

**Mathematical Analysis
Of
Packs Poker**

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**Prepared
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Packs Poker is a table game played using a standard 52-card deck, in which players try to beat the dealer with the best 5-card poker hand that can be formed from their 5-card hand and 2 community cards. The community cards are divided into two or three 2-card "packs". Each player and the dealer may use the community cards from one of the packs they bet on, along with the cards they are individually dealt, to form a 5-card Poker hand. Player hands of Three of A Kind or better (in some pay tables, Straight or Better) can earn additional bonus payouts. The game can be played with either 2 or 3 packs of community cards and a variety of Pay Tables for the bonus payouts.

Players start by making an Ante Bonus bet of unit size, or a separate Pack bet, or both, in one or more of the betting areas. Each betting area has a circle for an Ante Bonus bet and a Pack bet. A "5-card Bonus" bet may be offered in addition to or instead of the Ante Bonus bet.

Each player starts with a hand of 5 cards dealt face down and the dealer is also dealt a 5-card hand. After players view their cards, the first 2-card pack of community cards is turned face up. Players who placed a bet on the first pack have their Pack Bet settled at even money by comparing the best 5-card hand they can make using cards from their hand and the first 2 card pack of community cards with the best hand the dealer can make. However, players must qualify with a pair or better to win this bet; if they have no pair or better but still beat or tie the dealer's hand, then the Pack Bet is pushed. (In an alternative version of the rules, the Pack Bet is lost if the player does not have a pair, even if he beats or ties the dealer's hand.)

Then the second pack of community cards is turned face up, and players who placed a bet on the second Pack Bet have that bet settled at even money by comparing the best 5-card hand they can make using cards from their 5- card hand and the second 2 card pack of community cards with the best card hand the dealer can make, where beating the dealer with less than a pair only pushes. In the 3-pack version, the same process is done for the third pack. After choosing which packs to bet on before the cards were dealt, the player does not fold or raise or make any other decisions.

The dealer determines the best 5-card poker hand that can be made from the player's 5-card hand and the 2-card pack of community cards. If this hand is Three of a Kind or better, the Ante Bonus bet is paid according to the following payable (other paytables, some of which require lower or higher minimum hands to win, are shown in the Appendix to this report):

7-card Straight Flush \$25,000 (fixed payout)

6-card Royal Flush \$5,000 (fixed payout)

5-card Royal Flush 500:1

Straight Flush 200:1

4 of a Kind 50:1

Full House 10:1

Flush 5:1

Straight 3:1

3 of a Kind 2:1

The payouts, except for the top two which are fixed dollar amounts, shown are on a "to 1" basis: each of the player's Ante Bonus wagers, is also returned if he achieves Three of a Kind or better by combining his cards with 0, 1, or 2 cards from the corresponding 2-card pack. The player may receive up to 3 Bonus payouts, which will always happen if his original 5-card hand is Three of a Kind or better. This wager may also be offered on a pure "odds" basis, with no special top payout but only the best 5-card hand being used.

The player makes no decision after the initial wagers are made. The Pack bets are independent of each other and provide a small advantage to the House, because the player must have a qualifying hand to win. Most of the House's advantage from the player comes from the Ante Bonus bet, which pays based only on the player's cards and the Community cards and does not involve the dealer cards.

A "5 Card Bonus" bet may also be offered, based only on the player's 5 card hand and not on the community cards. This bet is only made in one place, because it doesn't depend on the cards in the packs. A typical pay table might look like the following (also shown on a "to 1" basis):

Royal Flush 1000:1

Straight Flush 500:1

4 of a Kind 250:1

Full House 30:1

Flush 20:1

Straight 10:1

3 of a Kind 5:1

Two Pair 3:1

One Pair, Jacks or Better: 2:1

This game was analyzed using combinatorial mathematics for the Ante Bonus bet and 5 card Bonus bet, and using a computer simulation of 52,000,000 deals to estimate the frequency of the player beating the dealer with less than “one pair or better” for the Pack bets.

