POKER WORK BOOK FOR MATH GEEKS

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Contents

Pre-Flop All-In Percentages

If all the money goes in before the flop, there is no more action and the cards just run out.

There are eight basic ways two hands can relate to each other. They are shown on the following pages. A common match-up is for one person to have two overcards and one person to have a pair. This is commonly referred to as a race or a coin flip because each person will win essentially 50% of the time.

A second typical match-up is pair versus pair. The lower pair will only win 20% of the time. The percent chance of winning is also known as your equity. So if there was $100 in the pot, on average the lower pair would win $20 because 20% of $100 is $20.

Pre-flop equities are not calculated at the tables, they are remembered. All of the equities that are listed on the next pages were calculated with Equilab, but any of the tools in the appendix of this book would do the same.

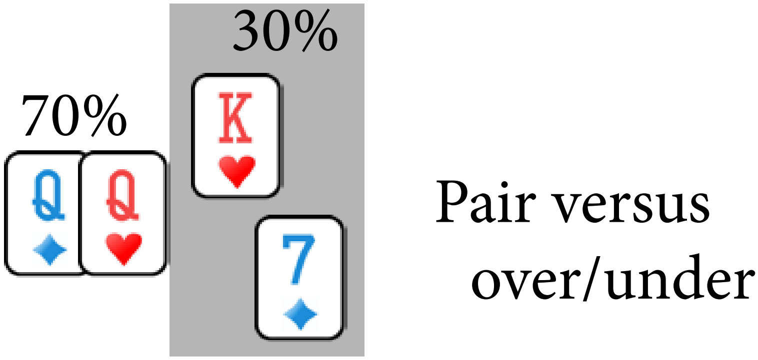
We only need an approximation of the percent chance of each hand winning, and we can round the equities off to make them easier to remember. As with most of this book, we are only trying to get close. These equities are important when calling a shove or making a shove pre-flop.

A simple example would be if you raise to $10 with Ace King and someone shoves all-in for $50. You have seen this player do this kind of thing with small pocket pairs quite often, and you believe that is what he has now. You are being given the opportunity to call $40 to win a total pot of $100.

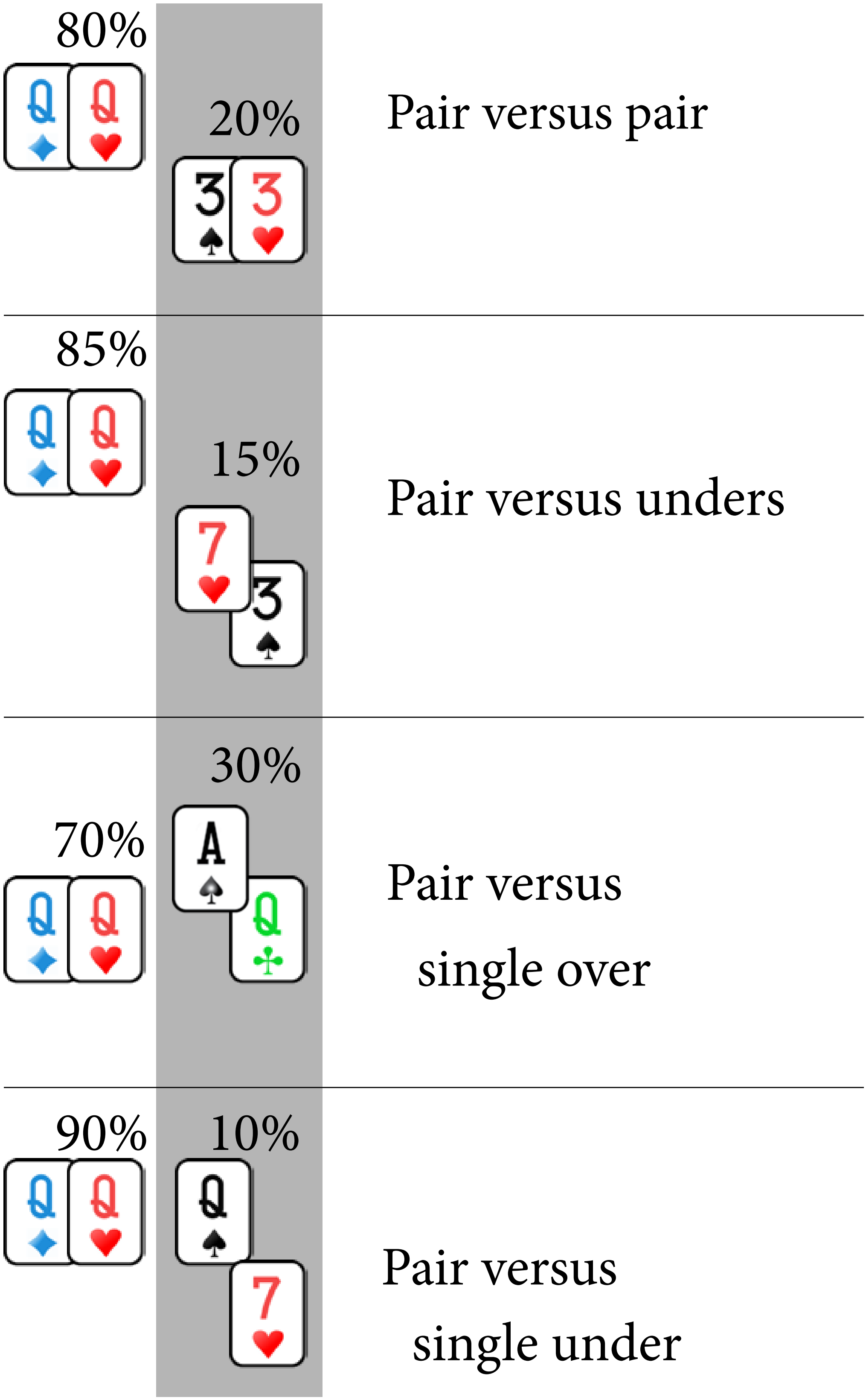
Your Ace King wins 50% of the time versus his assumed holding of a small pocket pair like 77. Since you expect to walk away with 50% of the $100, that is $50. If you put $40 into the pot and expect to win $50, this is a good bet and you should call. Later in the book we consider more complex (and realistic) situations, like the fact that the Villain might also hold AQ, KK, or something like 78s.

