

CHAPTER 44

SPORTS GAMBLING 101

In this chapter, we will review (through a Q&A format) the basic definitions and concepts involved in football, basketball, and baseball gambling.

In the 2017 Super Bowl the Patriots were favored by three points over the Falcons and the predicted total points for the game was 59 points. How could I bet on these odds?

Theoretically the Patriots being favored by three points means the bookies think that there is an equal chance that the Patriots would win by more than three or fewer than three points (in the next chapter we will see this may not be the case!). We often express this line as Patriots -3 or Falcons $+3$, because if $(\text{Patriots' points} - 3) > 0$, a Patriots bettor wins, while if $(\text{Falcons' points} + 3) > 0$, a Falcons bettor wins.

Most bookmakers give 11-10 odds. This means that if we bet "a unit" on the Patriots to cover the point spread (i.e., win the game with more than three points) then we win \$10 if the Patriots indeed win by more than three points. If the Patriots win by fewer than three points we pay the bookmaker \$11. If the Patriots win by exactly three points, the game is considered a "push" and no money changes hands. Total points bets work in a similar fashion. If we bet the "over" on a totals bet we win \$10 if more than 59 points are scored, while we lose \$11 if the total points scored is fewer than 59 points. If

exactly 59 points is scored, the totals bet is a “push” and no money changes hands. Similarly, if a bettor takes the under, the bettor wins if total points scored is fewer than 59 and loses if total points scored is greater than 59. Most gamblers believe the totals line (in this case 59 points) is the most likely value of the total points scored in the game. Basketball point spread betting and totals betting work in an identical fashion to football betting.

HOW CAN BETTORS MAKE MONEY GAMBLING?

Let p = probability that a gambler wins a point spread bet. If $10p - 11(1 - p) = 0$, our expected profit on a bet equals 0. We find that $p = 11/21 = .524$ makes our expected profit per bet equal to 0. Therefore, if we can beat the spread or totals more than 52.4% of the time, we can make money! Suppose we are excellent at picking games and can win 57% of our bets. What would be our expected profit per dollar invested? Our expected return per dollar invested is $(.57(10) + .43(-11))/11 = 8.8\%$. This implies that a bettor who can pick 57% winners against the spread can make a pretty good living betting. Picking 57% winners against the spread in the long run is virtually impossible, however. If we believe we have a probability $p > .524$ of winning a bet what percentage of our bankroll should we bet on each gamble? In Chapter 49 we will use the famous Kelley growth criterion to answer this question.

HOW DO BOOKMAKERS MAKE MONEY?

Until Steven Levitt's (2004) brilliant article on NFL betting (to be discussed in Chapter 45), the prevailing wisdom was that bookmakers tried to set the line so half the money was bet on each side. If this is the case, the bookmaker cannot lose! For example, suppose one bettor bets \$10 on the Patriots -3 (Patriots to win by three points) and another bettor bets \$10 on the Falcons +3. Then unless the game is a push, the bookie pays one bettor \$10 and collects \$11 from the

other bettor and is guaranteed a profit of \$1. The bookmaker's mean profit per dollar bet is called vigorish or “the vig.” In our example, $\$10 + \$11 = \$21$ are bet and the bookmaker wins \$1, so the vig is $1/21 = 4.8\%$. In our example, the bookmaker makes a riskless profit of 4.8%. We will see in the next chapter that a smart bookmaker can take advantage of gambler biases and make an expected profit (with some risk, however) exceeding 4.8%.

HOW DOES THE MONEY LINE WORK?

The money line enables a bettor to bet on who wins a game or an event straight up, without involving the margin of victory. For example, the money line on the 2017 NBA Finals was: Warriors -240/Cavaliers +200. For any money line bet, the team with the negative number is the favorite and the team with the positive number is the underdog. The meaning of this money line is that to win \$100 on the Warriors you must bet or risk \$240. If I place this bet and the Warriors win the series, I win \$100, but if the Warriors lose the series I lose \$240. If I bet \$100 on the Cavaliers to win the series and the Cavaliers win the series, I win \$200. If the Cavaliers lose the series, I lose \$100. Let p be the probability that the Warriors will win the series. A risk-neutral gambler (this means a gambler who makes decisions based on expected profit) who believes that $100p - 240(1 - p) > 0$ would bet on the Warriors, while a gambler who believes that $200(1 - p) - 100p > 0$ would bet on the Cavaliers. Solving for the value of p that satisfies each inequality, we find that gamblers who feel the Warriors have a chance of winning greater than $240/340 = 71\%$ would bet on the Warriors, while gamblers who feel that the Warriors have a chance $p < 200/300 = 67\%$ chance of winning would bet on the Cavs. If we assume that the true probability of the Warriors winning was the average of 67% and 71% (69%) and also assume that bettor estimates of the Warriors' chances of winning are symmetrically distributed about 69%, then we would expect an equal number of bettors to bet on the Cavaliers and the Warriors. Suppose one gambler bets on the Warriors and one on

