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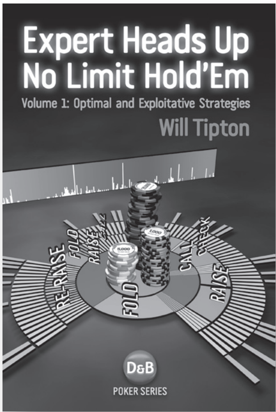

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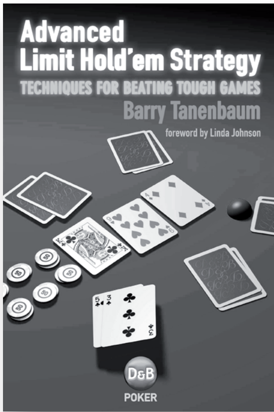

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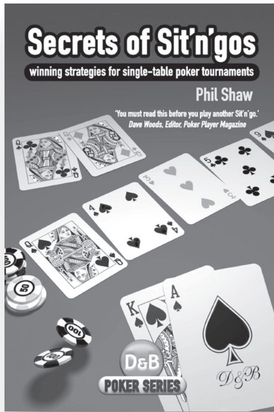

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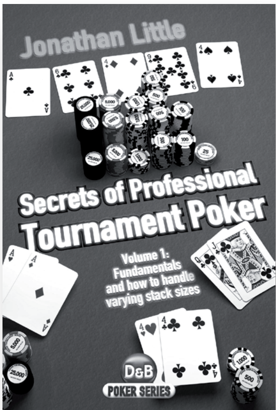

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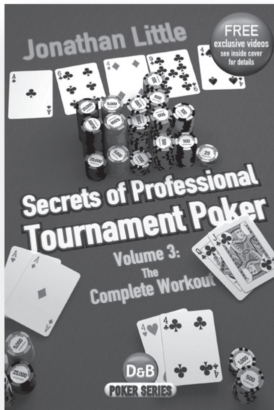

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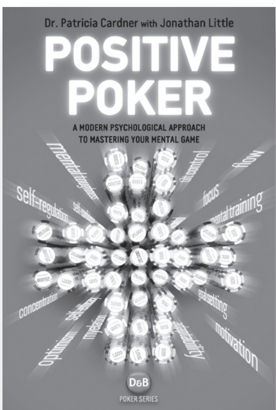

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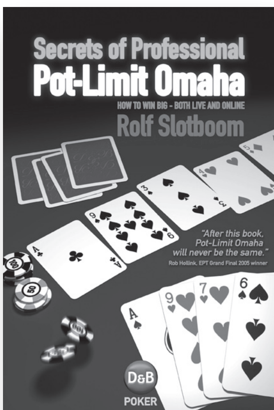

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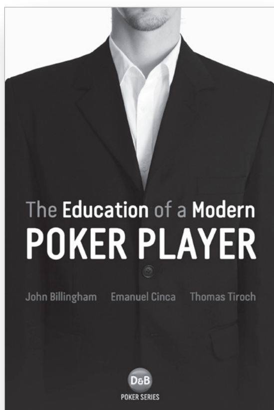

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Will Tipton began playing poker online in 2007. He steadily moved up in stakes in online HUNL tournaments to become a regular winner in the high stake games. He recently completed his PhD work at Cornell University and has taken a position as a software engineer at Google.

Expert Heads Up No Limit Hold'Em

Volume 2: Strategies for Multiple Streets

Will Tipton

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Contents

Please note that this book starts at Chapter 9 since it follows on directly from Volume 1. The two books can be considered together as one complete work.

Preface

The best time to plant a tree was 20 years ago. The second best time is now.
– Chinese proverb

Welcome back to Expert Heads Up No Limit Hold'em – it's new and improved with flops, turns, and way more draws! Having covered a lot of basics in Volume 1, we're now ready to tackle the complexities of multi-street play. We'll start with a quick review of the tools and big ideas we developed in the first volume before starting on turn play. Starting in Chapter 10, we will extend our study of polar-versus-bluff-catcher (PvBC) play to multiple streets. As on the river, it captures the core of poker: value-betting and bluffing versus some poor schmuck who wants nothing more than to show down.

