

Rock and Roll 21

Mathematical Analysis
prepared for David Moss.

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An analysis of the mathematics and statistics inherent to a proposed new casino table game.

Rock and Roll 21

Mathematical Analysis

Prepared by Charles Mousseau, B.Sc. on May 8, 2008.

Introduction and general procedure:

1. "Rock and Roll 21" is played with anywhere between one and six decks of ordinary playing cards.
2. Players begin play by making an initial bet (hereafter referred to as the "Rock Bet") and an optional side bet (hereafter referred to as the "Bonus Bet").
3. Each player receives two cards, face-up, and the dealer receives two cards, one face-up and one face-down.
4. Each player decides whether to fold the hand (forfeiting the Rock Bet) or to play on by making an additional bet that matches the Rock Bet (hereafter referred to as the "Roll Bet"). **N.B.: *Players who have made the Bonus Bet but fold will receive a third card if their hand could possibly win the Bonus Bet and if they would normally be entitled to a third card, as detailed in rule 6.***
5. When all players have decided whether to fold or play on, the dealer reveals his hole card, and each player's hand total is compared to the dealer's hand total, to see which hand is closer to a total of 21.
 - a. Hands are totalled in the traditional blackjack fashion – namely, face cards count as ten, deuce through ten are worth the same as their rank, and aces count as either one or eleven, depending on which brings that hand closer to 21. **N.B.: *Since there is no 'busting' rule in this game, a starting hand with two aces counts as 22, and as detailed in rule 6, will stand pat.***
 - b. If both the player and the dealer have a hand totalling between 18 and 22, neither player draws and the Rock and Roll bets are settled immediately, as follows:
 - i. If the player's hand is closer to 21 than the dealer's hand, the player wins both the Rock and Roll bets.
 - ii. If the dealer's hand is closer to 21 than the player's hand, the player loses both the Rock and Roll bets.
 - iii. If the player's and dealer's hands are equidistant to 21, both bets are pushed.
 - c. If either the player or the dealer has a hand of 17 or less, the Rock Bet is acted on, as follows:
 - i. If the player's hand is closer to 21 than the dealer's hand, the Rock Bet stays in that designated betting spot.
 - ii. If the dealer's hand is closer to 21 than the player's hand, the Rock Bet is moved into an ***en prison*** area, hereafter referred to as the "Bandstand Area".
 - iii. If the player's and dealer's hands are equidistant to 21, the Rock Bet is pushed and returned to the player.
6. Next, all player hands that total 17 or less receive a third card, as does the dealer's hand.
7. Again, each player's hand is compared to the dealer's hand, to see which hand is closer to a total of 21.

- a. If the player's hand is closer to 21 than the dealer's hand, the player is paid on the Roll Bet, and either has the Rock Bet returned from the Bandstand Area, or paid if it is still in the Rock Bet area, depending on where it was located after the first tier of action.
 - b. If the dealer's hand is closer to 21 than the player's hand, the player loses all bets.
 - c. If the player's and dealer's hands are equidistant to 21, the Roll Bet pushes, and if the player has a bet in the Bandstand Area, that bet loses.
 - d. If the player wins with a two-card total of 21, all winning bets are paid at a rate of 3:2.
 - e. If the player wins with a three-card total of 21, all winning bets are paid at a rate of 2:1.
- N.B.: If the player's Rock Bet is moved to the Bandstand Area, and draws to a three-card total of 21, only the Roll Bet is a "winning bet"; it is paid at 2:1 while the Rock Bet is returned from the Bandstand Area.***
8. Finally, for each player that made the Bonus Bet, their hand is compared to the payable in Appendix A, and paid or taken accordingly.

Methodologies:

1. To determine the expectation and optimal strategy for the main game, a computer program was written to calculate the exact player expectation off of the first hand of the shoe, assuming optimal player strategy, by iterating through every possible hand and every possible outcome, multiplying the expected return of that hand by the probability of that hand occurring, and summing the results.
2. These results were verified by writing a second computer program to simulate game play over 1,000,000,000 hands; the results for this simulation agreed with the results calculated in Step 1 within a tolerance of 0.01%
3. Steps one and two were repeated above for purposes of calculating the expectation of the Bonus Bet, and a similar level of tolerance was achieved.

Results:

1. The house advantage by number of decks, for Main and Bonus bets, are available in Appendix B.
2. In those tables, the "House Edge" refers to the average win for the house as a percentage of the initial bet, whereas the "Element of Risk" refers to the average win for the house as a percentage of all money wagered by the player on both Rock and Roll bets, assuming optimal player strategy.

Game security:

1. As with any blackjack variant, the odds will change from hand to hand depending on what cards are being dealt. Care should be taken to observe players who are spreading bets substantially and appear to be playing near perfect optimal strategy.
2. In general terms, The Rock and Roll 21 'main game' is less vulnerable to a count-based strategy than traditional blackjack; player advantageous hands occur less often, and the player's advantage never grows to the rates it may grow to in regular blackjack.
3. For a complete summary of the vulnerability to card counting and other relevant information, please see the Card-Counting Analysis Report.

Report completed on May 8, 2008 by Charles Mousseau, B.Sc.

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Results are deemed reliable.

Appendix of Tables:

Table #1: "House Edge" and "Element of Risk", assuming optimal player strategy.

