



MONEYBALL

The Power of Sports Analytics

15.071 – The Analytics Edge

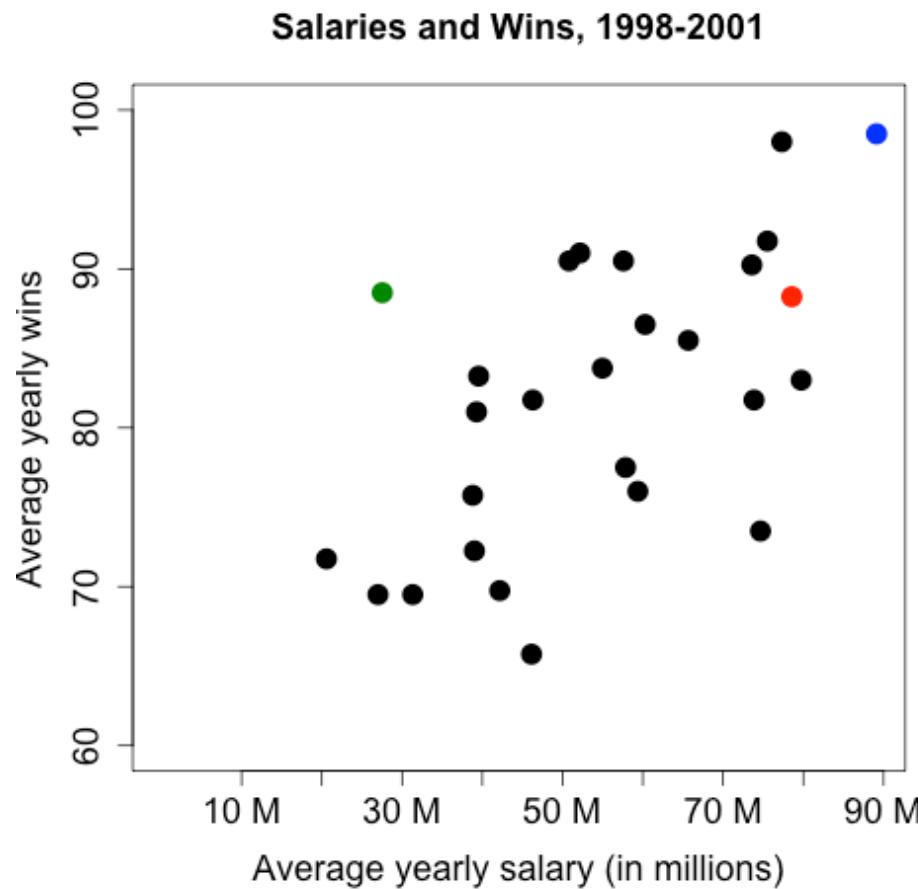
The Story

- *Moneyball* tells the story of the Oakland A's in 2002
 - One of the poorest teams in baseball
 - New ownership and budget cuts in 1995
 - But they were improving

| Year | Win % |
|------|-------|
| 1997 | 40% |
| 1998 | 46% |
| 1999 | 54% |
| 2000 | 57% |
| 2001 | 63% |

- How were they doing it?
 - Was it just luck?
- In 2002, the A's lost three key players
- Could they continue winning?

The Problem



- Rich teams can afford the all-star players
- How do the poor teams compete?

Competing as a Poor Team



- Competitive imbalances in the game
 - Rich teams have four times the salary of poor teams
- The Oakland A's can't afford the all-stars, but they are still making it to the playoffs. How?
- They take a quantitative approach and find undervalued players

A Different Approach

- The A's started using a different method to select players
- The traditional way was through scouting
 - Scouts would go watch high school and college players
 - Report back about their skills
 - A lot of talk about speed and athletic build
- The A's selected players based on their statistics, not on their looks
 - “The statistics enabled you to find your way past all sorts of sight-based scouting prejudices.”
 - “We’re not selling jeans here”

The Perfect Batter

The A's



A catcher who couldn't throw
Gets on base a lot

The Yankees



A consistent shortstop
Leader in hits and stolen bases

The Perfect Pitcher

The A's



The Yankees



Unconventional delivery

Slow speed

Conventional delivery

Fast speed

Billy Beane



- The general manager since 1997
- Played major league baseball, but never made it big
 - Sees himself as a typical scouting error
- Billy Beane succeeded in using analytics
 - Had a management position
 - Understood the importance of statistics – hired Paul DePodesta (a Harvard graduate) as his assistant
 - Didn't care about being ostracized