Our models will become more and more sophisticated from there. If we can solve a game by hand, it is relatively easy to understand exactly why the players adopt the strategies they do. However, we must turn to computational methods to solve very large decision trees that accurately represent complex situations. Examining these solutions will often lead to new insights about strategic play.

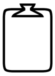
We will soon take our first steps outside of the PvBC model. Early street play often leads to "nearly-static, nearly-PvBC" play on the turn. Here, only weak draws are possible, and the players' ranges overlap in only a few easily understood ways. In Chapter 11, we will focus on the effect of these complications in the context of the PvBC decision tree. This decision tree is actually quite fundamental, since it describes play where the "betting initiative" does not change hands.

In Chapter 12, we will consider more complex starting distributions and board textures. These factors lead to changes in initiative and much more interesting strategies in general. We will discuss specific plays such as the delayed c-bet, the turn check-raise, and the protection raise, among others, and see how to estimate unexploitable frequencies for making these plays with matrix models. Finally, we will wrap up our discussion of turn play in Chapter 13 with a look at computationally-generated solutions to a variety of turn spots.

Why do we have several chapters on the turn but only one each on flop and pre-flop play? For one thing, the deeper we get into a hand, the more board run-outs are possible, and the more chances the players have had to split their ranges. So, there are many more distinct situations on the later streets. More importantly, we will see many aspects of multi-street play in the context of two-street (i.e., turn-onward) situations. So, when we study the solutions of very large early-street games, it will not take long to understand them. The strategies we find will, however, have significant, actionable implications for many aspects of modern HUNL play, including SB opening and flop c-betting.

The final two chapters cover extra topics relating to match play. In Chapter 16 we will develop the tools to decide when we can pass up small edges to wait for better spots. The short answer: quite frequently if Villain is bad enough. Finally, we'll wrap up with a discussion of building reads and adjusting to opponents. I believe in carefully considering every bit of information available early in a match to begin making exploitative adjustments as quickly as possible. However, it is important we do not overreact to shaky intel.

Many questions are included in this book. When a question has a simple, black-and-white answer, I try to mention it in the text, but many do not. Some are merely meant to test your understanding of a topic we have covered, while others call for much more independent thought. We have used different symbols to differentiate these.



These questions should be relatively easy to answer if you've understood the text. Definitely give them a shot before proceeding, and if you get stuck, consider re-reading.

These are harder and often quite open-ended. If the correct approach is not immediately obvious, don't worry, and don't feel compelled to struggle with these unless you want to know the answer!

We've done something similar with the book sections themselves. We've marked several with a star (*) to indicate that they are in some sense optional. These sections are both challenging and can be omitted without seriously hampering your understanding of later content. It's not that they aren't interesting or important – they are. However, if you're turned off by math, it might be better to skip them, at least initially, rather than risk getting stuck. As far as that goes, this book is a bit top-heavy in its theory content. The material gets somewhat less challenging as the book proceeds and we focus more on computational solutions to large games and less on analytical models.

In addition to everyone I noted in this work's first volume, I'd really like to express my gratitude to Dário Abdulrehman, Rick Atman and Yoann Brient. This book has benefited greatly from their careful readings and insightful suggestions.

9.4.2 The Bluff-catching Indifference and Odds

The bluffing indifference is probably the one most commonly used for estimating equilibrium frequencies. It helps us choose good continuing frequencies when facing a bet and thus provides guidance for how to play our mediocre holdings. Playing bluff-catchers is often difficult, so it makes sense to turn to game-theoretic ideas for guidance. However, other sorts of indifferences are also common at equilibrium, and these also provide information about GTO play.

Suppose Hero is facing a bet. On the river, a properly-constructed betting range will make many of Hero's hands indifferent between calling and folding – everything below the bottom of his value range and better than his bluffs, neglecting card removal. The effect of a bet is not quite as clear on earlier streets because of the presence of draws and the need for balance.

