Why We Bet in No-limit Hold ‘em: a Failure of Intuition

by Donald Phillips and Brian SpaceTwo Plus Two Magazine, Vol. 14, No. 5

We ran across a hand on a forum recently and it spurred some informative analysis. It raises the questions of why we bet and points out that well informed and sensible intuition can be misleading at times.

To be clear, there is only one truistic reason to bet: to maximize our expected value (EV) vs. our opponents’ strategies. At times, reasons are easily rationalized post facto as:

1. To make a better hand fold.
2. To get worse hands to call.
3. To protect our equity while denying our opponents equity.

Other times the reasons are less obvious. We bet a particular sizing that might be small for our particular combination in a vacuum, but the strong holding protects our smaller bets as part of an overall weaker betting range. Other times we bet simply because our opponents fold too much in a particular spot and betting any combination will show a profit. In No-Limit Hold ‘em For Advanced Players: Emphasis on Tough Games, Matthew Janda recognized the limitations of the traditional reasons for betting and suggested two reasons for betting: equity protection and putting more money in the pot for the times we win.

Another useful heuristic for betting is that a particular hand has a certain value, say as judged on the flop. Consider in no-limit hold ‘em, A♦K♦ on a K♥8♠9♠ flop. Consider being 40 big blinds deep with a three-bet 20 big blind pot preflop. Our hand is worth enough that the money is always getting in versus a willing opponent. So, the question is how to bet our stack in the manner that makes the most money. The idea is that we know our hand is going to put in at least a certain amount of money, so what line makes it most likely we face a range that maximizes our EV. In the simple case above, we will always be committing our stack. We will almost always lose to flopped sets. Facing 4♣5♣, we are likely to never win another bet. When we face flush draws, Q♠Q♣ and combination draws (holdings with both straightening and flushing equity), the manner in which we counter our opponent’s strategy, exploit their tendencies, and/or play our hand approximately optimally is likely to alter our EV.

The point is that how we rationalize our bets is only a guide based on a simplified model that, at best, helps us design and implement a useful strategy in real time. Indeed, with the introduction of solvers into poker, the solution for a particular spot typically has one betting a variety of combinations for multiple bet sizes with fractional frequencies -- the same combination might both optimally bet and check some percentage of the time. Indeed, the ultimate optimal solution in no-limit hold ‘em likely

uses continuous bet size distributions with fractional frequencies. In some cases, a simple reason for the bet is apparent. If we were to bet our A♦K♦ hand on the flop as part of an optimal strategy, clearly, we would be seeking both value and protection versus our opponent's range. Worse hands are likely to call a bet -- consider if our opponent holds A♣ Q♣. We get protection versus hands like 6♥6♠ that are unlikely to ever put in more money unless they improve to beat us by turning a set.

A seemingly simple spot occurred recently that involves multiway action in a live $5/$10 no-limit hold 'em game. The person who played the hand described that action as follows.

Two villains, V1 and V2, were seen to be playing a wide range preflop. One of them, V1, had tripled up from $2,000 to $6,000 in a couple of hours and had just lost $2,000 of it with a one pair hand, seemingly unwisely calling down an opponent betting strongly on all streets. Hero sits with $1,450 on the button and is covered by both villains. A tight regular opens UTG+1 to $30, V1 calls next to act, V2 calls in the cutoff and Hero three-bets to $150 on the button with A♦10♦. The blinds fold and everyone else calls.

Flop (Pot size = $615): Q♦9♦4♠. UTG+1, V1, and V2 check to Hero who bets $320. The opener folds and V1 and V2 both call. Turn (Pot size = $1,575): Q♦9♦4♠A♥. The action quickly proceeds as V1 and V2 both check. Hero has $980 remaining. The question we seek to answer is how best for Hero to proceed in this spot? The pot is already large due to all the preflop action making the spot tricky.

One of us thought that going all-in looked slightly better than betting a modest amount and that checking was ill-advised. The other of us, and another person who is a very accomplished live professional, both looked at the hand and had the instinct that worse hands won't call an all-in and better hands are never folding. Further, our hand has a nut draw and seemingly needs little protection versus our opponents' ranges. This suggested checking or betting smaller. When good winning, experienced players have different instincts in a particular spot, it merits further analysis.

To proceed, we established what ranges were likely to call us if we were to bet all-in on the turn. While our recreational opponents might have a wider range here, a conservative range will serve as a worst-case scenario in evaluating the performance of jamming the A♦10♦ on the turn. To keep things simple, we will assume that only one opponent will ever be strong enough to call us (both players will have a hand strong enough to call only about 5% of the time and it complicates the analysis without changing the thrust of the argument).

We conjecture that the following nine combinations in our opponent's range will call Hero's all-in. It is a relatively narrow range considering the three-bet preflop. Note, not all the offsuit combinations of AQ were assumed to call the three-bet preflop. Adding some hands like 4♦5♦ strengthens Hero's position but are omitted here.