# of decks:	Hands played:	House Edge:	Element of Risk:
1	87.26%	-1.07%	-0.57%
2	85.83%	-0.97%	-0.52%
3	85.65%	-0.94%	-0.50%
4	85.74%	-0.92%	-0.49%
5	85.73%	-0.91%	-0.49%
6	85.73%	-0.90%	-0.49%

Table #2: Paytable for Bonus Bet.

Hand	Payout
(not 21)	-1
Two-card 21	4
Three-card 21 using a ten or face card	6
Three-card 21 with no ten or face card	20
Three sevens	77

Table #3: Hit rate and house edge summary for Bonus Bet

# of Decks	Hit Rate	House Edge
1	10.648567%	6.63%
2	10.509745%	6.50%
3	10.465019%	6.42%
4	10.442936%	6.39%
5	10.429776%	6.33%
6	10.421038%	6.31%

Table #3a: Bonus Bet paytable breakdown for 1 deck game.

Hand	% to Hit	Payout	Value
(not 21)	89.351433%	-1	-0.89351
Two-card 21	4.826546%	4	0.193062
Three-card 21 using a ten or face card	3.861237%	6	0.231674
Three-card 21 with no ten or face card	1.942685%	20	0.388537
Three sevens	0.018100%	77	0.013937
Total	100.000000%		-0.066305

Table #3b: Bonus Bet Paytable breakdown for 2 deck game.

Hand	% to Hit	Payout	Value
(not 21)	89.490255%	-1	-0.8949
Two-card 21	4.779686%	4	0.191187
Three-card 21 using a ten or face card	3.748774%	6	0.224926
Three-card 21 with no ten or face card	1.950534%	20	0.390107
Three sevens	0.030752%	77	0.023679
Total	100.000000%		-0.065003

Table #3c: Bonus Bet Paytable breakdown for 3 deck game.

Hand	% to Hit	Payout	Value
(not 21)	89.534981%	-1	-0.89535
Two-card 21	4.764268%	4	0.190571
Three-card 21 using a ten or face card	3.712417%	6	0.222745
Three-card 21 with no ten or face card	1.952886%	20	0.390577
Three sevens	0.035448%	77	0.027295
Total	100.000000%		-0.064162

Table #3d: Bonus Bet Paytable breakdown for 4 deck game.

Hand	% to Hit	Payout	Value
(not 21)	89.557064%	-1	-0.89557
Two-card 21	4.756596%	4	0.190264
Three-card 21 using a ten or face card	3.694444%	6	0.221667
Three-card 21 with no ten or face card	1.954014%	20	0.390803
Three sevens	0.037882%	77	0.02917
Total	100.000000%		-0.063668

Table #3e: Bonus Bet Paytable breakdown for 5 deck game.

Hand	% to Hit	Payout	Value
(not 21)	89.570224%	-1	-0.8957
Two-card 21	4.752005%	4	0.19008
Three-card 21 using a ten or face card	3.683725%	6	0.221023
Three-card 21 with no ten or face card	1.954676%	20	0.390935
Three sevens	0.039370%	77	0.030315
Total	100.000000%		-0.063349

Table #3f: Bonus Bet Paytable breakdown for 6 deck game.

Hand	% to Hit	Payout	Value
(not 21)	89.578962%	-1	-0.89579
Two-card 21	4.748949%	4	0.189958
Three-card 21 using a ten or face card	3.676606%	6	0.220596
Three-card 21 with no ten or face card	1.955112%	20	0.391022
Three sevens	0.040372%	77	0.031087
Total	100.000000%		-0.063126

Table #4: Optimal Player strategy for 6 deck game.

	A	2	3	4	5	6	7	8	9	T
22	P	P	P	P	P	P	P	P	P	P
21	P	P	P	P	P	P	P	P	P	P
20	P	P	P	P	P	P	P	P	P	P
19	P	P	P	P	P	P	P	P	P	P
18	X	P	P	P	P	P	P	P	P	X
17	X	P	P	P	P	P	P	P	P	P
16	X	P	P	P	P	P	P	P	P	P
15	X	P	P	P	P	P	P	P	P	P
14	1	P	P	P	P	P	P	P	P	P
13	P	P	P	P	P	P	P	P	P	P
12	P	P	P	P	P	P	P	P	P	P
11	P	P	P	P	P	P	P	P	P	P
10	X	P	P	P	P	P	P	P	P	P
9	X	P	P	P	P	P	P	P	X	X
8	X	P	P	P	X	X	X	X	X	X
7	X	P	X	X	X	X	X	X	X	X
6	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X
4	X	X	X	X	X	X	X	X	X	X

P: Play

X: Fold

1: Fold 77, play 86, 95, T4 or A3

Table #5: Changes to 6-deck optimal strategy when using one, two or three decks.

In a one deck game:

- Fold 86 v A (as well as 77, but play all other 14s v A)
- Play T5 v A (but fold all other 15s v A)
- Play 88, 97, T6 v A (but fold A5 v A)
- Play 98 or T7 v A (but fold A6 v A)
- Play 99 v T (but fold A7 v T)

In a two deck game:

- Fold 86 v A (as well as 77, but play all other 14s v A)
- Play 99 v T (but fold A7 v T)

In a three deck game:

- Fold 86 v A (as well as 77, but play all other 14s v A)