There is no folding or raising and no strategy: this is a game of chance and not a game of skill. Each pack on which the player bet is independently used to compare the best 5 out of 7 cards for the player and the dealer, while for each Ante Bonus wager the dealer evaluates the best hand the player can make using that wager's corresponding pack, against a pay table.

Summary of Results:

In the base game, the dealer has an advantage equal to the probability that the player beats the dealer with less than “one pair or better” which is estimated to be **1.48%** (with a standard error of 0.004%).

In the alternative version of the rules, where the player loses his bet when he does not have a pair even when he beats the dealer, this advantage is **2.98%**.

On the Ante Bonus bet, the House has an advantage that depends on the pay table.

Because the payouts for 7-card and 6-card Royal Flushes are fixed dollar amounts, the House Edge Percentage varies depending on the player's initial bet. For a \$5 unit bet, with the given pay table (\$25,000/\$5,000/500/200/50/10/5/3/2, labeled as Pay Table "3oakC" below) the House Edge is **4.35%** of a unit wager or \$0.218. In practice the House Edge will be the same as the theoretical advantage because the player makes no decisions and so cannot play worse than optimally (whether he bets on 1, 2, or 3 packs has no effect on the percentage of money the House wins). If the player places Pack and Ante Bonus bets of equal amounts, the House Edge is the average of these two numbers, or **2.92%**

If the player is allowed to bet a different amount than the standard unit amount for the Ante Bonus wager, the House Edge will change because of the fixed payouts. For the pay table given, the 4.35% House Edge on a \$5 bet becomes 3.34% on a \$1 bet, or 4.56% on a \$25 bet. If no fixed payouts are offered for special hands of more than 6 cards, the House Edge is 4.61% regardless of bet size.

In a similar way, the House Edge changes when the fixed payouts are changed, according to the ratio between the payouts and the bet size. If, instead of \$25,000 and \$10,000, the fixed payouts are reduced a factor of 5, to \$5,000 and \$1,000 respectively, that has the same percentage House Edge as if the bet size had increased by 5x. With a \$1 bet, the House Edge is the same 4.35% as it was for the original version with a \$5 bet. With a \$2 bet, the House Edge is the same 4.48% as it was for the original version with a \$10 bet, as indicated in the tables below.

For the 5 card Bonus bet, the given pay table (1000/500/250/30/20/10/5/3/2, labeled as Pay Table C below) gives a House Edge of **9.52%**. It can also be offered with a fixed top payout. For example, a fixed payout of \$5000 for a Royal Flush has a House Edge of 9.52% on a \$5 bet because the ratio of 1000 is the same as in the original pay table. The probability of winning the top award is 0.00000154, so if instead the bet is \$1 the ratio becomes 5000 and the House Edge decrease by $4000(0.00000154) = 0.616\%$. With a \$10 bet the ratio becomes 500 and the House Edge increases by $500(0.00000154) = 0.077\%$, etc.

Results for other pay tables are shown on the following pages. The House Edge for the Pack bets remains at **1.48%** (or **2.98%** in the alternative version) no matter what pay table is used.

Both the Ante Bonus bet and the 5 card Bonus bet may be configured as Progressives, with an accumulating jackpot, with odds displayed on a "for 1" basis rather than a "to 1" basis. The Appendix to this report shows results for these configurations.

Packs Poker: Ante Bonus Pay Tables (1)