However, Villain's early-street bets still often make many of Hero's hands at least nearly indifferent between calling and folding, and if we think carefully, we can see that this is reasonable. First, even on early streets, betting ranges tend to be somewhat polarized. It makes sense to bet with strong hands in the hope of getting called by worse, but if we only bet strong, we will see lots of folds and be incentivized to bluff as well. If Villain's betting range is polar, we will still have holdings that are stronger than the bluffs and weaker than the value, and Villain's equilibrium bluff-to-value ratio will still need to make many of these mediocre hands more or less indifferent. If he bluffs too much, we will call a lot, and he will be motivated to bluff less, and vice versa. Thus, the stable point will still occur when bluff-catchers can sometimes call and sometimes fold, i.e., when the two choices have the same EV.

There are caveats here. We will encounter "reasons for betting" other than for value and to bluff, and these can lead to non-polarized betting ranges that do not create indifferent bluff-catchers. Also, even when we do face a polarized bet, few early-street holdings are really equivalent. Different hand combinations have more or fewer outs and backdoor outs, play differently on possible future cards, etc. Thus, facing a flop c-bet, it may be most accurate to say that just one of our hands is actually indifferent between calling and folding while the rest strictly prefer one or the other. All that said, hopefully you are convinced that early-street betting ranges often make many hands at least nearly indifferent to calling. The conditions under which this indifference holds and the particular hands that are made indifferent will become clearer as we take some examples.

The following holds for Hero's hands that are indifferent to bluff-catching when facing a bet:

$$\mathrm{EV}(\text{bluff-catching}) = \mathrm{EV}(\text{folding})$$

This is called the bluff-catching indifference, since it applies to bluff-catchers. Don't get confused here – the bluffing indifference applies to a player's bluffs (and usually gives us information about his opponent's bluff-catchers), while the bluff-catching indifference applies to bluff-catchers (but usually provides information about a bluffing frequency).

How can we apply the bluff-catching indifference? Again, the naive case is embodied by the simple river PvBC game. There are only three types of hands here – Villain's value hands that are obviously going to bet, Hero's bluff-catching hands whose play we determined by applying the bluffing indifference to Villain's air in the previous section, and Villain's air, whose play we can find through the bluff-catching indifference. For Hero's bluff-catchers, we have

$$\mathrm{EV}(\text{bluff-catching}) = \mathrm{EV}(\text{folding})$$
$$V(S-B) + (1-V)(S+B+P) = S$$

Here, V is the fraction of the Villain's betting range that consists of value bets. If we bluff-catch, then V of the time we lose the bet B, and the other $(1-V)$ of the time, we end up with the pot and Villain's bet in addition to our starting stack. Solving, we find V equals $(B+P)/(2B+P)$, and this specifies Villain's play with his air hands. As usual, Hero's indifference has given us information about Villain's strategy. By applying the bluff-catching indifference to a player's bluff-catchers, we can find his opponent's bluff-to-value ratio.

Now, as with the bluffing indifference, applying the bluff-catching indifference can be challenging in practice. Finding EV(folding) is easy – we know the size of our stack at the end of the hand if we immediately fold – but, what is the EV of bluff-catching? It is often something like in the PvBC case – our stack after we call, plus the pot after we call, times the fraction of the pot we capture after we call. In the PvBC case, and on the river in general, the fraction of the pot we capture is just our raw equity. However, if calling does not guarantee a showdown, then the amount of the pot we can capture (and thus our EV) will depend on future action for several reasons:

1. Our hand can improve to beat some of Villain's value hands, and we may be able to bet for value.
2. Villain's bluffs might improve, allowing him to extract more value from us.
3. Even if hand values do not change, we can face future value bets and bluffs.

One of the main lessons from our study of the river was that mediocre hands have a hard time realizing all of their equity. If both players just checked down, they would both capture exactly their equity. But, at the equilibrium of the PvBC model, for example, Villain's bluffs are indifferent to checking down while his strong holdings do much better by betting. All the EV that Villain gains with value bets is EV lost by Hero's bluff-catchers. Thus, the possibility of future action will have a large effect on the EV of bluff-catching even in very static situations. The possibility of changing hand values complicates things further.