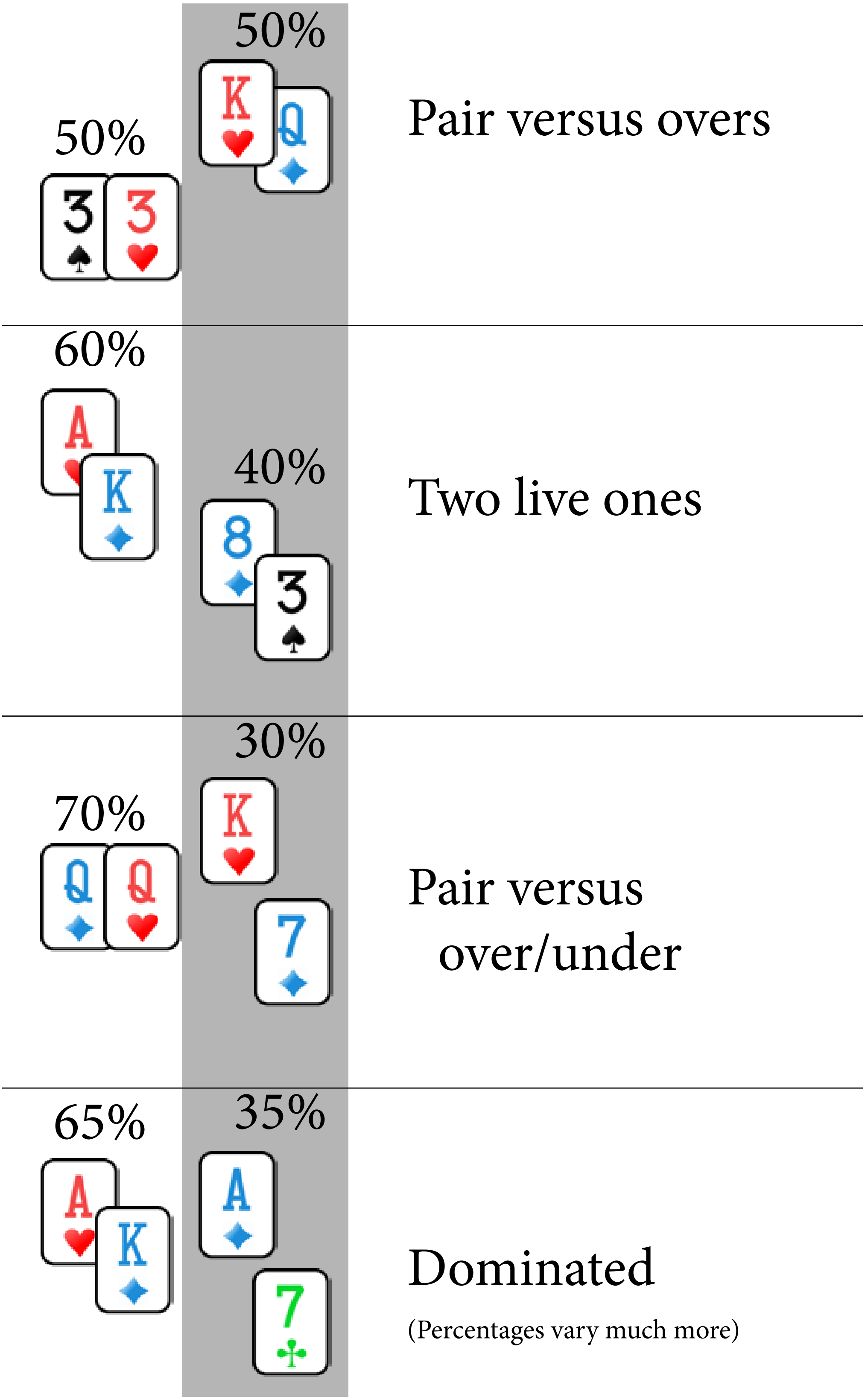
In the following diagrams, notice that the cards are not haphazardly placed, they are higher or lower in the space based on their ranks so it is easier to see their relationships.