Total hands	133,784,560	1 out of	Probability	2PairA	3oakA	3oakB	3oakC	3oakD	3oakE
7-card Str Flush	32	4,180,768	0.000000239	\$50,000.00	\$25,000.00	\$10,000.00	\$25,000.00	\$50,000.00	\$10,000.00
6-card Royal	180	743,248	0.000001345	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00
Royal Flush	4,140	32,315	0.0000309	500	500	500	500	500	500
Straight Flush	37,232	3,593	0.0002783	200	200	200	200	200	100
Four of a Kind	224,848	595	0.0016807	50	100	50	50	25	50
Full House	3,473,184	39	0.0259610	5	10	10	10	10	10
Flush	4,047,644	33	0.0302549	4	5	5	5	5	5
Straight	6,180,020	22	0.0461938	2	2	3	3	3	3
Three of a Kind	6,461,620	21	0.0482987	1	1	2	2	2	2
Two Pair	31,433,400	4	0.2349554	0	-1	-1	-1	-1	-1
One Pair	58,627,800	2	0.4382255	-1	-1	-1	-1	-1	-1
No Pair	23,294,460	6	0.1741192	-1	-1	-1	-1	-1	-1
			Win Freq	38.77%	15.27%	15.27%	15.27%	15.27%	15.27%
Bet:	\$1.00	House edge:		4.70%	4.38%	3.70%	3.34%	6.94%	6.48%
Bet:	\$2.00	House edge:		5.63%	5.02%	4.15%	3.97%	7.87%	6.93%
Bet:	\$5.00	House edge:		6.19%	5.40%	4.42%	4.35%	8.44%	7.21%
Bet:	\$10.00	House edge:		6.38%	5.53%	4.52%	4.48%	8.62%	7.30%
Bet:	\$25.00	House edge:		6.49%	5.60%	4.57%	4.56%	8.73%	7.35%
only 5 card pays		House edge:		6.57%	5.65%	4.61%	4.61%	8.81%	7.39%

Packs Poker: Ante Bonus Pay Tables (2)

Total hands	133,784,560	1 out of	Probability	3oakF	3oakG	StraightA	StraightB	StraightC	FlushA	FullHouseA
7-card Str Flush	32	4,180,768	0.000000239	\$50,000.00	\$25,000.00	\$50,000.00	\$25,000.00	\$50,000.00	\$50,000.00	\$50,000.00
6-card Royal	180	743,248	0.000001345	\$5,000.00	\$2,500.00	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00
Royal Flush	4,140	32,315	0.0000309	500	400	500	500	250	500	500
Straight Flush	37,232	3,593	0.0002783	100	200	250	250	200	250	250
Four of a Kind	224,848	595	0.0016807	50	50	100	100	50	50	100
Full House	3,473,184	39	0.0259610	10	10	10	10	10	15	25
Flush	4,047,644	33	0.0302549	5	4	5	5	5	10	-1
Straight	6,180,020	22	0.0461938	3	3	3	4	4	-1	-1
Three of a Kind	6,461,620	21	0.0482987	2	2	-1	-1	-1	-1	-1
Two Pair	31,433,400	4	0.2349554	-1	-1	-1	-1	-1	-1	-1
One Pair	58,627,800	2	0.4382255	-1	-1	-1	-1	-1	-1	-1
No Pair	23,294,460	6	0.1741192	-1	-1	-1	-1	-1	-1	-1
			Win Freq	15.27%	15.27%	10.44%	10.44%	10.44%	5.82%	2.80%
Bet:	\$1.00	House edge:		5.52%	7.01%	7.43%	3.41%	13.38%	6.21%	5.12%
Bet:	\$2.00	House edge:		6.46%	7.47%	8.37%	4.05%	14.32%	7.14%	6.06%
Bet:	\$5.00	House edge:		7.02%	7.76%	8.93%	4.43%	14.88%	7.70%	6.62%
Bet:	\$10.00	House edge:		7.20%	7.85%	9.12%	4.56%	15.06%	7.89%	6.80%
Bet:	\$25.00	House edge:		7.32%	7.90%	9.23%	4.63%	15.18%	8.00%	6.92%
only 5 card pays		House edge:		7.39%	7.94%	9.30%	4.68%	15.25%	8.07%	6.99%

Packs Poker: Ante Bonus Pay Tables (3)

