on the rank of the other three cards, the rank of the dealer's up card, and sometimes the suits of all six cards seen.

There's no simple rule of thumb that will correctly advise the player how to play every situation. It's also not practical to waste space with a large chart covering every possible situation. However, such a table is available on my website at [www.thewizardofodds.com/game/carstudapx.html](http://www.thewizardofodds.com/game/carstudapx.html). By studying this table, patterns and general rules emerge that will correctly advise the vast majority of ace/king hands.

- Raise if the dealer's card is less than king and matches one of yours.
- Raise if the dealer's card is an ace or king and you have a queen or jack.
- Raise if the dealer's card doesn't match any of yours, you have a queen, and your fourth highest card is higher than the dealer's card.

If none of these conditions is met, then fold. The house edge following these three rules of thumb is only .001 percent less than that by playing optimal strategy.

Here are some other common strategies, listed from best to worst.

**Raise on ace/king/jack/8/3 or better:** Professor John Gwynn and Peter Griffin determined that this is where the line should be drawn between raising and folding if the dealer's card is ignored.

**Raise on ace/king with any card matching the dealer's rank:**

**Table 3. Six Pay Tables**

| HAND             | TABLE 1   | TABLE 2   | TABLE 3   | TABLE 4   | TABLE 5   | TABLE 6   |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Four of a kind   | \$100     | \$150     | \$500     | \$500     | \$500     | \$500     |
| Full house       | \$75      | \$100     | \$100     | \$150     | \$75      | \$100     |
| Flush            | \$50      | \$50      | \$50      | \$50      | \$50      | \$75      |
| Break even meter | \$263,205 | \$246,784 | \$217,047 | \$176,613 | \$230,363 | \$201,245 |

If one of the player's cards matches the rank of the dealer's card, then it lowers the dealer's probability of forming a pair. The player does not want the dealer to get a pair, beating his ace/king.

**Raise on any pair or better:** This is a risk-averse strategy that may suit the player who wants to raise more confidently.

**Raise on any ace/king or better:** This strategy may suit the gambler who's not concerned with volatility and is willing to raise on sub-optimal hands.

**Raise always:** Otherwise known as playing blind. Some players raise on everything without even looking at their own cards. This is a very foolish strategy; a player should never raise with a non-qualifying hand.

### House Edge

Figure 2 presents the house edge and the element of risk for all strategies discussed.

### Progressive Side Bet

For an extra dollar the player can make a side bet that pays a bonus if the player gets at least a flush. This bet pays regardless of what hand the dealer has, and some view it as protection of a good hand in the event the dealer doesn't qualify.

As players make their ante wagers, they may put a \$1 token in a designated slot. When all wagers have been made, the dealer presses a button, the tokens vanish, and a light designates which players made the side bet.

A royal flush always pays 100 percent of the progressive meter, and a straight flush pays 10 percent. The payoff for a four of a kind, full house, or flush varies from place to place. Figure 3 shows six different pay tables I've seen and the break-even point for the meter to be a fair bet.

Casual observation will show that the meters rarely reach the break-even point; most of the time they don't even come close. Typically, the meters stay in five-digit territory.

The bottom line is that it's a sucker bet. The house keeps such a generous cut of every bet made, about 29 cents, that the progressive meter seldom has the opportunity to rise high enough to give the bet a positive expectation. On average, once every 649,740 times this bet is made somebody will get a royal flush and the house will have to reseed the meter, usually with \$10,000. But the expense of reseeding is minimal compared with the revenue generated between royal flushes. Based on a 29-cent cut and \$10,000 meter reseeding at the Casino Niagara (which is typical of all casinos), the overall house edge is 27.46 percent.

A little-known bit of information is what happens in the event two players get a royal flush in the same hand. Usually the rules will state that the player closest to the dealer's left will win the progressive meter and the second player will win only \$10,000, or whatever the casino reseeds the meter with. This

seems terribly unjust to the second player, but it's so unlikely it probably hasn't happened yet.

### Let It Ride

Let It Ride is a fairly simple game based on five-card stud. The player's cards are revealed gradually and as the game progresses, the player may reduce his bet if his hand doesn't look promising. If the player has a qualifying hand after all five cards are dealt, he'll be paid according to the hand itself and the total bet remaining. In addition, there's a \$1 side bet available that also pays according to the final hand.

### Rules

The game is played at a blackjack-size table with up to seven players. Play begins with each player making three wagers of equal size. Three circles designate where to place the bets. Five dollars per bet is the usual minimum.

After all bets have been made, three cards are dealt to each player. Two community cards are also dealt face down in front of the dealer. Based on these three cards, each player in turn must decide to take back one of the three bets or to leave all

**Figure 4. Let It Ride Payoff Table**

| HAND                   | PAYOFF     |
|------------------------|------------|
| Royal flush            | 1,000 to 1 |
| Straight flush         | 200 to 1   |
| Four of a kind         | 50 to 1    |
| Full house             | 11 to 1    |
| Flush                  | 8 to 1     |
| Straight               | 5 to 1     |
| Three of a kind        | 3 to 1     |
| Two pair               | 2 to 2     |
| Pair of tens or better | 1 to 1     |

bets alone—"let it ride."