For instance, in the diagram below, the King is higher up than the pair of Queens and the Seven is placed lower. Also using Equilab, we know that the Queens are a 70%-30% favorite over K7o, and this statistic is mentioned above the pairs of cards. This basic percentage will hold whenever a pair is matched up against an over card and under card with slight bonuses for the possibility of a straight or flush by the unpaired cards.



Note that in a dominated situation (a hand like A7 versus AK below) the actual equities can vary quite a bit from the stated 35%-65%. This is because in a dominated situation like K3 versus K2, frequently neither the Deuce nor the Trey will play, so the equities are much closer to 50%-50%. In other situations like A7o versus 78s is 35%-65%. Hands that share a small card, like Q2o versus K2o are more like 25%-75%. It is not worth doing a lot of work to remember all these possibilities.


80%
20%
Pair versus pair
85%
15%
Pair versus unders
30%
70%
Pair versus
single over
90%
10%
Pair versus
single under


50%
50%
Pair versus overs
60%
40%
Two live ones
30%
70%
Pair versus over/under
65%
35%
Dominated
(Percentages vary much more)

These first exercises are very straight forward and based off of the percentages mentioned above. The point of this exercise is to get you thinking about the possible variations of the type of hands described above and begin to develop an intuition on your own of how mathematically good your hand is versus other possible hands.

For the first set, circle the hand that is ahead if all the money goes in pre-flop. The second set of exercises are tougher but more useful. Write the percentages in for each hand. Just find the applicable case in the prior page and fill in the percentages.

To further refine the estimates, the hand that is behind gets an equity boost for being suited and/or connected. For instance:

- KK versus 92o is 13%,
- KK versus 92s is 17%,
- KK versus 98o is 19%,
- KK versus 98s is 22%.

Add 4% for suitedness and 4% for connectedness and that is a good approximation.

Just about any poker calculator will be capable of this kind of calculation. Look for the video accompaniment to this book on RedChipPoker.com to see how to use compute tools to solve these. See the appendix for recommended tools.

7♦ 2♣ vs. A♠ A♥	3♣ 3♠ vs. A♣ K♠
8♣ 8♦ vs. 7♣ 7♠	A♥ 3♥ vs. K♣ K♠
2♦ 2♠ vs. 3♠ 4♠	K♣ J♣ vs. A♥ Q♠
A♠ 3♠ vs. A♥ 2♥	7♦ 7♣ vs. 8♥ 9♥
A♠ K♠ vs. 2♣ A♣	3♣ 9♦ vs. K♣ 4♠

Answers: page 250

K♣ K♠ vs. 7♦ 7♥ %______ vs. %______	K♣ K♠ vs. A♥ 4♥ %______ vs. %______	A♠ A♣ vs. K♠ Q♠ %______ vs. %______
J♦ 10♣ vs. 8♠ 3♦ %______ vs. %______	J♦ J♣ vs. A♠ 7♥ %______ vs. %______	A♥ 9♠ vs. K♣ 3♥ %______ vs. %______
3♣ 3♠ vs. K♣ Q♣ %______ vs. %______	A♠ K♣ vs. 9♠ 8♦ %______ vs. %______	2♦ 2♥ vs. A♣ K♠ %______ vs. %______
K♣ 3♣ vs. K♠ 2♠ %______ vs. %______	10♠ 10♣ vs. J♦ J♣ %______ vs. %______	A♣ 2♣ vs. J♦ 10♦ %______ vs. %______
10♣ 9♠ vs. 10♠ 2♥ %______ vs. %______	10♣ 10♠ vs. 2♦ 7♥ %______ vs. %______	6♠ 6♣ vs. 2♣ 2♦ %______ vs. %______
Q♦ Q♠ vs. A♣ 10♣ %______ vs. %______	K♣ 2♣ vs. J♦ 10♦ %______ vs. %______	J♠ J♣ vs. 8♠ 2♣ %______ vs. %______
J♠ 3♠ vs. 9♣ 2♠ %______ vs. %______	3♣ 3♠ vs. K♣ Q♠ %______ vs. %______	J♠ 9♣ vs. 2♦ 8♥ %______ vs. %______
3♠ 3♣ vs. 2♣ 10♦ %______ vs. %______	K♣ J♠ vs. Q♦ 10♥ %______ vs. %______	10♣ 10♠ vs. 3♠ 3♣ %______ vs. %______

Calling Odds

In poker there are good bets and there are bad bets. The real art is setting up bad bets for your opponents while only taking the good bets offered to you. There are two components to any bet, the odds of winning and the pay off odds. In order to decide what to do when presented with a bet, we need to know both. We might calculate that we will win a given bet only one time for every nine losses, but if we get one hundred times our bet when we win, this is a bet we should take every time.

Let's look at an example:

In the above example, the Villain bets his last two chips into a pot of four chips. We can see that we are getting a chance to win all six chips for the two we are asked to put into the pot. This is a ratio of six in the pot to two in the call. We would write this as 6:2. In the interest of simplicity, we can simplify this 6:2 ratio to 3:1 to keep the numbers smaller. All that matters is the ratio. We could do this same simplification for a bet of $200 into a $400 pot or even a bet of $133 into a pot of $266.