These issues arise in traditional exploitative decision-making as well, and it may be helpful to make that connection. Generally, we look to estimate the EV of bluff-catching when we have a call-or-fold decision with a borderline hand. We want to choose the action with the highest EV. The EV of folding is fixed, whereas the issues mentioned above affect the EV of calling. A simple way to approach this decision is to compare our equity to our pot odds. Pot odds are the ratio of the size of the pot after Villain's bet (how much we stand to win) to Villain's bet size (how much we stand to lose). Calling when our equity is greater than this ratio (appropriately converted to decimal) is equivalent to calling when EV(calling) is greater than EV(folding), *if calling means that we realize exactly our equity in the pot*.

An example will help make this clear. Suppose we face a half-pot bet. Then, the ratio of how much we stand to win versus how much it costs to call is 3:1. So, a pot-odds calculation tells us that we need to win one time for every three times we lose in order to have a profitable call. That is, we need at least 25% equity. On the river, calling gets us to showdown immediately, so a call allows us to capture exactly our equity in the pot, and in the PvBC game, Hero's equity is the fraction of Villain's range that is not value hands, i.e., $1-V$. Plugging in to the naive bluff-catching indifference above, the equity we need to be indifferent is $1-V=1-(B+P)/(2B+P)=0.25$. With any more equity, a pot-odds analysis tells us to call, and with any less, it tells us to fold.

If there is no more betting after our call, a pot odds-based approach is all we need to make a correct exploitative call-or-fold decision (regardless of whether we hold a draw, a made hand, or some combination of the two). Otherwise, we need to account for the possibilities enumerated above. The first deals with the possibility we improve, so it is most relevant when we have a hand that is likely to do so, i.e., a draw. Again, pot odds are essentially the ratio of what we stand to lose to what we stand to gain with a call, and we can adjust for the possibility of winning more on later streets by increasing the amount we stand to win. For example, if we face a bet with a draw to the nuts, the amount we must risk stays the same, but the amount we stand to win must increase, since we expect additional value if we make our hand. The ratio of the costs to this improved estimate of how much we stand to win is known as our implied odds, and it takes the role of the equity in the previous decision-making process. If we make a call-or-fold decision by comparing our implied odds to the odds offered by the pot, we have accounted for much of point 1 above.

Accounting for the other two points is a bit more difficult. When we have a pure draw to the nuts, we will be certain about whether or not we have the best hand on later streets. However, with a non-nut draw or made hand, we will be in danger of calling with the worse of it or folding with the better, either because Villain has the best hand now or because he improves. We adjust the odds to make them less favorable in an attempt to account for these possibilities (thus obtaining reverse implied odds), but it's difficult to be quantitative about it. However, these effects are actually quite large in no-limit games. For example, if it weren't for them, we could defend pre-flop min-raises with 100% of hands against almost all opening ranges.

We cannot treat early streets in a vacuum – to strategize for multiple streets, we must take into account the possibility of future action. Although it will be a couple of chapters before we get to it in full, we'll take an approach that is similar in spirit to the implied and reverse implied odds methods. We'll replace raw equity in the pot odds decision-making process with another number that more accurately describes the amount of the pot we can expect to capture on later streets, called the capture factor. If we become good at estimating this quantity, we will be able to sweep a lot of the details of multi-street play under the covers, which is useful for making quick decisions at the tables.

Suppose we are facing a bet on the turn with a mediocre hand that is unlikely to improve. Do these multi-street effects make us want to fold more or less than in a comparable single-street situation? How can Villain change his betting range to keep us indifferent?

Consider the SB bet-or-check river game from Section 7.3.2 and the pre-flop 3-betting situation we saw in Section 9.4.1. Use the bluff-catching indifference to estimate the fraction of the bettor's range that consists of bluffs at equilibrium. In the pre-flop case, again refer to your hand database, if you keep one, to find extra contributions to the EV of bluff-catching. How do your results compare with your own play and that of your regular opponents?

9.4.3 The Nuts, Near-nuts, and Nut Draws

In Section 2.3.1, we discussed the BB's play with a flopped flush draw and focused on check-calling and check-raising. Under certain conditions, we argued that he would take both lines with some frequency at the equilibrium. If he took one action too frequently, the SB's response would incentivize him to take the other. This indicates that neither pure strategy is unexploitable, a mixed strategy must be played at the equilibrium, and the EVs of the two lines must be equal. The same sort of argument can be made in many spots where some play can lead to our holding a capped range later in the hand. If we work through the equilibration exercise, we can often convince ourselves that Villain's response will make it profitable to start showing up in those spots with our strong hands. However, if we play all of our strong holdings that way, ranges in other parts of our strategy will be neglected, and we will be incentivized to readjust.