the Cavs. If the Warriors win, the bookmaker breaks even by paying the Warriors bettor \$100 and collects \$100 from the Cavs bettor. If the Cavs win the bookmaker wins \$240 by collecting \$240 from the Warriors bettor and loses \$200 to the Cavs bettor. If the Warriors true chance of winning the series is 69% then the bookmaker's expected profit per dollar bet is given by $(.69(0) + .31(40)) / (240 + 100) = 3.6\%$.

In Chapter 47 we will learn how to use point spreads to estimate probabilities of a team winning a game, an NBA playoff series, or the NCAA tournament.

As another example, in the 2017 Super Bowl the money line was Patriots -120 and Falcons +100. That means if we bet the Patriots to win and they lose, we lose \$120, and if the Patriots win, we win \$100. If we bet the Falcons to win and they win, we win \$100, and if the Falcons lose, we lose \$100.

HOW DOES BASEBALL BETTING WORK?

The starting pitchers play a critical role in determining the winner of a game. Therefore, the baseball gambling line is only valid if the listed starting pitchers start the game. For example, on July 28, 2017, the World Series Champions Cubs were playing the Milwaukee Brewers in a crucial game. The pregame odds are shown in Table 44-1.

This information means the Cubs were playing at the Brewers with Quintana starting for the Cubs and Suter for the Brewers. As

TABLE 44.1
Odds on Cubs at Brewers July 28, 2017

Date and Time	Teams		Starting Pitchers	Money Line	Total Runs Line	Favorite -1.5 Runs Line
	(Away Team first)					
July 28, 2017	Cubs		Jose Quintana	-149	Over 9 - 125	+100
8:10 PM	Brewers		Brent Suter	+133	Under 9 +105	-120

before, the team with the negative entry in the money line is the favorite and the team with the positive entry in the money line is the underdog. If we bet \$149 on the Cubs and they win, we win \$100, and if the Cubs lose, we lose \$149. If we bet \$100 on the Brewers to win and they win, we win \$133, and if the Brewers lose, we lose \$100. Following the logic in our Warriors-Cavs example, the interested reader can show that a gambler would bet on the Cubs if she believes the Cubs' chance of winning exceeds $149/249 = 60\%$ and a gambler would bet on the Brewers if she believes the Cubs' chance of winning is less than $133/233 = 57\%$.

The totals runs part of the table is analogous to the total points betting line in football or basketball. The Over 9 runs bet plays the role of favorite. If we bet \$125 on the Over, we win \$100 if more than nine total runs are scored in the game. If fewer than nine runs are scored, then we lose \$125. On the underside of the bet, we lose \$100 if more than nine runs are scored. If fewer than nine runs are scored, we win \$105. If exactly nine runs are scored, then no money changes hands.

If we bet \$100 on the Cubs -1.5 runs bet, and the Cubs win by two or more runs, we win \$100; if the Cubs lose or win by one run, we lose \$100. Similarly, if we bet \$120 on the Brewers +1.5 runs and the Brewers win or lose by one run we win \$100. Otherwise the Brewers bettor loses \$120.

WHAT IS AN ARBITRAGE BETTING OPPORTUNITY?

Often, different bookmakers or Internet betting sites have lines on games that differ slightly. In rare cases, a combination of bets exists (called an arbitrage opportunity) that guarantees you a riskless profit. For example, suppose two different bookies had the following lines on the 2020 Super Bowl:

Bookie 1 Chiefs -122 49ers +112

Bookie 2 Chiefs -135 49ers +125

Since Bookie 1 offers better odds on the Chiefs and Bookie 2 offers better odds on the 49ers, we will bet on the Chiefs with Bookie 1 and the 49ers with Bookie 2. Suppose we bet x with Bookie 1 on the Chiefs and suppose you bet \$100 with Bookie 2 on the 49ers. If the Chiefs win, your profit is $100 * (x/122) - 100$. This will be greater than 0 if $x > \$122$. If the 49ers win your profit is $125 - x$, which is greater than 0 if $x < 125$. This implies that by betting \$100 on the 49ers and between \$122 and \$125 on the Chiefs we can lock in a sure profit. For example, betting \$123.50 on the Chiefs and \$100 on the 49ers locks in a sure profit of \$1.23. The problem with an arbitrage opportunity is that the line can move before you finish placing all the needed bets. For example, if after betting \$100 on the 49ers with Bookie 2 the Chiefs line with Bookie 1 moves to -130 before we can place our bet, then an arbitrage opportunity no longer exists.

