Basketball I

Produced by Dr. Mario

UNC STOR 390

Ninh Explains ...

The Rules of
BASKETBALL

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Basketball Statistics

- **Information Tracked in Box Score**
  - **Two-Point Field Goals**
  - **Three- Point Field Goals**
  - **Free Throws**
  - **Personal Fouls**
  - **Assists**
  - **Offensive/Defensive Rebounds**
  - **Blocked Shots**
  - **Turnovers**
  - **Steals**
  - **Minutes Played**

Basketball Statistics

- **Classic Measures of Field Goal Percentage**

$$FG\% = \frac{FGM}{FGA} \qquad 3FG\% = \frac{3FGM}{3FGA}$$

FGM = Field Goal Made
FGA = Field Goal Attempt
3FGM = 3-Pointer Made
3FGA = 3-Pointer Attempt

- **Effective Field Goal Percentage (EFG)**
  - **Problem with Previous Metrics**
    - **Knicks: 15/20 Field Goals = 30 Points**
    - **Lakers: 15/20 3-Pt Field Goals = 45 Points**
    - **Same Field Goal Percentage (75%)**
  - **New Metric**

$$EFG\% = \frac{FGM + 0.5 \times 3FGM}{FGA}$$

  - **Adjusted EFG%**
    - **Knicks: 75%**
    - **Lakers: 1125%**

Basketball Statistics

- **Rebounding**
  - **Raw Rebounds is Misleading**
  - **Percentage of Rebounds When on Offense (OREB%)**

$$OREB\% = \frac{OREB}{Missed\ FGA}$$

  - **Percentage of Rebounds When on Defense (DREB%)**

$$DREB\% = \frac{DREB}{Opponent\ Missed\ FGA}$$

REB = Rebound
OREB = Offensive Rebound
DREB = Defensive Rebound
FGA = Field Goal Attempt
FTM = Free Throw Made
FTA = Free Throw Attempt

Basketball Statistics

- **Free Throws**
  - **Classic Free Throw Percentage (FT%)**

$$FT\% = \frac{FTM}{FTA}$$

  - **Free Throw Rate (FTR)**

$$FTR = \frac{FTA}{FGA}$$

  - **Interpretation: Suppose FTR = 0.39. For Every 100 Shots, the Team is Getting Around 37 Free Throws**

FGA = Field Goal Attempt
FTM = Free Throw Made
FTA = Free Throw Attempt

Basketball Statistics

- **Turnovers**

  - **Possession**
    - **Starts When Team Gets Ball**
    - **Ends When Shot Hits Rim or Opponent Gets Ball**
    - **Average Possessions Per Game Between 90 and 95**
  - **Turnover Defined**
    - **Occurs When Team Loses Possession Before Attempting Shot**
    - **Offense Commits Turnovers and Defense Causes Turnovers**
  - **Offensive Turnovers Per Possession (TO%)**

$$TO\% = \frac{TO\ Committed}{Offensive\ Possessions}$$

  - **Defensive Turnovers Per Possession (DTO%)**

$$DTO\% = \frac{TO\ Caused}{Defensive\ Possessions}$$

Basketball Statistics

- **Four Factors For Team Offense**
  - EFG%
  - OREB%
  - FTR
  - TO%

- **Four Factors For Team Defense**
  - Opponent's EFG%
  - DREB%
  - Opponent's FTR
  - DTO%

- **Four Factors Credited to Dean Oliver (Denver Nuggets)**

Basketball Statistics

- **Four Factors are Uncorrelated**
  - **All Giving Unique Information**
  - **Highest Correlation**
    - **Opponent's EFG% and DREB% (-0.67)**
    - **EFG% and OREB% (-0.47)**
    - **OREB% and TO%**