Of course, this style of argument does not only apply to strong draws. Often, nut hands on early streets have a high chance of remaining the nuts after future cards arrive, and playing them one way all the time would cap our range in other spots. The number of hand combinations involved is important. For example, excluding top set from your range following a K♠-7♥-3♥ flop does not cap your range as severely as, say, excluding all heart draws. However we'll see that the argument does not only apply to the pure nuts. Rather, it frequently applies to many strong or near-nut hands for reasons we will see shortly. I believe it is most accurate to understand this indifference in terms of distributions rather than particular hand combinations: whenever we cap our distribution, Villain's counter-strategy might incentivize us to stop.

Now, we do need to take a bit of care. Taken too far, this sort of argument can lead to conclusions such as that unexploitable play will involve having some chance of showing up with the nuts in any spot. That's certainly not the case. For example, any pre-flop hand can end up being the nuts on later streets, but of course we should not take every possible pre-flop line with every starting hand with positive frequency. The remote chance of a particularly favorable board will not make up for putting a lot of money in bad. Generally, the shorter the effective stack size, the less important is the threat of future action. If we always check-raise the flop with our draws, we will usually be left with a capped range when we check-call and then the draws come in, thus allowing the SB to play aggressively with much of his range. However, if the stack-to-pot ratio on the flop is sufficiently small, the value we gain from showing up with a made draw after check-calling may simply not be enough to outweigh the advantages of semi-bluffing. Or, if the chance of our draw coming in is sufficiently remote, check-folding might be best. We can usually be happy to fold all our 5-4 combinations to a flop c-bet on A♥-Q♦-9♠, despite the possibility that the board runs off 2♥-3♣. That simply does not happen often enough (and Villain will not put in enough action when it does) to make up for the money we lose by drawing.

On the other hand, missing a bet with a strong hand can sometimes be costly enough to prevent us from ever slow-playing. Other times, Villain's distribution just doesn't let him put in enough action against our passive lines to incentivize us to start slow-playing. These indifferences are emergent properties of the complex dynamics when both players try to play HUNL games as profitably as possible, but they are not really fundamental. In future chapters, we will see a variety of computationally-generated equilibria of multi-street situations and will make note of the sorts of spots where nuts and draws to the nuts are made indifferent and nearly indifferent. Pay attention to these to build intuition for attacking these spots. In practice, we often need to proceed carefully through the equilibration exercise, keeping all options and all parts of players' ranges in mind. Only then can we convince ourselves that none of the relevant options can be played all the time at equilibrium and identify which are used with a non-zero frequency.

Review the solutions to the river examples described in 7.4. In which cases did the players play their nut hands in more than one way at the equilibrium? In which did they not? Why?

Now, all that said, players play mixed strategies with nut, near-nut, and potential-nut hands in many cases for balance-related reasons, and we can use the corresponding indifference relationships to learn about the equilibrium. The indifferences applying to draws turn out to be difficult to leverage in practice. To see why, let us continue with the example of a BB's flopped flush draws. We expect the BB's indifference to tell us something about SB's GTO strategy. We have, for the BB's flush draws:

$$\text{EV(check-calling)} = \text{EV(check-raising)}$$

What are these EVs? The EV(check–calling) depends on a lot of things – how often the draw comes in, how often the SB barrels the turn when it does and does not, and so on. Hero's EV(check–raise) depends on how often the SB folds to the raise and to additional barrels, how he plays versus a turn check after calling, how much action he gives in general after the draw comes in and does not, etc. We can estimate these EVs if we're clever, but there is no escaping the fact that this indifference equation is a rather complicated relationship between many different aspects of the SB's play. This is in contrast with the bluffing and bluff-catching indifferences above, which happily depended on just one of a player's frequencies, which allowed us to immediately solve for it. Our potential-nuts indifferences may be simplified in short-stack situations (for example, if a check-raise is necessarily an all-in so that there is no future action), but we noted earlier that the indifference might not even hold in such a short-stacked spot. We will spot the indifference of draws in games' solutions and use them as landmarks to make sure we understand what's going on, but we will rarely use them to solve for unexploitable frequencies from scratch.

