



# Basketball I



Produced by Dr. Mario  
UNC STOR 538





# Overview of Basketball

Ninh Explains ...

## The Rules of **BASKETBALL**

@NinhLyUK [www.ninh.co.uk](http://www.ninh.co.uk)

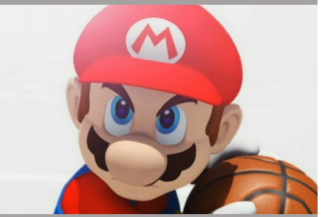




# Basketball Statistics

- **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**

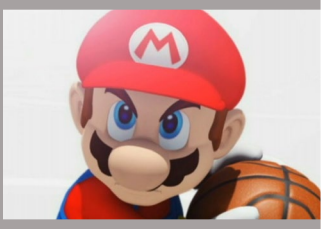
- Knicks: 15/20 Field Goals = 30 Points
- Lakers: 15/20 3-Pt Field Goals = 45 Points
- Same Field Goal Percentage (75%)

- **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%)

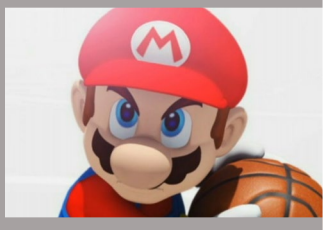
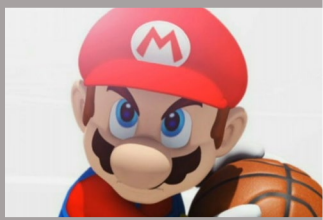
$$DREB\% = \frac{DREB}{Opponent\ Missed\ FGA}$$

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

TO = Turnover

- **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**

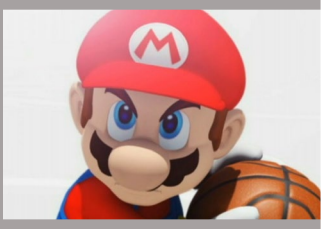
- Occurs When Team Loses Possession Before Attempting Shot
    - Offense Commits Turnovers and Defense Causes Turnovers

- **Offensive Turnovers Per Possession (TO%)**

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

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

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





# Basketball Statistics

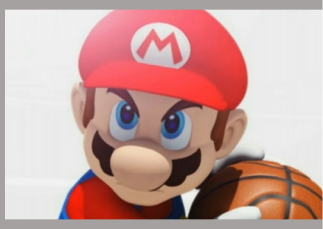
- **Four Factors For Team Offense**

- 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)**





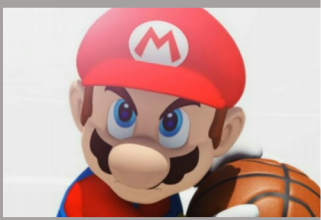


# Basketball Statistics

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

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

- **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

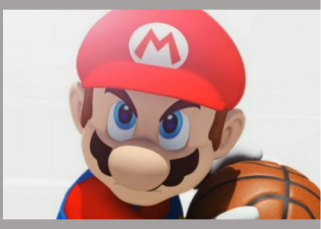
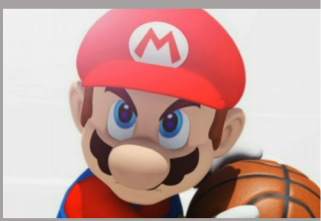
Opponent's FTR

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

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

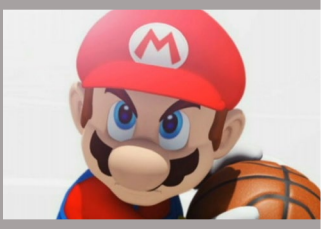
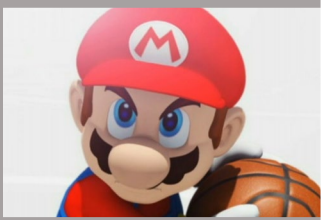
PTS = Point  
 REB = Rebound  
 AST = Assist  
 STL = Steal  
 TO = Turnover  
 FG = Field Goal  
 FT = Free Throw  
 G = Game

- 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	<b>30.95</b>	684.4	22.8
2	James Harden, HOU	78	36.8	.616	18.0	11.9	40.8	2.5	17.8	10.0	<b>30.62</b>	839.5	28.0
3	Anthony Davis, NO	56	33.0	.597	14.1	7.2	29.4	9.9	27.5	18.8	<b>30.32</b>	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	<b>26.38</b>	599.6	20.0
	Nikola Jokic, DEN	80	31.3	.589	26.5	11.3	29.4	9.8	27.6	18.7	<b>26.38</b>	589.7	19.7

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# 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

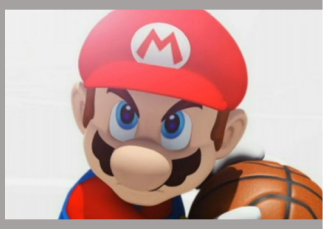
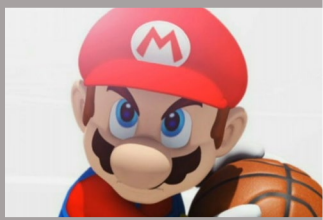
TO = Turnover

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