A Computational Analysis of Arbitrage Opportunities in Sports Gambling

PRINCETON UNIVERSITY

Brian Matejek

Advisor: Christopher Moretti

Introduction

- Arbitrage is the only gambling strategy that may guarantee a profit for the gambler.
- RebelBetting and Sports Arbitrage World both specialize in finding arbitrage opportunities for gamblers.
- There are two major issues with arbitrage gambling.
  - Micromanaging bets on individual games.
  - Macromanaging financial accounts with multiple bookkeepers over a period of time.
- Goal of the project is to address the issues with arbitrage and analyze the claims of RebelBetting and Sports Arbitrage World.

Existing Research

- Online gambling is a multi-billion dollar industry, so it attracts a lot of attention from online sources, but not much from academia.
- Some attention in academia with combining arbitrage with exchange rates.
- RebelBetting and Sports Arbitrage World both claim that users can grow their investments by 10% per month.
- Arbitrage gamblers currently use minimax strategies first developed by John von Neumann.
- Wisdom of the Crowd predicts that averaging the probability guesses from multiple sources produces a better probability estimate than most individual guesses.

Web Scraping

- OddsPortal.com has archived results containing the odds for many games over the last 8 to 10 years.
- The archived results tables are generated with JavaScript so urllib and other standard HTML scraping packages could not load the data.
- Used phantomjs, a "headless Webkit", that loads the entire contents of the page before scraping the content.
  - Took about 5 to 7 seconds per webpage (~107,000 webpages).
  - Around 145 – 205 CPU hours.
- Scraped 105,065 games from 90 different sports leagues in 13 different sports.

Bookkeepers

- I considered odds from 16 different bookkeepers from several different countries.
- Each bookkeeper has a different perspective on arbitrage gambling; some support it, while others try to prevent it.
- Some bookkeepers, such as BetVictor and bet-at-home, try to blacklist arbitrage gamblers because they fear having to payout excessive amounts of money with one bad odd.
- Some bookkeepers, such as myBet and Bet365, restrict the maximum amount a gambler can bet on any one game.

Micromanaging Bets

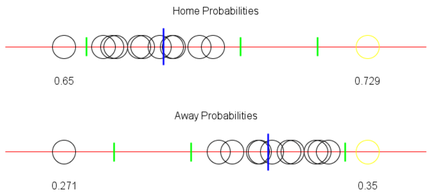
- o_H, o_X, o_A are the payoffs if the home team wins, both teams draw, or the away team wins. C is the total amount bet on an individual game.
  - Payoffs in European decimal format – bookkeeper pays the amount bet times the odd.
- Gamblers can maximize their minimum guaranteed payoff by betting:

$$b_H = \left(\frac{o_A}{o_H + o_A}\right) C \qquad b_A = \left(\frac{o_H}{o_H + o_A}\right) C$$

$$b_H = C\left(\frac{o_X * o_A}{o_H * o_A + o_X * o_A + o_X * o_H}\right) \quad b_A = C\left(\frac{o_H * o_X}{o_H * o_A + o_X * o_A + o_X * o_H}\right)$$

$$b_X = C\left(\frac{o_H * o_A}{o_H * o_A + o_X * o_A + o_X * o_H}\right)$$

- Bookkeepers assign odds based on the probabilities they believe each team has of winning.
- Arbitrage opportunities appear with bookkeepers that greatly disagree on the probabilities of each team winning.

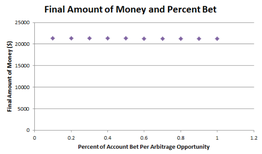


November 26, 2009 – New York Giants versus the Denver Broncos. The blue line is the average probability among all the bookkeepers, the green lines are standard deviations from the mean and the gold rings are the probabilities given by bookkeepers used in the arbitrage opportunity.