Continue with our example of the BB's flopped flush draws. What does the EV of leading the flop depend on? When might the BB be indifferent between leading and check-calling, while check-raising is worse than either? When might EV(leading)=EV(check–raising)>EV(check–calling)?

It turns out the indifference facing actual nut hands is quite a bit easier to deal with. Draws want to get as much money as possible in the pot when they make their hand, but when they miss, they benefit from having kept the pot as small as possible, except when they are able to win without showdown. Of course, trying to win without showdown often involves the risk of putting in a lot of money and still not forcing an opponent to fold. The tradeoffs here are a bit complicated.

Playing the nuts is much easier, at least when we are not worried about being drawn out on, i.e., on the river or on static boards. Then, the only consideration facing these hands is how to get as much money in the pot as possible. If our hand can't lose (or chop), its EV is simply all the money in Hero's stack, plus the entire pot, plus whatever additional money Villain will put in the pot, on average. At any particular decision point, the first two terms are fixed, so we maximize our EV by taking whatever line causes Villain to put the most money in the pot, on average. Thus, if we are indifferent between two lines, it tells us something very intuitive about Villain's play following both actions – Villain puts the same amount of money in the pot, on average, against both of them. The simplicity of this statement makes it very powerful, as we will see in an example shortly.

First, notice that the same reasoning often also applies to strong but non-nut holdings, especially on static boards. Suppose we have a hand strong enough that we are happy to get all-in and strong enough that, whenever Villain has better, he too will try to get all-in. Then, whenever we are losing, we are sure to get all-in and go broke. Since the outcome when Villain has a better hand is already fixed, we maximize our overall EV by playing to maximize it in the case that Villain has a worse hand. When Villain has a losing hand, we do best by simply trying to get as much money into the pot as possible. So, if a near-nut hand is indifferent between two lines, it must be the case that Villain puts in the same amount of action versus both of them on average. That is, the sort of indifference relationships we have been discussing in this section apply to near-nut hands as well. Also, although our argument has assumed the board is static, we can imagine that when it is only nearly static, then players' nut and near-nut hands will often be nearly indifferent, still a useful relationship for making approximations.

Consider the following useful example. The decision tree for the 1-bet-behind full-street river game is shown in Figure 9.1. As the name suggests, it models river situations where the stack-to-pot ratio is small enough at the beginning of river play that any bet is all-in. In complexity, this game lies sort of in between the bet-or-check games and the two-bets-behind games we focused on in Chapter 7. However, it is useful in its own right for understanding river play, since players often size their early street bets so as to end up with just one bet left behind on the river. We will study it further in Section 13.4.2.

Take for simplicity the symmetric distributions case with one pot-sized bet behind at the beginning of river play. Suppose Hero is in the BB and holds a hand that is the nuts or the near-nuts in the sense that it will always get all-in versus a better hand. These holdings actually make up a significant portion of his range. For example, with our assumptions, it turns out that the top one-third of his river starting distribution always gets it in versus better hands at the equilibrium. So, with his near-nuts, Hero's options are to jam or to check with the intention of calling a bet all-in, and we can convince ourselves that he cannot be taking either line 100% of the time at the equilibrium.

Why is it that Hero's GTO strategy cannot involve either always checking or always leading here with all his near-nut hands?

Because of this indifference, Villain must put in the same amount of money, on average, versus both of Hero's actions. In particular, the SB must be jamming when checked to with exactly the same frequency as he calls a lead all-in. This turns out to be a useful observation when trying to understand river play with one bet behind. In fact, combined with the previous indifferences, we now make a lot of progress towards solving this game. Consider giving it a try before continuing.