For the rest of the example, we will think in the reduced or simplified ratio because keeping the numbers simple allows us to more easily do the mental math.

Even though we only play out a given situation once, we really care what happens on average. An easy way to think about these situations is to imagine that we call the bet several times in a row and we win or lose in the exact proportion to what the odds dictate we should. After playing out the hand several times, we add up all the wins and losses.

Let's pretend we know we will win this bet exactly 25% of the time. This is 75%-25% or a ratio of 3:1. This says we will lose three times and win once on average. We will look at four trials in this case. We use four trials because it is the smallest number that lets us keep the ratios of wins and losses right.

If we were to call this bet four different times, we would lose three times for a total loss of three chips. On the fourth time, we win, and we would get three chips from the pot. This one win of three chips would pay for all three of the losses. Because on average we neither win nor lose, this is our break even chances of winning. Playing out the scenario four times is illustrated below.

We just saw that getting 3:1 on our call, the break even percent of winning is 3 losses to 1 win, or 75% losses and 25% wins. What if we actually won this hand 50% of the time?

1:1 ODDS (50% WIN)

CALL AND LOSE

CALL AND WIN

Looking above illustration, if we win 50% of the time, our ratio is 50%-50% or 1:1. The smallest number of trials we can do to keep the ratios right is two. Play it out twice to see the results: once losing and once winning. We will suffer a single one chip loss and also get three chips from the pot for our one win. Over the two trials we win more than we lose. Profiting two chips over the two trials means this is a great bet. We should take it every chance we can get.

What if we only win this hand 20%? We know this is less than our break even percentage (25% was break even). Looking to the ratio, 80% losses and 20% wins means 4:1 odds. We should play this out five times to keep the ratios right. Illustrated below is four losses to one win:

Over the five trials, we lose four chips and only win three. We can see that we are slowly losing money because the payoff does not justify the risk. We are losing one chip over five trials or on average losing 0.2 chips every time we make this call.

These small losses are often disguised in the luck of Hold'em, but they are silent killers. Avoid these small losses and instead inflict them on your opponent and you will win at poker.

Hand Versus Range, Implied Odds

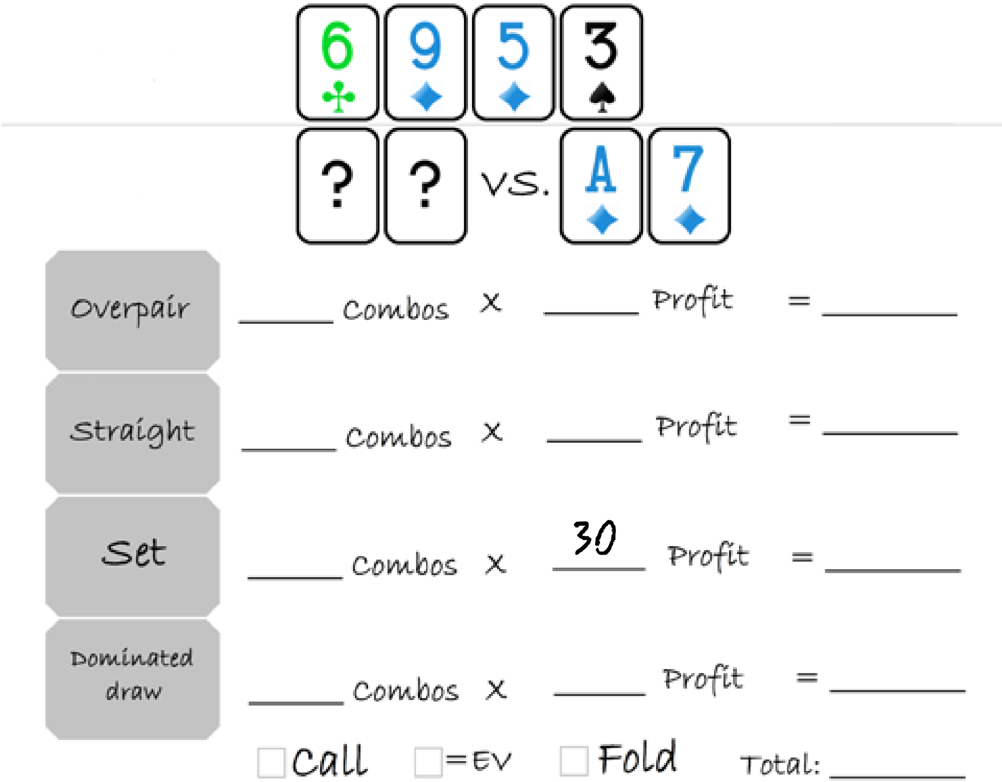
In this section we are using a very similar worksheet as before. In the earlier sections, the Villain shipped all of his money in on the turn. In this section he bets but has more money left for a river bet.

The call decision is more complicated when there is still money left to bet on the next street. The money left behind after the bet and call is referred to as implied odds. We never know if Villain is willing to put that money in the pot later, so we need to guess.

Here is an example of a completed worksheet for the next section. We will use this to estimate the profit or loss of this hand versus hand match-up including the implied odds.