Total hands	133,784,560	1 out of	Probability	3oakH	3oakI	3oakJ	3oakK	3oakL
7-card Str Flush	32	4,180,768	0.000000239	\$25,000.00	\$25,000.00	\$25,000.00	\$25,000.00	\$25,000.00
6-card Royal	180	743,248	0.000001345	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00
Royal Flush	4,140	32,315	0.0000309	500	500	500	500	500
Straight Flush	37,232	3,593	0.0002783	200	100	150	100	100
Four of a Kind	224,848	595	0.0016807	50	50	50	50	50
Full House	3,473,184	39	0.0259610	10	10	10	10	15
Flush	4,047,644	33	0.0302549	4	5	5	4	3
Straight	6,180,020	22	0.0461938	3	3	3	3	2
Three of a Kind	6,461,620	21	0.0482987	2	2	2	3	2
Two Pair	31,433,400	4	0.2349554	-1	-1	-1	-1	-1
One Pair	58,627,800	2	0.4382255	-1	-1	-1	-1	-1
No Pair	23,294,460	6	0.1741192	-1	-1	-1	-1	-1
			Win Freq	15.27%	15.27%	15.27%	15.27%	15.27%
Bet:	\$1.00	House edge:		6.36%	6.12%	4.73%	4.32%	3.81%
Bet:	\$2.00	House edge:		7.00%	6.75%	5.36%	4.95%	4.44%
Bet:	\$5.00	House edge:		7.38%	7.14%	5.74%	5.33%	4.83%
Bet:	\$10.00	House edge:		7.51%	7.26%	5.87%	5.46%	4.95%
Bet:	\$25.00	House edge:		7.58%	7.34%	5.95%	5.53%	5.03%
only 5 card pays		House edge:		7.63%	7.39%	6.00%	5.59%	5.08%

Packs Poker: Ante Bonus Pay Tables (4)

Total hands	133,784,560	1 out of	Probability	3oakM	3oakN	StraightD	StraightE	StraightF
7-card Str Flush	32	4,180,768	0.000000239	\$25,000.00	\$25,000.00	\$25,000.00	\$25,000.00	\$25,000.00
6-card Royal	180	743,248	0.000001345	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00	\$5,000.00
Royal Flush	4,140	32,315	0.0000309	500	500	500	500	500
Straight Flush	37,232	3,593	0.0002783	100	100	150	100	100
Four of a Kind	224,848	595	0.0016807	50	50	75	50	50
Full House	3,473,184	39	0.0259610	10	10	10	10	10
Flush	4,047,644	33	0.0302549	5	5	6	7	8
Straight	6,180,020	22	0.0461938	4	3	4	5	5
Three of a Kind	6,461,620	21	0.0482987	2	3	-1	-1	-1
Two Pair	31,433,400	4	0.2349554	-1	-1	-1	-1	-1
One Pair	58,627,800	2	0.4382255	-1	-1	-1	-1	-1
No Pair	23,294,460	6	0.1741192	-1	-1	-1	-1	-1
			Win Freq	15.27%	15.27%	10.44%	10.44%	10.44%
Bet:	\$1.00	House edge:		1.50%	1.29%	7.37%	5.32%	2.29%
Bet:	\$2.00	House edge:		2.14%	1.92%	8.01%	5.95%	2.93%
Bet:	\$5.00	House edge:		2.52%	2.31%	8.39%	6.34%	3.31%
Bet:	\$10.00	House edge:		2.64%	2.43%	8.51%	6.46%	3.44%
Bet:	\$25.00	House edge:		2.72%	2.51%	8.59%	6.54%	3.51%
only 5 card pays		House edge:		2.77%	2.56%	8.64%	6.59%	3.56%

Packs Poker: 5 card Bonus Pay Tables (odds shown on "To 1" basis: 1 is even money, 0 is a push, -1 is a loss)