First, we already knew how to estimate how often the SB calls a lead in this spot – we apply the bluffing indifference to the BB's bluffs to find that the SB must call 50% of the time in order to keep the BB's weak hands indifferent to bluffing, and he builds this calling range out of his strongest 50% of hands, since it does not make sense to call with a weaker hand while folding a stronger one. Previously, we had no short-cuts that allowed us to determine how frequently the SB bet when checked to, but now, we know that his GTO betting frequency in that spot must also be 50%! To drive this point home, suppose the SB bet less than half the time when checked to. Then, Hero would lead with all his strong hands, Villain would counter by playing aggressively versus Hero's severely capped checking range, and Hero would be motivated to begin checking strong hands.

So, the SB is jamming half the time facing a check. Additionally, since the bet is the size of the pot, his betting range should contain two value-bets for every one bluff in order to make Hero's bluff-catchers indifferent to calling. Thus, 2/3 of his betting range should be value, and 1/3 should be bluffs. Logically, we know that the SB will build his value range from his strongest hands, and he will pull his bluffs from his weakest. So, we can conclude that the SB's equilibrium strategy involves betting when checked to with the top 1/3 and bottom 1/6 of his river starting distribution, and we have completely determined the SB's equilibrium play of this game!

A similar indifference between checking and leading holds for the BB's nut hands in the two-bets-behind river situation we covered in Section 7.3.3, at least in the symmetric-distributions case. Of course, when the BB leads with the nuts, it is with the intention of bet-calling, and when he checks, he will check-raise if given the chance. Thus, it is not necessarily the case that the SB bets when checked to with exactly the same frequency that he calls a bet, but he puts in the same amount of money on average versus the BB's check-raises and bet-calls. If he bets when checked to more than he calls a lead, he must make up for that by calling a check-raise more than he raises a bet.

Suppose we have flopped the nuts. We are indifferent between slow-playing and fast-playing, but draws are possible and some of Villain's range has some chance to improve to beat our hand. How does this affect the relative amounts of money Villain must put in versus our two lines on average when the draws come in and when they do not?

9.4.4 Putting it all Together: Blocking Bets

Finally, we can combine some of these ideas to learn a bit more about block-betting from the BB on the river. In Section 7.3.3, we focused on using them exploitatively, since NLHE players' response to small bets varies extremely widely and is often quite poor, and it can be difficult to see exactly how they might be useful in equilibrium play. For one thing, when we use multiple bet sizings in a spot, the solutions can rarely be broken down into clearly defined action regions. The solutions almost always end up being highly mixed for balance-related reasons, making it difficult to see quite what is happening.

However, in the context of the 1-bet-behind river situation, it is relatively easy to see how blocking bets might fit into our GTO strategy with certain river starting distributions. So suppose we are playing a game like the one shown in Figure 9.1, except that the BB may also lead for a blocking-sized bet, and, facing such a bet, the SB can fold, call, or jam. That is, any bet is all-in except for the BB's blocking bets. We start the river with one pot-sized bet left in the effective stacks. Suppose the BB's blocking bets are 1/5 the size of the pot, and suppose the starting distributions are such that all the indifferences we have been discussing indeed hold.

First of all, many aspects of the solutions to this game are going to be similar to the solutions to the basic 1-pot-sized-bet-behind game we saw in the last section. The SB will still probably call a lead all-in 50% of the time in order to keep Hero's air indifferent to bluffing. Then, the SB must also jam 50% of the time when checked to in order to keep Hero's nuts indifferent between check-calling and leading all-in.

Now, how should the SB play when facing a blocking bet? How often does he continue versus the bet? We can apply the bluffing indifference to find out, but first, it should seem reasonable that the SB cannot fold very much at all or else the BB could very profitably use the small sizing to bluff. In particular, if *P* and *S* are the sizes of the pot and effective stack at the beginning of the river, *L* is the size of a blocking bet, and the SB folds to a block *F* of the time, then we have for the BB's potential bluffs:

$$\mathrm{EV}_{\mathrm{Villain}}(\text{bluff}) = \mathrm{EV}_{\mathrm{Villain}}(\text{not bluff})$$
$$F(S+P) + (1-F)(S-L) = S$$
$$F(2) + (1-F)\left(\frac{4}{5}\right) = 1$$

so that the SB's folding frequency is F=1/6. So, the SB must indeed be continuing a lot versus a blocking bet. This assumes that the BB's river starting distribution actually contains a sufficient number of relatively-weak hands that can be used as bluffs.