Taking a Quantitative View

- Paul DePodesta spent a lot of time looking at the data
- His analysis suggested that some skills were undervalued and some skills were overvalued
- If they could detect the undervalued skills, they could find players at a bargain



The Goal of a Baseball Team

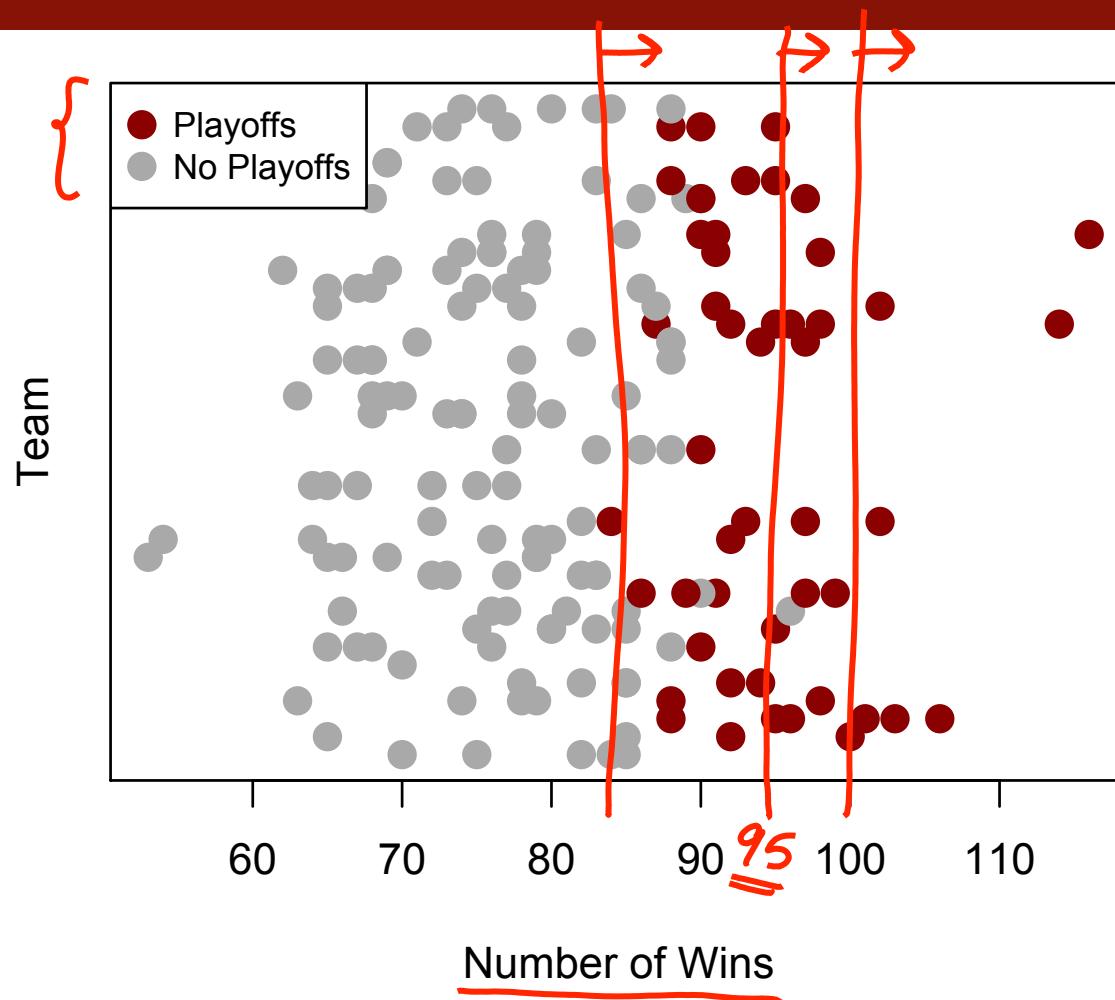


Making it to the Playoffs



- How many games does a team need to win in the regular season to make it to the playoffs?
- “Paul DePodesta reduced the regular season to a math problem. He judged how many wins it would take to make it to the playoffs. 95.”