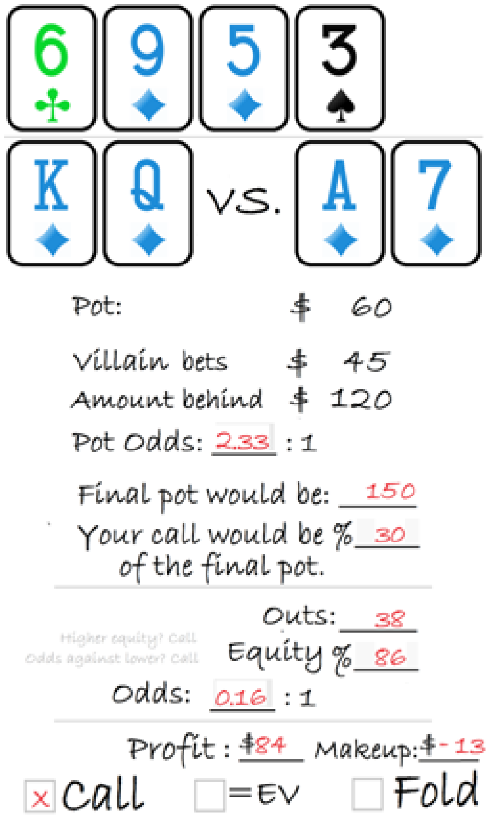
The $0 profit means we are breaking even every time we make this call. If the Villain were all-in, this would be a pointless call since we neither win nor lose on average with the call. However, after we make this call, there is $120 in implied odds. Because the Villain has such a strong hand, we think we will get the remaining $120 most of the time when we hit our hand. Let's be a little conservative and say that sometimes he will fold to the obvious flush. Discount and say we will only make $100 when we hit.

We hit 30% of the time, so on average we make $30 with this call in implied odds. This is our average profit for this match-up of set versus combo draw. We put this guessed number in the profit for the combo counting sheet.



We need to be realistic about this guess. Sometimes you will hit your draw and the Villain will not have a strong enough hand to pay you off. In this case, your profit from implied odds might be zero.

Let's look at another hand for Villain on the same board.



In the above match-up, the Villain bet into us with a dominated draw. Because we have such huge equity here, this $45 call into a $105 pot already profits us $84. Barring bluffs, the only way more money is likely to go in is when the flush comes on the River.

The flush will hit about 15% of the time and we will get the Villain's entire stack every time. This 15% of the remaining $120 is about $20 more on average. In the combo counting worksheet we will note that this match-up is worth about $100 ($84 + $20) on average.

When making these estimates, be sure to account for situations where you will pay off the Villain and count that as negative profit.

Note that when we are ahead, the number of outs is huge. It is often better to calculate the outs from Villain's point of view in these cases, but the answer key will show the large number of outs.

3♦ Q♠ 5♠ J♥

A♣ Q♣ vs. A♠ K♠

Pot: $ 80

Villain bets $ 75

Amount behind $ 75

Pot Odds: ____ : 1

Final pot would be: _____

Your call would be % _____ of the final pot.

Outs: _____

Higher equity? Call
Odds against lower? Call

Equity % _____

Odds: ____ : 1

Profit : $ ____ Makeup: $ ____

☐ Call ☐ =EV ☐ Fold

3♦ Q♠ 5♠ J♥

Q♦ Q♣ vs. A♠ K♠

Pot: $ 80

Villain bets $ 75

Amount behind $ 75

Pot Odds: ____ : 1

Final pot would be: _____

Your call would be % _____ of the final pot.

Outs: _____

Higher equity? Call
Odds against lower? Call

Equity % _____

Odds: ____ : 1

Profit : $ ____ Makeup: $ ____

☐ Call ☐ =EV ☐ Fold

3♦ Q♠ 5♠ J♥

Q♦ J♦ vs. A♠ K♠

Pot: $ 80

Villain bets $ 75

Amount behind $ 75

Pot Odds: ____ : 1

Final pot would be: _____

Your call would be % _____ of the final pot.

Outs: _____

Higher equity? Call
Odds against lower? Call

Equity % _____

Odds: ____ : 1

Profit : $ ____ Makeup: $ ____

☐ Call ☐ =EV ☐ Fold

3♦ Q♠ 5♠ J♥

K♥ K♦ vs. A♠ K♠

Pot: $ 80

Villain bets $ 75

Amount behind $ 75

Pot Odds: ____ : 1

Final pot would be: _____

Your call would be % _____ of the final pot.

