



Basketball I



Produced by Dr. Mario
UNC STOR 538





Overview of Basketball

Ninh Explains ...

The Rules of **BASKETBALL**

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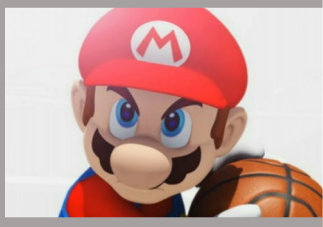
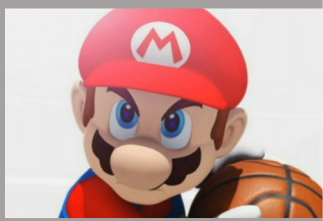




Basketball Statistics

- 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

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

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: 112.5%





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





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 39 Free Throws**

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





Basketball Statistics

- **Turnovers**

TO = Turnover

- **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%)**

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

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

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

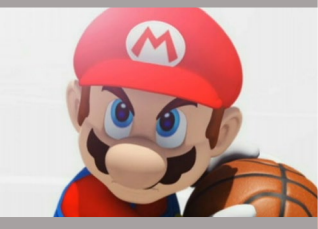




Basketball Statistics

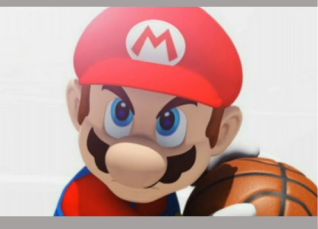
- **Four Factors For Team Offense**

- 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)**



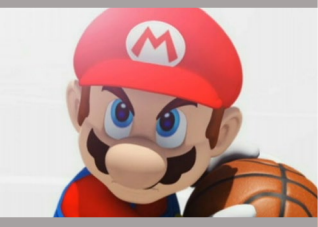
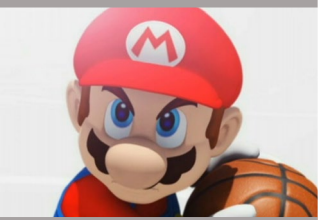


Basketball Statistics

W = Win

- **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% (0.46)



- **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**

$$X_1 = EFG\%$$

$$X_5 = \text{Opponent's } EFG\%$$

$$X_2 = TO\%$$

$$X_6 = DTO\%$$

$$X_3 = OREB\%$$

$$X_7 = DREB\%$$

$$X_4 = FTR$$

$$X_8 = \text{Opponent's } FTR$$



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
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

FTR

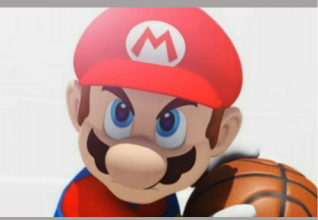
Opponent's FTR

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

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

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

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

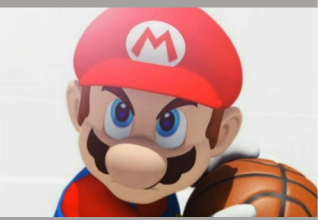
Hollinger Stats - Player Efficiency Rating - Qualified Players

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

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

- 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 \approx 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

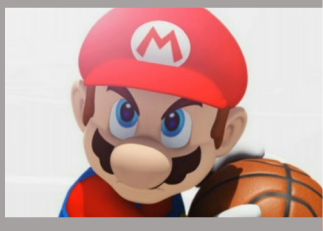
PF = Personal Fouls





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