Making it to the Playoffs



Data from
all teams
1996-2001

Winning 95 Games



- How does a team win games?
- They score more runs than their opponent
- But how many more?
- The A's calculated that they needed to score 135 more runs than they allowed during the regular season to expect to win 95 games
- Let's see if we can verify this using linear regression

Coefficients:

| | Estimate | Std. Error | t value | Pr(> t) | |
|-------------|------------------|------------|---------|----------|-----|
| (Intercept) | <u>80.881375</u> | 0.131157 | 616.67 | <2e-16 | *** |
| RD | <u>0.105766</u> | 0.001297 | 81.55 | <2e-16 | *** |

$$W = 80.8814 + 0.1058(RD)$$

$$W \geq 95$$

$$80.8814 + 0.1058(RD) \geq 95$$

$$RD \geq \frac{95 - 80.8814}{0.1058} = 133.4 \sim 135$$

The Goal of a Baseball Team



Scoring Runs

- • How does a team score more runs?
- The A's discovered that two baseball statistics were significantly more important than anything else
- • On-Base Percentage (OBP)
 - Percentage of time a player gets on base (including walks)
- • Slugging Percentage (SLG)
 - How far a player gets around the bases on his turn (measures power)

Scoring Runs

- Most teams focused on Batting Average (BA)
 - Getting on base by hitting the ball
- The A's claimed that:
 - • On-Base Percentage was the most important
 - • Slugging Percentage was important
 - • Batting Average was overvalued
- Can we use linear regression to verify which baseball stats are more important to predict runs?

Allowing Runs

- We can use pitching statistics to predict runs allowed
 - • Opponents On-Base Percentage (OOBP)
 - • Opponents Slugging Percentage (OSLG)
- We get the linear regression model
 - Runs Allowed = $-837.38 + 2913.60(\text{OOBP}) + 1514.29(\text{OSLG})$
- $R^2 = \underline{0.91}$
- Both variables significant

Predicting Runs and Wins



- Can we predict how many games the 2002 Oakland A's will win using our models?
- The models for runs use team statistics
- Each year, a baseball team is different
- We need to estimate the new team statistics using past player performance
 - Assumes past performance correlates with future performance
 - Assumes few injuries
- We can estimate the team statistics for 2002 by using the 2001 player statistics

Predicting Runs Scored

- At the beginning of the 2002 season, the Oakland A's had 24 batters on their roster
- Using the 2001 regular season statistics for these players
 - Team OBP is 0.339
 - Team SLG is 0.430
- Our regression equation was

$$RS = -804.63 + 2737.77(\text{OBP}) + 1584.91(\text{SLG})$$

- Our 2002 prediction for the A's is

$$RS = -804.63 + 2737.77(0.339) + 1584.91(0.430) = 805$$

Predicting Runs Allowed

- At the beginning of the 2002 season, the Oakland A's had 17 pitchers on their roster
- Using the 2001 regular season statistics for these players
 - Team OOBP is 0.307
 - Team OSLG is 0.373
- Our regression equation was

$$RA = -837.38 + 2913.60(\text{OOBP}) + 1514.29(\text{OSLG})$$

- Our 2002 prediction for the A's is

$$RA = -837.38 + 2913.60(0.307) + 1514.29 (0.373) = 622$$

Predicting Wins



- Our regression equation to predict wins was

$$\text{Wins} = 80.8814 + 0.1058(\text{RS} - \text{RA})$$

- We predicted

- $\text{RS} = 805$

- $\text{RA} = 622$

- So our prediction for wins is

$$\text{Wins} = 80.8814 + 0.1058(805 - 622) = 100$$

The Oakland A's

- Paul DePodesta used a similar approach to make predictions
- Predictions closely match actual performance

| | Our Prediction | Paul's Prediction | Actual |
|-------------|-------------------|----------------------|--------|
| Runs Scored | 805 | 800 – 820 | 800 |

The Oakland A's

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| | Our Prediction | Paul's Prediction | Actual |
|--------------|-------------------|----------------------|--------|
| Runs Scored | 805 | 800 – 820 | 800 |
| Runs Allowed | 622 | 650 – 670 | 653 |

The Oakland A's

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| | Our Prediction | Paul's Prediction | Actual |
|--------------|-------------------|----------------------|--------|
| Runs Scored | 805 | 800 – 820 | 800 |
| Runs Allowed | 622 | 650 – 670 | 653 |
| Wins | 100 | 93 – 97 | 103 |

- The A's set a League record by winning 20 games in a row
- Won one more game than the previous year, and made it to the playoffs

The Goal of a Baseball Team



Why isn't the goal
to win the World
Series?