Outs: _____

Higher equity? Call
Odds against lower? Call

Equity % _____

Odds: ____ : 1

Profit : $ ____ Makeup: $ ____

☐ Call ☐ =EV ☐ Fold

AA	AKs	AQs	AJs	ATs	A9s	A8s	A7s	A6s	A5s	A4s	A3s	A2s
AKo	KK	KQs	KJs	KTs	K9s	K8s	K7s	K6s	K5s	K4s	K3s	K2s
AQo	KQo	QQ	QJs	QTs	Q9s	Q8s	Q7s	Q6s	Q5s	Q4s	Q3s	Q2s
AJo	KJo	QJo	JJ	JTs	J9s	J8s	J7s	J6s	J5s	J4s	J3s	J2s
ATo	KTo	QTo	JTo	TT	T9s	T8s	T7s	T6s	T5s	T4s	T3s	T2s
A9o	K9o	Q9o	J9o	T9o	99	98s	97s	96s	95s	94s	93s	92s
A8o	K8o	Q8o	J8o	T8o	98o	88	87s	86s	85s	84s	83s	82s
A7o	K7o	Q7o	J7o	T7o	97o	87o	77	76s	75s	74s	73s	72s
A6o	K6o	Q6o	J6o	T6o	96o	86o	76o	66	65s	64s	63s	62s
A5o	K5o	Q5o	J5o	T5o	95o	85o	75o	65o	55	54s	53s	52s
A4o	K4o	Q4o	J4o	T4o	94o	84o	74o	64o	54o	44	43s	42s
A3o	K3o	Q3o	J3o	T3o	93o	83o	73o	63o	53o	43o	33	32s
A2o	K2o	Q2o	J2o	T2o	92o	82o	72o	62o	52o	42o	32o	22

198 combos in preflop range

0% 21.6%

3♦ Q♠ 5♠ J♥

? ? vs. A♠ K♠

Top pair ______ Combos x ______ Profit = ________

Set ______ Combos x ______ Profit = ________

Two Pair ______ Combos x ______ Profit = ________

Overpair ______ Combos x ______ Profit = ________

☐ Call ☐ =EV ☐ Fold Total: ________

Equity on the Flop

The equities on the flop are calculated with the Rule of Two or Rule of Four depending on if a turn bet is expected. If you expect to face a bet on the turn, use the Rule of Two as we have been doing already for turn math. If you expect to get the next two cards for the calling the flop bet, use the Rule of Four.

The Rule of Four says to count your outs and multiply by four to get your percent chance of winning. There are refinements to this rule that we will cover later.

Calculations on the flop are more complicated than on the turn because there are two chances to hit the needed outs. If the needed out comes on the turn, there is still a chance for the river to change things again. There are cards that can come on the turn that will add more outs on the river. These are often called "outs to outs" or back door equity. Mathematically they are just a few percent change in equity, but strategically they can mean a lot more.

As an example of back door draws, imagine there are three different suits on the flop. Matching one of the suits on the turn and then again on the river makes a flush possible. This flush is called a back door flush.

You can also have back door straight draws. If your hand combined with the board makes three to a straight, the turn and river can combine to make a straight. So if you have pocket Sixes on an A57 board, you still can get a straight.

We simplify back door draws by saying there is a bonus 4% for back door flushes and 2%-4% for back door straights. Three cards to a straight get the 4% bonus, for instance 456. Three cards that have one gap that must be filled gets a 3% bonus, for instance 679. Three cards that have two specific gaps that must be filled get a 2% bonus, for instance 8TQ or AKJ.

On most boards there is chance for the turn and river to bring three of a kind or other perfect run outs. These are very rare and do not change equities enough to be worth accounting for. We will only look for the major back door draws of flushes and straights. These bonus equity amounts are only for the hand that is behind and counting outs, not for the hand in the lead.

If we are drawing to a straight or a flush and suspect that the Villain could get a full house with a single card then we need to account for that. This would happen when a player has three of a kind or two pair. This player is said to have a redraw.

A set has seven redraw outs on the turn and then an additional ten on the turn to get a full house. We need to discount our draw's equity to account for the redraw. Reduce the draw's equity by 30% *of the total equity*. To do this, calculate your draw's equity versus a simple top pair or overpair and take the 30% off for being against a set. Note that you do not subtract 30%, you reduce by 30%. Similarly, the draw loses 15% of the total equity versus two pair. If you suspect the made hand has either two pair or a set, reduce by 20%.

Some outs are only a marginal improvement, like making a single low pair or a single pair becoming two pair. The Villain usually has similar redraws against these small improvements. Because of this, we give back 4% percent. This is a small adjustment that does not apply to strong draws like straights and flushes, only to two pair and pair outs.

If a set is against a straight or a flush, they have seven outs on the turn and then ten on the river since they might pair the turn card also. This can be thought of as 17 outs and use the Rule of Two to arrive at 34% equity.

Add-ons to the Rule of Four

Back door flush draws add 4% to their equity

Back door straight draws add 2% to 4% to their equity

Draws give back 30% *of their equity* to sets

Draws give back 15% *of their equity* to two pair

Draws give back 20% *of their equity* to sets and two pair range

Small improvements should discount 4% at end

Sets that need to boat have 7 outs on the flop then 10 on river. Call this 17 outs and use Rule of Two to say 34% to boat by the river.

Pocket pairs that need to boat or pair the board are similar to the sets.

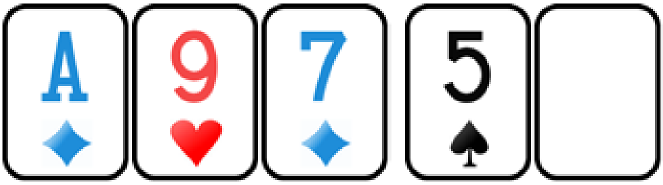
Fold Equity

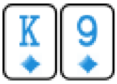
Our cards have both showdown equity and fold equity. Showdown equity is the value we get when you go to showdown and have a superior five card hand. Fold equity is what makes bluffing and semi-bluffing work because sometimes we will bet and everyone folds. In semi-bluffing, when called we still have appreciable equity.