Total Hands	2598960	1 out of	Probability	A	B	C	D	E
Royal Flush	4	649740.00	1.53908E-06	1000	1000	1000	1000	1000
Straight Flush	36	72193.33	1.38517E-05	250	200	500	250	250
4 of a Kind	624	4165.00	0.000240096	100	100	250	100	100
Full House	3744	694.17	0.001440576	50	50	30	25	25
Flush	5108	508.80	0.001965402	25	25	20	20	20
Straight	10200	254.80	0.003924647	10	8	10	10	10
3 of a Kind	54912	47.33	0.021128451	4	5	5	5	3
2 Pair	123552	21.04	0.047539016	3	4	3	4	2
1 Pair JQKA	337920	7.69	0.130021239	2	2	2	2	1
1 Pair 2-10	760320	3.42	0.292547788	-1	-1	-1	-1	0
0 Pair	1302540	2.00	0.501177394	-1	-1	-1	-1	-1
			Win Freq	20.63%	20.63%	20.63%	20.63%	49.88%
			House Edge	11.71%	5.70%	9.52%	9.43%	6.91%

Appendix: Packs Poker Progressive

In the following tables, it is assumed that there is a Progressive Jackpot for the Ante Bonus wager which is seeded at \$50,000, and a unit Progressive bet of \$5.00 (smaller or larger bets may be allowed). The top two awards (7 card Straight Flush, or 6 card Royal Flush) pay the entire jackpot, or 10% of the jackpot, respectively. All pays are shown on a "for 1" basis. 5% of each wager is applied to the growing Progressive Jackpot. Although the Jackpot always starts at \$50,000, it may temporarily go lower if one of the 10% partial pot awards occurs before it has grown to at least \$55,555. Tables are also shown for a Progressive Jackpot for a 5 card Bonus wager, where the top payout is a "Royal Flush in Diamonds" and it starts at \$25,000 with a unit bet of \$5..

The probability of a 7-card Straight Flush is 0.000000239, so every change of 1000 in the ratio of seed amount to bet corresponds to a change in House Edge of 0.024% in the opposite direction. Thus, for a \$1 bet the ratio increases from 10000 to 50000 and the House Edge decreases by 0.96%. For a \$25 bet the ratio decreases from 10000 to 2000 and the House Edge increases by 0.19%.

In the 5-card Bonus Progressive, the probability of a Diamond Royal Flush is 0.000000385, so every change of 1000 in the ratio of seed amount to bet corresponds to a change in House Edge of 0.0385% in the opposite direction. Thus, for a \$1 bet the ratio increases from 5000 to 25000 and the House Edge decreases by 0.77%. For a \$25 bet the ratio decreases from 5000 to 1000 and the House Edge increases by 0.15%.

Packs Poker: Progressive Ante Bonus Pay Tables (1) (odds shown on "For 1" basis: 2 is even money, 1 is a push, 0 is a loss)

Total hands	133,784,560	1 out of	FOR 1 BASIS	2PairA	3oakA	3oakB	3oakC	3oakD	3oakE	3oakF
7-card Str Flush	32	4,180,768	0.000000239	100%	100%	100%	100%	100%	100%	100%
6-card Royal	180	743,248	0.000001345	10%	10%	10%	10%	10%	10%	10%
Royal Flush	4,140	32,315	0.0000309	500	500	500	500	1000	500	500
Straight Flush	37,232	3,593	0.0002783	200	200	200	250	200	100	100
Four of a Kind	224,848	595.0	0.0016807	50	100	50	50	25	50	50
Full House	3,473,184	38.5	0.0259610	5	10	10	10	10	10	10
Flush	4,047,644	33.1	0.0302549	4	5	5	5	5	4	5
Straight	6,180,020	21.6	0.0461938	3	3	4	4	4	3	4
Three of a Kind	6,461,620	20.7	0.0482987	2	2	3	2	3	2	3
Two Pair	31,433,400	4.3	0.2349554	1	0	0	0	0	0	0
One Pair	58,627,800	2.3	0.4382255	0	0	0	0	0	0	0
No Pair	23,294,460	5.7	0.1741192	0	0	0	0	0	0	0
		Prog. Contrib.		5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
		Win Freq		38.77%	15.27%	15.27%	15.27%	15.27%	15.27%	15.27%
7-card SF seed	\$50,000.00	Avg Jackpot		\$700,923	\$700,923	\$700,923	\$700,923	\$700,923	\$700,923	\$700,923
Partial award	10.00%	Avg partial pot		\$70,092	\$70,092	\$70,092	\$70,092	\$70,092	\$70,092	\$70,092
Average bet	\$5.00	House Edge		7.15%	6.23%	5.19%	8.63%	7.84%	20.45%	7.97%

