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Scoring Strategies for the Underdog: Using Risk as an Ally in Determining Optimal Sports Strategies

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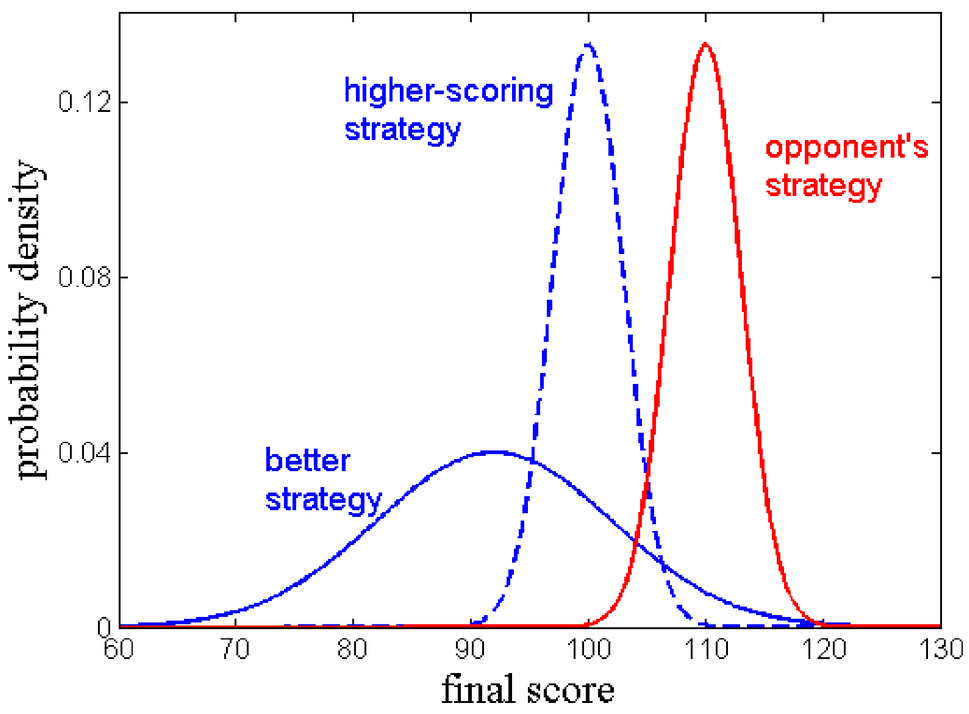
Risk as a Statistical Quantity

In sports, a risky strategy is one with a wide distribution of potential outcomes. Risk can be defined as the *variance* in a team's potential final score.



An *underdog* should be willing to sacrifice from its expected final score in order to *increase the variance* [1]. A *favored team* should be willing to sacrifice from its expected final score in order to *reduce the variance*.

How often should a team run risky plays?

If all plays are *statistically independent* [2], the variance is given by the binomial distribution:

$$\sigma^2 = (\text{point value of play})^2 \times N \times p \times (1\text{-}p).$$

The total variance is the team's final score is additive:

$$\sigma^2_{\text{total}} = \sigma^2_1 + \sigma^2_2 + \sigma^2_3 + \ldots$$

The success rate p of a play may depend on the number of times N that it is run [3, 4].

For large N, the probability of winning depends only on

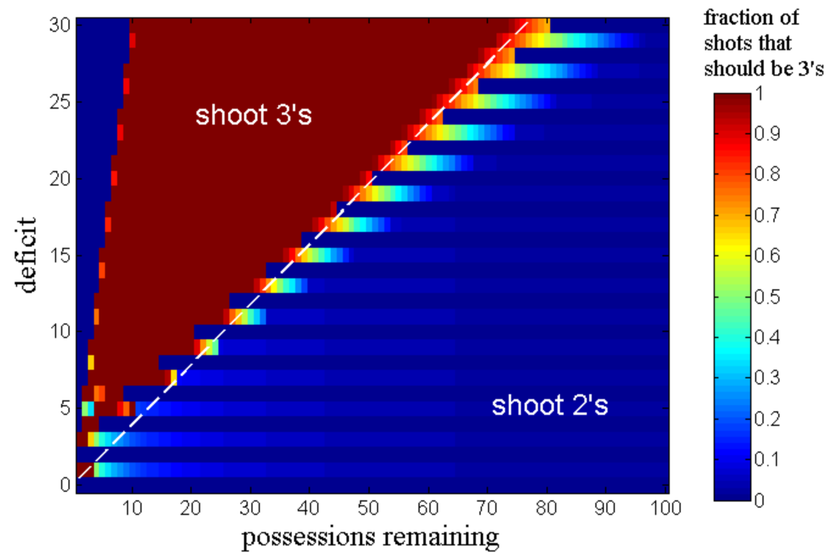
$$Z = \frac{\mu - \mu_{opp}}{\sqrt{\sigma^2 + \sigma^2_{opp}}}.$$

This suggests the following simple, quantitative rule for the risk/reward tradeoff in sports, the "CLT rule":

A team's best strategy is the one that maximizes Z.

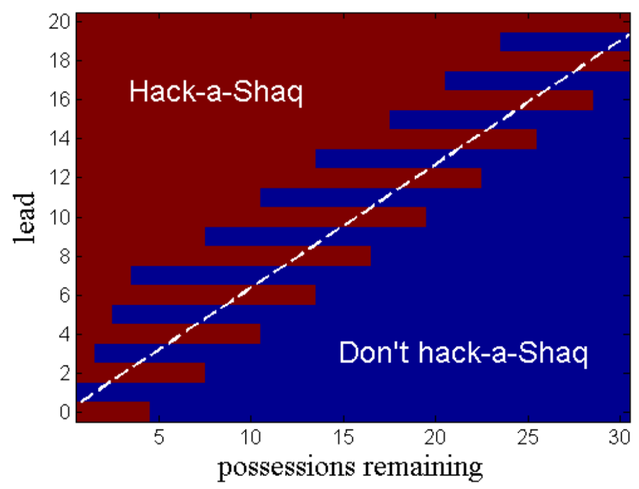
Examples

How often should a basketball team shoot 3's?



This team shoots $p_2 = 0.5$, $p_3 = 0.3$ against an opponent with $p_2 = 0.55$. They sacrifice 10 points/100 possessions by shooting 3's, but they should still shoot 3's if they trail by more than $0.4N$ points with N possessions left.

Playing Hack-a-Shaq



$p_2 = 0.55$
$p_{2,\text{opp}} = 0.5$
$p_{\text{FT,opp}} = 0.55$

This team gives up 5 more points/100 possessions to their opponent by fouling, but they should still foul if they lead by more than $0.3N$ points with N possessions remaining.

Other examples in the paper

- The run, the pass, and the Hail Mary in football
- When to stall for time

References

[1] Dean Oliver, 1995, http://www.rawbw.com/~deano/articles/BellCurve.html.
[2] John Huizinga and Sandy Weil, "Hot Hand or Hot Head? The Truth About Heat Checks in the NBA", MIT Sloan Sports Analytics Conference, 2009.
[3] Dean Oliver, *Basketball on Paper: Rules and Tools for Performance Analysis*, chapter 19, Potomac Books, Dulles, 2004.
[4] Brian Skinner, "The Price of Anarchy in Basketball," Journal of Quantitative Analysis in Sports, vol. 6, iss. 1, article 3, 2010.