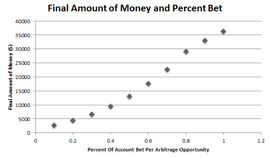
- Using the average probabilities in the above graph, if $p_H * o_H > 1$ and $p_A * o_A > 1$, better to bet $p_H * o_H$ and $p_A * o_A$.
  - Not guaranteed to win as much but expected value higher.

Macromanaging Accounts

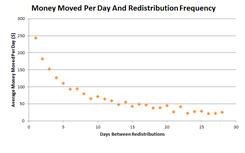
- Since arbitrage gambling is guaranteed to make a profit, a gambler would do best by gambling his entire account on every game.
  - This would alert bookkeepers that the gambler is hedging his bets with another bookkeeper or has a gambling problem.
  - Instead, bet a percentage of an account amount on each arbitrage opportunity.



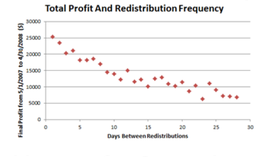
These graphs show the total profit from 5/1/2007 to 4/30/2008 depending on the percentage of an account bet on a game. The left graph depicts two outcome games and the right graph depicts three outcome games. The final algorithm uses 50% for 2 outcome games and 67% for 3 outcome games.



- If there is great disparity between the account amounts of two bookkeepers, a gambler cannot bet as much as would be desirable.
- Redistribute account balances every four days so that accounts remain roughly equal over time (2% transaction fee for all money withdrawn).



These graphs show the tradeoffs between frequency of redistributing all of the money in the accounts and the amount of money moved and the total profit. Data from 5/1/2007 to 4/30/2008. I chose every four days since the average amount of money moved per day per bookkeeper was around $12.



- If an account loses $10,000, stop using the bookkeeper for 6 months.
  - This amortizes the amount lost over a longer period so that bookkeepers do not investigate a gambler.

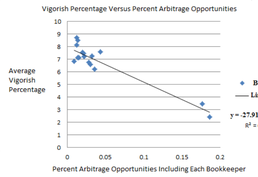
Simulation

- The simulation was written in Java and contained roughly 3,000 lines of code.
- Modeled a complex financial system between bookkeepers and my various accounts.
- Created classes for bookkeepers, dates, matches, teams, odds, and the simulation itself.
- Used TreeMaps, HashTables, ArrayLists, and other data structures to improve performance.
- No money was actually bet, and sports gambling is not legal in NJ.

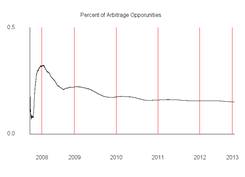
Analysis

- Assuming RebelBetting and Sports Arbitrage World grow the accounts of users by 10% per month, after three years and initial investment of $1,400, users would gross $43,277.75 before fees.
  - After accounting for the disparate fees charged by these companies, users would net $36,064.07 and $32,307.89.
  - My algorithm ended the three year period from 1/1/2009 to 12/31/2011 with $82,725.01 (average 12% growth per month).
- There are diminishing returns caused by maximum betting limits set by bookkeepers and my blacklisting avoidance procedure that may stop gambling with a bookkeeper for 6 months.

- Because of gambling constraints, RebelBetting and Sports Arbitrage World claims can only last for a short period of time.



Left: Correlation between average cut that a bookkeeper takes per game and the percentage of odds that contributed to an arbitrage opportunity.
Right: The gradually decreasing number of arbitrage opportunities in the market.



Future Developments and Conclusion

- OddsPortal.com only had the closing odds for the archived results in an easily accessible table.
  - Bookkeepers actually change odds several times before determining the closing odds.
- By looking at the odds at multiple snapshots of time, there are more opportunities for arbitrage. Could also consider odds such as first score, point differential, total score.
- The investment growth offered by RebelBetting and Sports Arbitrage World is not as good as claimed.
  - Betting constraints make it impossible to maintain the growth rate.
- Arbitrage is not a stable long-term investment strategy.