- **Importance of 4 Factors in Regression**
  - **Regression on W**

$$W = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_8 X_8 + \epsilon$$

  - **Eight Covariates**

$X_1 = EFG\%$ $X_5 = Opponent's\ EFG\%$

$X_2 = TO\%$ $X_6 = DTO\%$

$X_3 = OREB\%$ $X_7 = DREB\%$

$X_4 = FTR$ $X_8 = Opponent's\ FTR$

W = Win

Basketball Statistics

- **Regression Results from Justin Jacobs (Squared2020.com)**

```
Estimated Coefficients:
                      Estimate         SE       tStat        pValue
                      _____       _____    _____    _____

   (Intercept)        -107.19       72.077     -1.4871       0.15185
   x1                  391.83       43.613      8.9843    1.2211e-08
   x2                 -251.29       73.765     -3.4066     0.0026564
   x3                  137.08       28.408      4.8254    9.0615e-05
   x4                   36.745      39.751      0.92437      0.36579      FTR
   x5                 -368.68       55.135     -6.6869    1.2843e-06
   x6                  331.22       73.675      4.4958    0.00019862
   x7                  127.42       56.446      2.2574      0.034757
   x8                  -60.952      32.368     -1.8831       0.07361   Opponent's FTR

Number of observations: 30, Error degrees of freedom: 21
Root Mean Squared Error: 3.67
R-squared: 0.922,  Adjusted R-Squared 0.892
F-statistic vs. constant model: 31, p-value = 6.03e-10
```

Linear Weights in Basketball

- **NBA Efficiency Rating (EFF)**
  - **Equally Weights Good and Bad Stats**
  - **Formula**

$$EFF = [PTS + REB + AST + STL$$
$$-TO - (Missed\ FG) - (Missed\ FT)]/G$$

- **Player Efficiency Rating (PER)**
  - **Created by John Hollinger (VP of Operations for Memphis)**
  - **Average Across All NBA Players is 15**

PTS = Point
REB = Rebound
AST = Assist
STL = Steal
TO = Turnover
FG = Field Goal
FT = Free Throw
G = Game

Hollinger Stats - Player Efficiency Rating - Qualified Players

RK	PLAYER	GP	MPG	TS%	AST	TO	USG	ORR	DRR	REBR	PER	VA	EWA
1	Giannis Antetokounmpo, MIL	72	32.8	.644	18.9	12.0	32.3	7.3	30.0	19.3	**30.95**	684.4	22.8
2	James Harden, HOU	78	36.8	.616	18.0	11.9	40.8	2.5	17.8	10.0	**30.62**	839.5	28.0
3	Anthony Davis, NO	56	33.0	.597	14.1	7.2	29.4	9.9	27.5	18.8	**30.32**	519.7	17.3
4	Karl-Anthony Towns, MIN	77	33.1	.622	12.9	11.9	28.8	10.9	29.3	20.0	**26.38**	599.6	20.0
	Nikola Jokic, DEN	80	31.3	.589	26.5	11.3	29.4	9.8	27.6	18.7	**26.38**	589.7	19.7

Linear Weights in Basketball

- **Player Efficiency Rating (PER)**
  - **Significant Problems With PER**
  - **Bad Weights**
  - **Players With Poor Shooting Percentages Can Increase PER by Attempting More Shots**
  - **Rewards Bad Shooters**

- **David Berri**
  - **Publishes Research Regarding Sports Economics**
  - *Wages of Wins Journal*
  - **Critical About John Hollinger's PER**

Linear Weights in Basketball

- **Win Scores (WS)**
  - **Formula**

$$WS = PTS + REB + STL$$
$$+ \, 0.5 \times AST + 0.5 \times BLK$$
$$- \, \text{FGA} - \text{TO} - 0.5 \times FTA - 0.5 \times PF$$

  - **To Raise WS by Shooting More, Player Needs to Shoot Above 50% for 2-Pointers or Above 33.3% for 3-Pointers**

- **Wins Produced (WP)**
  - **Formula for WP Based on WS**
  - **Sum of WP for All Teams Players ≈ Teams Wins**
  - **Cannot Conclude WP Represents Individual Wins**
  - **WP is Not Good for the NBA's Top Defenders**
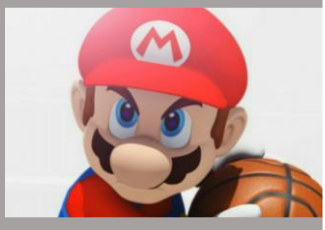
PTS = Point
REB = Rebound
AST = Assist
STL = Steal
TO = Turnover
BLK = Block
FGA = Field Goal Attempt
FTA = Free Throw Attempt
PF = Personal Fouls

Linear Weights in Basketball

- **Information Not Tracked in Box Score**
  - **Taking Charges**
  - **Deflecting a Pass**
  - **Box Out**
  - **Assisting the Assister**
  - **Help Defense**
  - **Screens**

Final Inspiration

If you can't dunk, lower the hoop.

- Mahatma Mario