Villain range that calls the Hero's all-in (9 combinations):

K♦J♦,A♣9♣, A♠9♠,A♠K♠, A♠Q♣,A♠Q♥,A♠Q♠,A♣Q♣,A♣4♣

This is a strong range of hands that Hero selected for by betting $980 all-in into a pot of $1,575. Hero is an equity underdog with A♦10♦ by a margin of: 47% Hero to 53% Villain. Incidentally, everyone has 33% equity in the rare three-way all-in. Nonetheless, the bet is very profitable as the pot was quite large on the turn. With the A♦, Q♦, and 10♦ accounted for, the combination of the board and our holding eliminate many of the other possible hands that might otherwise call Hero way behind like weaker pairs with flush draws.

Now consider that these high equity combinations were part of the larger range of hands that continued on the flop, most of which folded to our turn shove. Below we are using a short hand appropriate to PPT Odds Oracle where QxTx is all possible suited QT combinations and KQ represents both suited and off-suit holdings. This syntax takes into account cards that are excluded because they are on the board or in a player's hand. The hands we assume called the flop but did not call the all-in bet are:

Villains' range that called the flop but folds to the Hero's all-in (31 combinations):

TxJx, KxJx, QxTx, KxQx, 9xTx, KQ, QxJx, T♠T♥, J♠J♥

Only a single combination of TT and JJ are included assuming they call only occasionally on the flop. Thus, in our model, Hero folds out 31 hand combinations with a shove and 9 call the all-in. Now we can evaluate the expected value of our all-in bet on the turn. The pot is $1,575 and the Hero went all-in for $980.

HERO EV = $1575*0.60 + 0.40 [($1575+$980)*.47 -($980)*.53]=$1218.

Hero wins the existing pot 60.%. When Hero is called, 40%, Hero captures 47.% of the all-in pot, losing her whole stack the other 53.% of the time.Thus, Hero bets $980 for an EV of $1218 vs the villain playing a sensible strategy.

If we include 99 in the Villains' ranges the EV falls but remains around $1150. It seems likely that sets are going to raise the wet flop. But the basic conclusions remain throughout even if all combinations of 99 are included. Similarly, some reduced number of QQ and 99 can be distributed throughout the ranges without any significant modification of the analysis.

Now let's consider a simplified alternative version of the game tree.

If Hero checks the turn, we can asymptotically consider the EV of everyone checking the rest of the way. Clearly this is not quite right. Often, betting will occur as we will improve to the nuts or our opponents will improve to beat us. Occasionally they are already ahead and will remain so on the river betting holdings like AQ for value.

Hero can also consider betting smaller on the turn, but this creates a very small stack to pot ratio (SPR) and makes it hard to fold to any river aggression getting excellent pot odds. Further, if we bet small, they will call with more combinations, i.e. wider, on the turn. But, if we bet small the hands that are in the range that call the all-in bet are likely to go all-in on the turn and we are an equity underdog to those hands. We are likely getting all-in versus the strongest hands on the turn unless we check. Villains can then play very well on the river with holdings that just called the proportionally small turn bet. In

that case, Hero has reverse implied odds versus a range of villain holdings on the river except rarely when we both make a flush. Suffice it to say, in the end, it is reasonable to compare our EV of going all-in on the turn to that of the hand checking down to showdown because of the small SPR on the turn. If stacks were deeper, Hero would have more strategic options.

Now, in the asymptotic branch of the game tree that goes check turn, check river, Hero faces both V1 and V2 both having the combined 40 combination range given above. Versus the two villains, Hero has 54% equity averaging over every possible river card. The villain's ranges were approximated as the identical 40 holdings, giving them each 23% equity.

The pot is $1,575 and the Hero and villains check the hand down:

EV= $1,575*.54=$851.

It is clear that Hero performs better by shoving all-in even though she faces a much stronger range when called.

Note, the large difference in EV of checking versus going all-in on the turn is due in large part to facing two villains. If we faced a single villain then Hero has 70% equity and the EV is much closer, EV= $1,575*0.7=$1,102. In this case, we might consider betting smaller on the turn and playing good exploitative poker versus our opponents. Sometimes V1 will call with a fairly wide range and V2 then even wider. This can be good for Hero. But such considerations are unlikely to close the EV gap between going all-in on the turn and the alternatives. Indeed, with two opponents, the 31 combinations in the villain folding range have 38% joint equity vs. A♦10♦. The presence of two opponents makes their joint defense versus our hand much stronger even though we hold identically large equity edges versus each one individually.

Thus, the mathematics of a spot dictate the models that apply to characterizing a bet in a given situation and not the other way around. The principles that apply here are the strength of joint defense ranges even if they are individually relatively weak, and the idea that small SPR situations dictate going all-in with more of a merged range rather than a polarized distribution. Also, in live poker, the absolute magnitude of the bet, nearly $1,000, can make the ranges that get involved tighter than if the exact same mathematics applied in a $1/$2 no-limit hold 'em game where the river bet is less than $200 to win a pot of over $300.

So, why is it best to bet all-in on the turn when only strong hands call? All substantially worse hands fold and competitive and superior holdings call. Here, however, even though it seems like a mistake when we go all-in and AQ calls our bet, Hero is making so much money when both villains fold that it more than compensates for the times we are behind and asking our friendly villain "Run it once or twice?" on the river.

Donald Phillips is a live grinder and Brian Space is a scientist, professor and strategist. Both live and play poker in the Tampa Bay Florida area.