Luck in the Playoffs



- Billy and Paul see their job as making sure the team makes it to the playoffs – after that all bets are off
 - The A's made it to the playoffs in 2000, 2001, 2002, 2003
 - But they didn't win the World Series
- Why?
- “Over a long season the luck evens out, and the skill shines through. But in a series of three out of five, or even four out of seven, anything can happen.”

Is Playoff Performance Predictable?



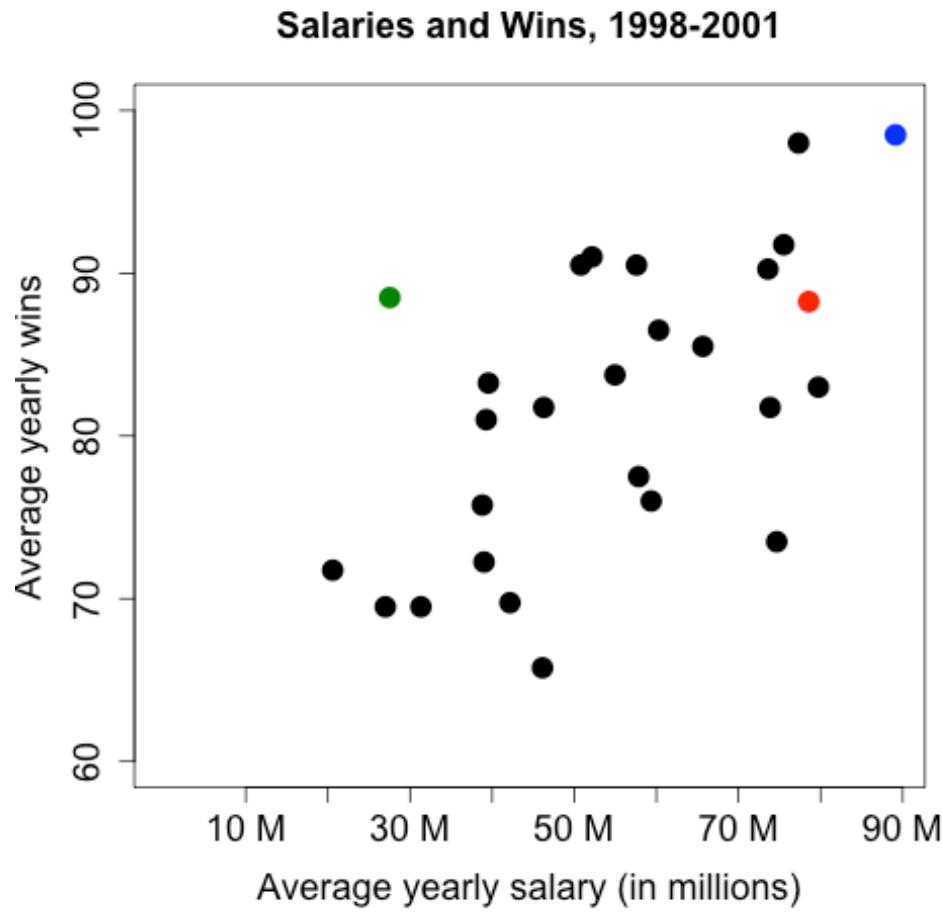
- Using data 1994-2011 (8 teams in the playoffs)
- Correlation between winning the World Series and regular season wins is 0.03
- Winning regular season games gets you to the playoffs
- But in the playoffs, there are too few games for luck to even out
- *Logistic regression* can be used to predict whether or not a team will win the World Series