Packs Poker: Progressive Ante Bonus Pay Tables (2) (odds shown on "For 1" basis: 2 is even money, 1 is a push, 0 is a loss)

	Total hands	1 out of	FOR 1 BASIS	3oakG	StraightA	StraightB	StraightC	FlushA	FullHouseA
7-card Str Flush	133,784,560	4,180,768	0.000000239	100%	100%	100%	100%	100%	100%
6-card Royal	180	743,248	0.000001345	10%	10%	10%	10%	10%	10%
Royal Flush	4,140	32,315	0.0000309	1000	500	1000	500	500	500
Straight Flush	37,232	3,593	0.0002783	250	250	250	100	250	250
Four of a Kind	224,848	595.0	0.0016807	50	100	50	50	75	100
Full House	3,473,184	38.5	0.0259610	10	10	10	20	15	25
Flush	4,047,644	33.1	0.0302549	5	5	5	5	10	0
Straight	6,180,020	21.6	0.0461938	4	4	4	2	0	0
Three of a Kind	6,461,620	20.7	0.0482987	2	0	0	0	0	0
Two Pair	31,433,400	4.3	0.2349554	0	0	0	0	0	0
One Pair	58,627,800	2.3	0.4382255	0	0	0	0	0	0
No Pair	23,294,460	5.7	0.1741192	0	0	0	0	0	0
		Prog. Contrib.		5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
			Win Freq	15.27%	10.44%	10.44%	10.44%	5.82%	2.80%
7-card SF seed	\$50,000.00		Avg Jackpot	\$700,923	\$700,923	\$700,923	\$700,923	\$700,923	\$700,923
Partial award	10.00%		Avg partial pot	\$70,092	\$70,092	\$70,092	\$70,092	\$70,092	\$70,092
Average bet	\$5.00		House Edge	7.08%	9.88%	16.74%	5.74%	4.45%	4.55%

Packs Poker: Progressive 5 card Bonus Pay Tables (odds shown on "For 1" basis: 2 is even money, 1 is a push, 0 is a loss)

5 card Progressive	2598960	1 out of	Probability	A	B	C	D	E
Diamond Royal	1	2598960.00	3.84769E-07	100%	100%	100%	100%	100%
Royal Flush	3	866320.00	1.15431E-06	1000	1000	1000	1000	1000
Straight Flush	36	72193.33	1.38517E-05	500	500	500	250	250
4 of a Kind	624	4165.00	0.000240096	100	200	100	100	100
Full House	3744	694.17	0.001440576	50	100	25	50	25
Flush	5108	508.80	0.001965402	25	50	20	25	20
Straight	10200	254.80	0.003924647	10	10	10	20	10
3 of a Kind	54912	47.33	0.021128451	5	5	5	5	4
2 Pair	123552	21.04	0.047539016	4	4	4	4	3
1 Pair JQKA	337920	7.69	0.130021239	3	2	3	3	2
1 Pair 2-10	760320	3.42	0.292547788	0	0	0	0	1
0 Pair	1302540	2.00	0.501177394	0	0	0	0	0
			Prog Ctrb	1.00%	1.00%	1.00%	1.00%	1.00%
Jackpot Seed	\$25,000.00		House Edge	10.97%	9.46%	15.56%	7.39%	6.52%
Average Bet	\$5.00		Avg Jackpot	\$90,127.00	\$90,127.00	\$90,127.00	\$90,127.00	\$90,127.00