In real life, arbitrage is surprisingly common in soccer betting. In soccer, you can bet on the home team to win, the away team to win, or the match to result in a draw. In his Yale undergraduate thesis, Avery Schwartz¹ found many examples of soccer arbitrage. To illustrate the idea, consider the betting odds for a soccer game shown in Figure 44-1. For example, if we bet \$10 with Bookie 1 on the home team to win and the home team wins, then we receive $2 * (\$10)$ and lose \$10 for a profit of \$10. The file Soccerarb.xlsx (see Figure 44-1) shows how a bettor with \$100 to bet can use the Excel Solver to find a maximum guaranteed profit.

For each possible match outcome, the bettor will bet with the bookie offering the best odds, so we enter trial bet values in cells G13, H13, and I14. Then in cells F17:F19 we compute the profit earned for each possible match outcome. Cell F20 computes the total amount bet, and with the formula $=\text{MIN}(F17:F19)$ cell F21 computes the bettor's guaranteed profit. The use of the MIN function makes our Solver model nonlinear. The MIN function often gives the ordinary GRG solver engine trouble. For this reason, we

1. https://economics.yale.edu/sites/default/files/files/Undergraduate/Nominated%20Senior%20Essays/2015-16/Schwartz_Avery_SeniorEssay%202016.pdf

	D	E	F	G	H	I
6			Odds			
7				Home Win	Draw	Away Win
8			Bookie 1	2	4	3.5
9			Bookie 2	1.5	3	5
10						
11			Bet			
12				Home Win	Draw	Away Win
13			Bookie 1	\$52.63	\$26.32	\$0.00
14			Bookie 2	\$0.00	\$0.00	\$21.05
15						
16	Profit Formula	Outcome	Profit			
17	$=G13*G8-100$	Home Win	\$5.26	$>=$	0	
18	$=H8*H13-100$	Draw	\$5.26	$>=$	0	
19	$=I4*I9-100$	Away Win	\$5.26	$>=$	0	
20	$=\text{SUM}(G13,H13,I14)$	Total Bet	\$100.00			
21	$=\text{MIN}(F17:F19)$	Guaranteed	\$5.26			

FIGURE 44.1 Finding a Soccer Arbitrage.

will use the GRG multistart engine. The GRG multistart engine tries many combinations of starting values for the changing cells and finds the best solution based on each set of starting values. Then Solver returns the best of the best answers found over all combinations of starting, changing cell values. **The GRG multistart engine requires both upper and lower bounds on all changing cells.** Here all changing cells are between \$0 and \$100. Our Solver settings are as follows:

Target Cell: Maximize F21.

Changing Cells: Bet amounts in G13, H13, and I14.

Constraints:

- All changing cells between 0 and 100.
- Profit for each match outcome (cells F17:F19) $>= 0$. **These constraints ensure that no matter how the match turns out, our bets cannot lose money.**
- Total amount bet (cell F20) = \$100.

After running Solver, we find that a profit of \$5.26 can be guaranteed by betting

- \$52.63 with Bookie 1 on a home team win.
- \$26.32 with Bookie 1 on a draw.
- \$21.05 with Bookie 2 on an away team win.

If the optimal target cell value is $\leq \$0$, then no arbitrage opportunity exists.

WHAT IS A PARLAY?

A parlay is a selection of two or more bets all of which must win for the parlay to pay off. If any of the bets result in a push, no money changes hands. An example of a two-bet parlay would be taking the Colts -4 to beat the Patriots and the Bears -6 to beat the Saints. You can combine totals bets with point spreads and even combine bets involving different sports. For example, in a two-team parlay we have a $\frac{1}{2}$ chance of winning each bet so our chance of winning the parlay (ignoring a push on either bet) is $(1/2)^2 = .25$. A 3-1 odds would be fair because then our expected profit on a \$100 bet would be $.25(300) - .75(100) = \$0$. With an actual payout of 2.6-1 our expected profit on a \$100 bet is $.25(260) - .75(100) = -\$10$, which is an average house edge of -10%. The more the number of teams in the parlay, the larger the house edge. The true odds and the typical payout on parlays are shown in Table 44-2.