How often does the SB raise a blocking bet? We can use what we learned in the previous section to figure it out! First of all, before doing the math, a bit of logic will give the main point: the SB cannot raise a block-bet as often as he calls a lead all-in or bets all-in when checked to. Why not? Well, if he did, then the BB's nut and strong value hands would all start block-betting, since it would allow them to make more money on average than the other options. The BB's nuts would get all-in just as often as if they took another line, but they would also get extra value from all the other hands the SB has to call with when facing a blocking-bet. We can find the SB's raising frequency necessary to make the BB indifferent to blocking with near-nuts. For these, if *G* is the SB's raising frequency when facing a blocking-bet, we have

$$\text{EV}_{\text{BB}}(\text{block bet}) = \text{EV}_{\text{BB}}(\text{check-call or lead all-in})$$
$$F(S+P) + G(2S+P) + (1-F-G)(S+P+L) = S+P+\frac{P}{2}$$
$$\frac{1}{6}(2) + G(3) + \left(1-\frac{1}{6}-G\right)\left(\frac{11}{5}\right) = \frac{5}{2}$$

and we find G=5/12 . So, the SB indeed gets all-in versus a blocking bet somewhat less than the 50% of the time he gets it in versus a check or a jam. We have implicitly assumed here that the BB's river starting distribution contains some strong value hands he can sometimes block bet with – no leading with any sizing is going to work well for him if his range is capped low.

Now we know that, when facing a blocking bet, the SB is calling a ton and getting it in fairly often but not as often as if he faced a check or a jam. This is a perfect environment for the BB's weak value hands, the sort that stereotypically might try a small bet to "block" the SB from making a bigger bet. These hands can make a small lead, actually get a bit of value from the SB's very wide calling range, and also not face an all-in as often as if they had checked. Avoiding the jam is something to be happy about for these mediocre holdings, since it usually makes them indifferent between a call and a fold, i.e., it makes it very difficult for them to realize their equity.

So, as we saw in the solutions to the examples in chapter 7, the BB's GTO river strategy frequently includes blocking bets, and now we can see why. The blocking range is usually comprised primarily of his hands with mediocre showdown value. If he were only blocking with these, the SB would raise him very frequently, so he is motivated to add strong value hands into his blocking range until the SB raises less often and block-betting the nuts is no more profitable than his other options. But if the BB were only blocking with weak value and strong value hands, the SB would fold a lot, so the BB can take the opportunity to block as a bluff with some very weak hands as well. If the BB's river starting distribution does not contain all of these three types of hands, he might not be able to incorporate block-betting in his river strategy.

Lastly, remember what we learned about block-betting when studying computational solutions of river spots. The BB rarely preferred to block bet with any of his holdings. More often, his blocking hands were indifferent to playing "normally". Nonetheless, he improved his overall EV by opening a blocking range, and the EVs of his mediocre made hands were particularly improved. This implies that moving some hands to his blocking range improved his EV when he checked those hands as well. What was going on there? Basically, the SB could no longer take advantage of the BB's checking range being quite as bluff-catcher-heavy as it was before. Thus, he could not value-bet and bluff quite as much when checked to, and the BB's mediocre made hands were able to see a showdown more often than they did before.

These indifferences will show up all the time – indifferences of bluffs, bluff-catchers, near-nuts, and draws. Identifying these will help us make sense of complicated strategies. It is not always easy to untangle the complicated interactions between players' equilibrium ranges, and these observations will give us some ways to understand what we see and give confident answers to questions about *why* GTO play is the way it is. Of course, these tools are also useful for estimating unexploitable frequencies for use in our own play.

9.5 You Should Now ...

- ♠ Know what equilibrium and exploitative play are and how we use them.
- ♠ Understand the importance of reading your own hand for playing strategically.
- ♠ Remember the Indifference Principle and its applications to players' bluffs, bluff-catchers, and nut hands.
- ♠ Understand river play with one bet behind and know the properties of the equity distributions that make block-betting reasonable in that context.