After this round, the dealer will turn over the first of the two community cards. Then there's a second round in which each player may pull back a bet or let the remaining bet ride. Finally, the second of the two community cards is turned over and each player is paid according to the following pay table and the player's remaining bet.

The way to indicate that you want to pull back a bet is to scrape the side of your three cards against the felt, like taking a hit in hand-held blackjack. To stand, lay the cards face down in front of the bets or tucked under one of them.

### Strategy

With three cards the player should let it ride with any of the following hands:

- Any paying hand (pair of 10s or better, three of a kind)
- Any three to a royal flush
- Three suited cards in a row, except 2-3-4, and ace-2-3
- Three to a straight flush, spread 4, with at least one high card (10 or greater)
- Three to a straight flush, spread 5, with at least two high cards.

Note: "Spread" refers to how many ranks the cards are spread apart. For example, a 4, 6, and 8 would have a spread of 5 between the three cards and two gaps.

With four cards, the player should let it ride with any of the following hands:

- Any paying hand (pair of 10s or better, two pair, three of a kind)
- Any four to a royal flush
- Any four to a straight flush
- Any four to a flush
- Any four to an outside straight

- Any four to an inside straight with four high cards.

Note: An outside straight can be complete on end-5, 6, 7, or 8, let's say. An inside straight can be completed only one way, for example 5, 6, 8, 9.

### House Edge

The house edge in Let It Ride, defined as the ratio of the expected loss to one of the original three wagers, is 3.51 percent. The element of risk is 2.85 percent.

### Side Bet

Some, but not all, casinos allow a side bet of \$1, for which the player receives an additional payoff with certain paying hands. To place this bet, the player puts a dollar in a slot on the table. The dealer presses a button, the dollars vanish, and a light goes on to designate who made the bet. The following table shows various payoffs I've seen. With a house edge as high as 36.52 percent, this is a sucker bet to be avoided. Note that if the side bet wins, the original wager is not returned.

The following is a list of which casinos have which pay tables based on my small sampling. Unless otherwise stated, all casinos are in Las Vegas:

**Table 1:** Lady Luck

**Table 2:** Las Vegas Club, Freemont, Californian, Plaza, Main Street Station, Ballys, Circus Circus, Hilton, Grand (Biloxi), Beau Rivage (Biloxi), Horseshoe (Tunica), Grand (Tunica)

**Table 3:** Bellagio, Excalibur, Mandalay Bay, Harrah's, Imperial Palace, Paris, Venetian

**Table 5:** MGM Grand, Golden Nugget

**Table 6:** Colorado Belle (Laughlin)

**Table 7:** Four Queens, Flamingo Hilton

**Table 8:** New York, New York

To learn about two more casino games, Spanish 21 and Three-Card Poker, visit the *Contingencies* website at [www.contingencies.org](http://www.contingencies.org). For information about other games of chance in the casino or gambling in general, visit Michael Shackelford's website at [www.thewizardofodds.com](http://www.thewizardofodds.com).

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**Table 5. Let It Ride Side Bet**

| HAND            | TABLE 1  | TABLE 2  | TABLE 3  | TABLE 4  | TABLE 5  | TABLE 6  | TABLE 7  | TABLE 8  |
|-----------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Royal flush     | \$20,000 | \$20,000 | \$20,000 | \$20,000 | \$20,000 | \$10,000 | \$20,000 | \$20,000 |
| Straight flush  | \$2,000  | \$1,000  | \$2,000  | \$2,000  | \$1,000  | \$2,000  | \$2,000  | \$2,000  |
| Four of a kind  | \$100    | \$100    | \$100    | \$400    | \$400    | \$100    | \$300    | \$300    |
| Full house      | \$75     | \$75     | \$75     | \$200    | \$200    | \$75     | \$150    | \$150    |
| Flush           | \$50     | \$50     | \$50     | \$50     | \$50     | \$50     | \$50     | \$50     |
| Straight        | \$25     | \$25     | \$25     | \$25     | \$25     | \$25     | \$25     | \$25     |
| Three of a kind | \$9      | \$4      | \$8      | \$5      | \$5      | \$8      | \$5      | \$5      |
| Two pair        | \$6      | \$3      | \$4      | 0        | 0        | \$4      | 0        | 0        |
| High pair       | 0        | \$1      | 0        | 0        | 0        | 0        | 0        | 0        |
| House edge      | 13.77%   | 32.73%   | 25.39%   | 25.53%   | 26.92%   | 26.93%   | 35.14%   | 36.52%   |