TABLE 44.2
Parlay Betting Payoffs

Number of Bets	Actual Odds	Standard Payout Odds	House Percentage Edge
2	3-1	2.6-1	10%
3	7-1	6-1	12.50%
4	15-1	12-1	18.75%
5	31-1	25-1	18.75%
6	63-1	35-1	43.75%

Our calculation of the house edge assumes that the bets are independent, that is, the outcome of one bet does not affect the outcome of the other bet. For example, the results of bets on the point spreads of two different games would be independent. If we were to choose

a two-bet parlay involving the Chiefs -7 points over the Broncos and the total points over on a line of 44 points, these bets might not be independent. Our logic might be that if the Chiefs cover the point spread, then Patrick Mahomes must have had a good day and the total points is more likely to go over 44. Looking at it another way, if the Chiefs fail to cover, it was probably a bad day for Mahomes, and our over bet has little chance of winning. This is an example of a correlated parlay, because the outcomes of the bets composing the parlay are correlated. Suppose that if the Chiefs cover there is a 70% chance the total will go over 44 points while if the Chiefs do not cover there is only a 30% chance that the total will go over 44 points. Then our chance of winning the parlay is $.5(.7) = .35$, which is far better than our chance of winning a two-bet parlay composed of independent bets. For this reason, most bookmakers will not take correlated parlays.

WHAT ARE TEASERS?

Teasers are similar to parlay bets, but the bettor can adjust the line by a predetermined amount of time. So let's assume that we have the following odds:

Game 1: Chargers -8
Game 2: Titans +3

A seven-point teaser for the above games makes the new lines of the bets:

Game 1: Chargers -1 (-8 + 7)
Game 2: Titans +10 (+3 + 7)

For an x-point teaser, we essentially add +x to the original line. In order to win the teaser we need to win both bets to collect. If we place the above seven-pointer teaser bet and take the Chargers and Titans, we win if and only if the Chargers win by more than one

point and the Titans lose by nine or fewer points. If either game ends with a tie against the revised point spread, the teaser is called off and no money changes hands. Otherwise we lose the teaser bet. Here are some examples of how this teaser might play out.

- Chargers win by 2 and Titans lose by 3: We win the teaser.
- Chargers win by three and Titans lose by 12: We lose the teaser.
- Chargers win by 1: The teaser is a push and no money changes hands.
- Chargers lose by 1 and Titans win by 5: We lose the teaser.

Teasers usually involve 6, 6.5, or 7 points. The betting site <https://www.sportsbookreview.com/best-sportsbooks/football-teasers/> gives odds from many bookies on teasers. An example is shown in Table 44-3. For example, if we bet a two-team seven-point teaser and we win the teaser, then we win \$100. If we lose the teaser, we lose \$135. If we bet a four-team six-point teaser and all four teams cover their revised points, we win \$265. If no games push and we do not cover all four revised spreads, we lose \$100. During the years 2000–2005 a team covered a seven-point teaser 70.6% of the time, pushed 1.5% of the time, and lost 27.9% of the time.

TABLE 44.3

Teaser Payoffs

	C	D	E	F	G	H
8	Points	2 team	3 team	4 team	5 team	6 team
9	5.0	103	190	315	490	745
10	5.5	100	180	300	465	710
11	6.0	-110	165	265	410	610
12	6.5	-120	150	240	365	550
13	7.0	-135	135	215	320	460
14	7.5	-150	120	185	270	380
15	8.0	-165	110	168	245	345

Let's determine our expected profit on a two-team, seven-point teaser with a \$100 bet. We begin by figuring out the probability

that we win the teaser, push, or lose the teaser. We assume that the outcomes of the individual teaser bets are independent events. That is, if we cover one game involved in the teaser, this does not affect our probability of covering any other game involved in the teaser. Now we can compute our probability of winning a two-team teaser bet.

- We win the teaser with probability $.706^2 = .498436$.
- We push if exactly one game is a push or both games push. This occurs with probability $(.015) * (1 - .015) + (1 - .015) * (.015) + (.015)^2 = .029775$.
- We lose the teaser with probability $1 - .498436 - .029775 = 0.471789$.

Our expected profit on the teaser is $(\$100) * (.498436) + 0 * (.029775) - \$135(.471789) = -\$13.85$. Therefore, in a two-team teaser the bookie has an edge of $-\$13.85/\$135 = 10.1\%$. The interested reader can show that the bookie's edge increases as more teams are involved in the teaser. Overall, teaser bets might appear easier to win—since the bettor is allowed to change the original line—but at the end of the day they are still parlay bets (with smaller payouts) that give the bookmaker an edge anywhere between 10% and 20%.