Other Moneyball Strategies



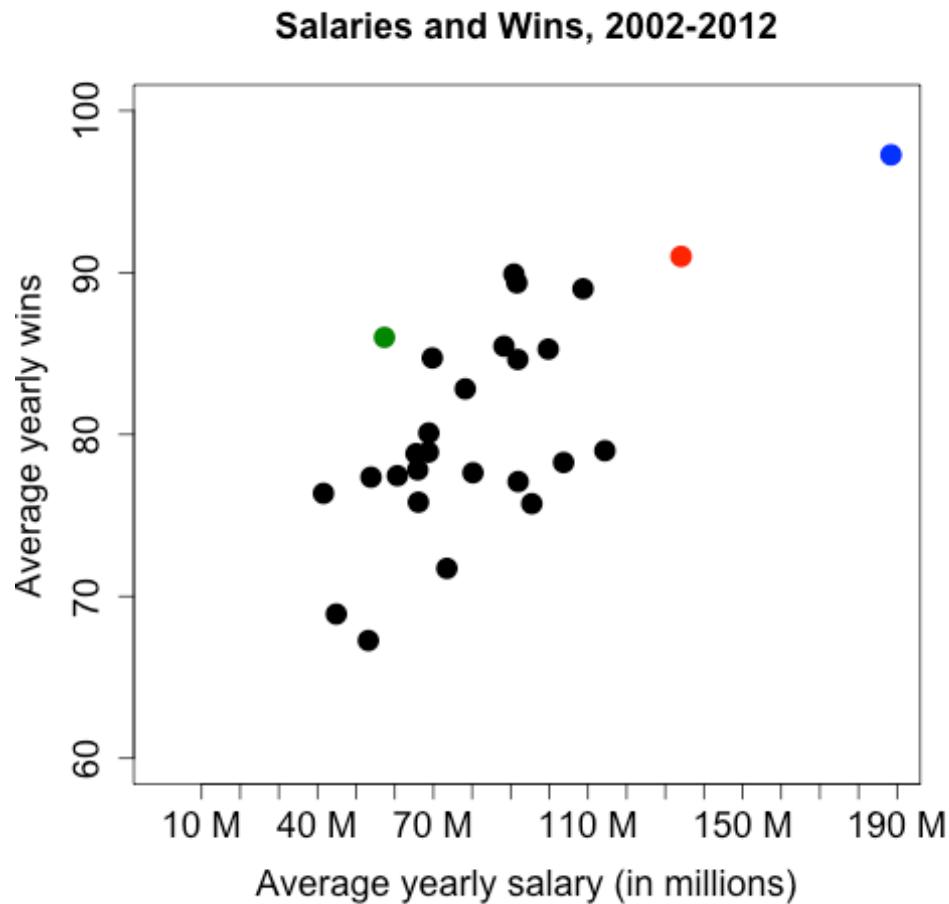
- *Moneyball* also discusses:
 - How it is easier to predict professional success of college players than high school players
 - Stealing bases, sacrifice bunting, and sacrifice flies are overrated
 - Pitching statistics do not accurately measure pitcher ability – pitchers only control strikeouts, home runs, and walks

Where was Baseball in 2002?



- Before Moneyball techniques became more well-known, the A's were an outlier
- 20 more wins than teams with equivalent payrolls
- As many wins as teams with more than double the payroll

Where is Baseball Now?



- Now, the A's are still an efficient team, but they only have 10 more wins than teams with equivalent payrolls
- Fewer inefficiencies

Sabermetrics

- Sabermetrics is a more general term for Moneyball techniques
- There has been a lot of work done in this field
 - Baseball Prospectus (www.baseballprospectus.com)
 - Value Over Replacement Player (VORP)
 - Defense Independent Pitching Statistics (DIPS)
 - *The Extra 2%: How Wall Street Strategies Took a Major League Baseball Team from Worst to First*
 - A story of the Tampa Bay Rays
 - Game-time decisions: batting order, changing pitchers, etc.

Other Baseball Teams and Sports



- Every major league baseball team now has a statistics group
- The Red Sox implemented quantitative ideas and won the World Series for the first time in 86 years
- Analytics are also used in other sports, although it is believed that more teams use statistical analysis than is publically known

The Analytics Edge



- Models allow managers to more accurately value players and minimize risk
 - “In human behavior there was always uncertainty and risk. The goal of the Oakland front office was simply to minimize the risk. Their solution wasn’t perfect, it was just better than ... rendering decisions by gut feeling.”
- Relatively simple models can be useful