As we have seen through this book, it is often difficult to make money by calling with draws. Playing more aggressively with draws is one way to make up for this and is the hallmark of great players. There are many strategic places where betting with a draw makes sense. Here we will see the math behind that.

In a pure bluff, we expect that we will always lose when called. If we have a chance to win when called because our draw might come in, then this is more of a semi-bluff. The showdown value of our hand is our second chance in a semi-bluff; the more equity you have when called the better.

As an example:





Pot: $120

Two players, we are in position, $90 stacks

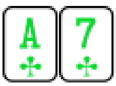
We put our Villain firmly on an Ace but not two pair. This means we have nine flush outs, two Nines, and three Kings unless Villain has Ace King. We will discount the King out by one. This gives us thirteen discounted outs. Rule of Two says we have 26% + 3% bonus for 29% equity against a variety of Aces.

This means that if we were to shove and get called, the pot would be $300. We are entitled to 30% of that pot or $90. Since we are shoving $90 and we expect to get back $90 *when called*, shoving costs us nothing. It is like a coin flip except we win less frequently and triple up when we do win.

The key part of the above statement is *when called*. It is reasonable to believe that sometimes when we shove the Villain will fold. Every time Villain folds,

Folding Nut Flush Draw on the Flop

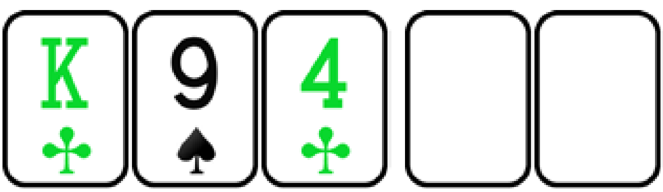
Effective stacks: $200.

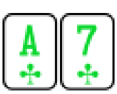


vs.

Villain raises to $12 in MP1. A player calls and we call on the button with a weak suited Ace.

We know very little about these ranges at this point, so lets go to the flop.





Pot: $39

Three players, we are in position, $190 stacks

The original raiser bets $40 into the pot and the middle player raises it up to $120. The flop raiser is not the type that would raise on a draw in this spot, so we put them solidly on two pair or better. Most likely we are against a set of

Nines or Fours with the occasional King Nine suited. Further, we believe that the flop raiser is never folding. If the flop bettor does not re-open the action, the remaining $70 will be bet on the turn.

It is unclear to us what the pre-flop raiser has or if he will come along to the turn, but we think he certainly has a weaker range than the flop raiser.

Let's start with pure aggression. Do we have the odds to just ship it right now? We might remember that a flush draw is 25% to win by the river versus a flopped set. If we assume pre-flop raiser has very little equity and is willing to call, then he will contribute a lot of dead money to the pot. In this rosy situation, we will put essentially 33% of the money in and only collect 25%. The $40 in pre-flop dead money is not enough to justify getting $190 more in right now since our 25% equity in the dead money is only $10. Clearly if all the money goes in now against a set, we are losing lots of money. It gets even worse if the pre-flop raiser does not come along.

Can we call the raise? In the best case scenario the flop bettor will call but not raise us. That makes the pot $120 x 3 for $360 and the original $40 for $400 total with $70 back.

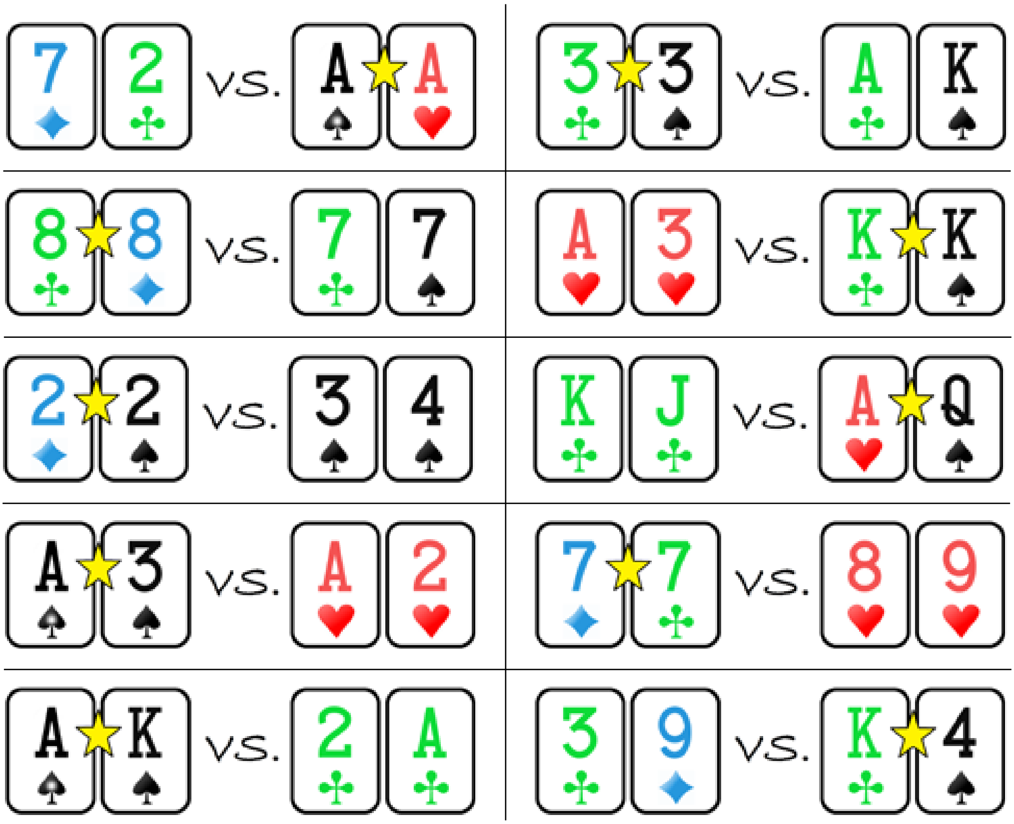
We make the nuts on the turn with only eight cards since the Nine of Clubs brings a boat or more to a flopped set. We will make this draw about 18% of the time. Let's call it 20%. This means we are entitled to $80 of the pot, and we are putting $120 in. This is not good for us either. However, we have $70 in reserve. Let's take the best case scenario where we hit our flush and get called by both Villains. The set still has ten clean outs to a boat or better, that is about 20% equity to our 80%. The final pot would be $600 again and we get $480 on average **when we hit on the turn**. That means we only get that $480 20% of the time. That is $96 (think 10% of $480 and then double it) in the absolutely best case scenario. And our best case scenario has us losing money on average.

If making our draw on the turn does not make us money, then calling the inevitable turn shove is going to be ugly for us also. There are seven board pairing turns where we are drawing stone dead. Imagine we get to the turn three ways for $120. The pot will be $360 + $40 for $400. If we catch a brick that does not pair the board and both players go all in before us, then giving us the best possible odds on our draw there would be $70 + $70 + $400. We would be forced to call getting such a good value on our 20% draw. The final pot would be $600 again so we would be entitled to $120 for our $70.

Essentially, by calling the flop we are setting ourselves up to be pot stuck on the turn. The turn call on a non-pairing brick would be +EV, but the whole line would be bad for us since we are losing money even those times when we do hit as we saw in the analysis where we hit on the turn.

All of these analysis were with the very generous assumption that the third player is shoving money in stone dead. In more realistic scenarios we are doing much worse. Just fold the flop, even with this monster draw if you truly believe the Villain has two pair or better.

ANSWER KEY


7 2 vs. A A
3 3 vs. A K
8 8 vs. 7 7
A 3 vs. K K
2 2 vs. 3 4
K J vs. A Q
A 3 vs. A 2
7 7 vs. 8 9
A K vs. 2 A
3 9 vs. K 4

K♣ K♠ vs. 7♦ 7♥ % 80 vs. % 20	K♣ K♠ vs. A♥ 4♥ % 67 vs. % 33	A♠ A♣ vs. K♠ Q♠ % 84 vs. % 16
J♦ 10♣ vs. 8♠ 3♦ % 70 vs. % 30	J♦ J♣ vs. A♠ 7♥ % 71 vs. % 29	A♥ 9♠ vs. K♣ 3♥ % 64 vs. % 36
3♣ 3♠ vs. K♣ Q♣ % 50 vs. % 50	A♠ K♣ vs. 9♠ 8♦ % 64 vs. % 36	2♦ 2♥ vs. A♣ K♠ % 53 vs. % 47
K♣ 3♣ vs. K♠ 2♠ % 53 vs. % 47	10♠ 10♣ vs. J♦ J♣ % 18 vs. % 82	A♣ 2♣ vs. J♦ 10♦ % 54 vs. % 46
10♣ 9♠ vs. 10♠ 2♥ % 70 vs. % 30	10♣ 10♠ vs. 2♦ 7♥ % 88 vs. % 12	6♠ 6♣ vs. 2♣ 2♦ % 81 vs. % 19
Q♦ Q♠ vs. A♣ 10♣ % 68 vs. % 32	K♣ 2♣ vs. J♦ 10♦ % 53 vs. % 47	J♠ J♣ vs. 8♠ 2♣ % 89 vs. % 11
J♠ 3♠ vs. 9♣ 2♠ % 65 vs. % 35	3♣ 3♠ vs. K♣ Q♠ % 51 vs. % 49	J♠ 9♣ vs. 2♦ 8♥ % 69 vs. % 31
3♠ 3♣ vs. 2♣ 10♦ % 69 vs. % 31	K♣ J♠ vs. Q♦ 10♥ % 62 vs. % 38	10♣ 10♠ vs. 3♠ 3♣ % 82 vs. % 18

About the Author

After the great success of his first book, Poker Plays You Can Use, in the spring of 2015 Doug quit his 9-to-5 engineering job to do this kind of stuff full-time in Las Vegas. He runs Red Chip Poker along with James Sweeney, Ed Miller and Christian Soto.

Doug does poker coaching by the hour and in three day boot camp style engagements. Say hello any time you see him at the tables or give him a call to tune up your game:

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