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# LS88: Sports Analytics

— Shooting Metrics & —  
The Evolution of the NBA

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# Shooting Metrics and Efficiency

→ Field Goal Percentage

$$\text{FG}\% = \frac{\text{Field Goals Made}}{\text{Field Goals Attempted}}$$

→ Effective Field Goal Percentage

$$\text{eFG}\% = \frac{\text{Field Goals Made} + .5 \times \text{3pt Field Goals Made}}{\text{Field Goals Attempted}}$$

→ True Shooting Percentage

$$\text{TS}\% = \frac{\text{Total Points}}{2(\text{Field Goals Attempted} + .44 \times \text{Free Throws Attempted})}$$

# Shooting Metrics and Efficiency

What we learned...

- Offensive Rating (points per 100 poss) is the measure of team efficiency we want
- FG%, eFG%, and TS% correlate strongly with Off. Rating (in that order)
- The core component of Off. Rating is the ability to score efficiently
  - ◆ Turnovers and offensive rebounding are secondary
- The correlations for FG%, eFG%, and TS% change by era
  - ◆ Why? Two ideas were posited: turnovers and increased 3pt shooting

# Turnovers and Off. Rating

So why did the correlations change?

Let's start with turnovers:

- Suppose no TOs or FTs and just 2 point shots.  
Then  $FG\% = eFG\% = TS\% = \text{Off. Rating}$ , ie. we will see a perfect correlation
- If there are FTs, only  $TS\% = \text{Off. Rating}$
- With TOs,  $TS\%$  is "noisy", ie. there is no longer perfect correlation
  - ◆ For fixed  $TS\%$ , more TOs means lower Off. Rating
  - ◆ For fixed TOs, higher  $TS\%$  means higher Off. Rating
- If you include Off. Rebs,  $TS\%$  is noisier, ie. less correlation (we'll see why)

# Off. Rebounding and Off. Rating

What about Offensive Rebounds?

→ Off. rebound means no new possession

$$\begin{aligned}\text{Off. Poss.} = & T_m\text{FGA} + \\ & 0.4 \times T_m\text{FTA} - \\ & 1.07 \times (T_m\text{ORB} / (T_m\text{ORB} + \text{OppDRB})) \times (T_m\text{FGA} - T_m\text{FG}) + \\ & T_m\text{TOV}\end{aligned}$$

→ Subtract out FGAs following Off. Rebounds to avoid double count

# Off. Rebounding and Off. Rating

→ Consider this team performance

- ◆ 100 possessions, 0 turnovers or FTs, shoot 50% on 2s (no 3s)
- ◆ 0 Off. Rebs
- ◆ 100 Off. Rating

→ Now consider this team performance

- ◆ 100 possessions, 0 turnovers or FTs, shoot 50% on 2s (no 3s)
- ◆ 100 Off. Rebs
- ◆ 200 Off. Rating

If a team gets more Off. Rebs, then it'll have a higher Off. Rating for fixed FG%  
i.e. the FG% matters less and thus is less correlated with Off. Rating

# 2s, 3s, and Off. Rating

## 2 vs 3: The effect of riskier shots

- Suppose there are two outcomes: a turnover or a guaranteed shot.
  - ◆ FG% is meaningless: it'll always be 100% and it'll have 0 correlation with Off. Rating
  - ◆ Off. Rating is entirely driven by how many turnovers there are
- Again suppose there are two outcomes: a turnover or a shot.
  - ◆ But turnovers happen on 99 out of 100 possessions and when we do get a shot, it's an even coin flip to make it and it's worth 100 points if we do make it.
  - ◆ FG% is everything: 0 Off. Rating if we miss, 100 if we make. So  $FG\% = Off. Rating$ , ie. perfect correlation

# 2s, 3s, and Off. Rating

In general:

All things being equal, if you take lower percentage shots, then your FG% is more indicative of Off. Rating, ie. more correlated.

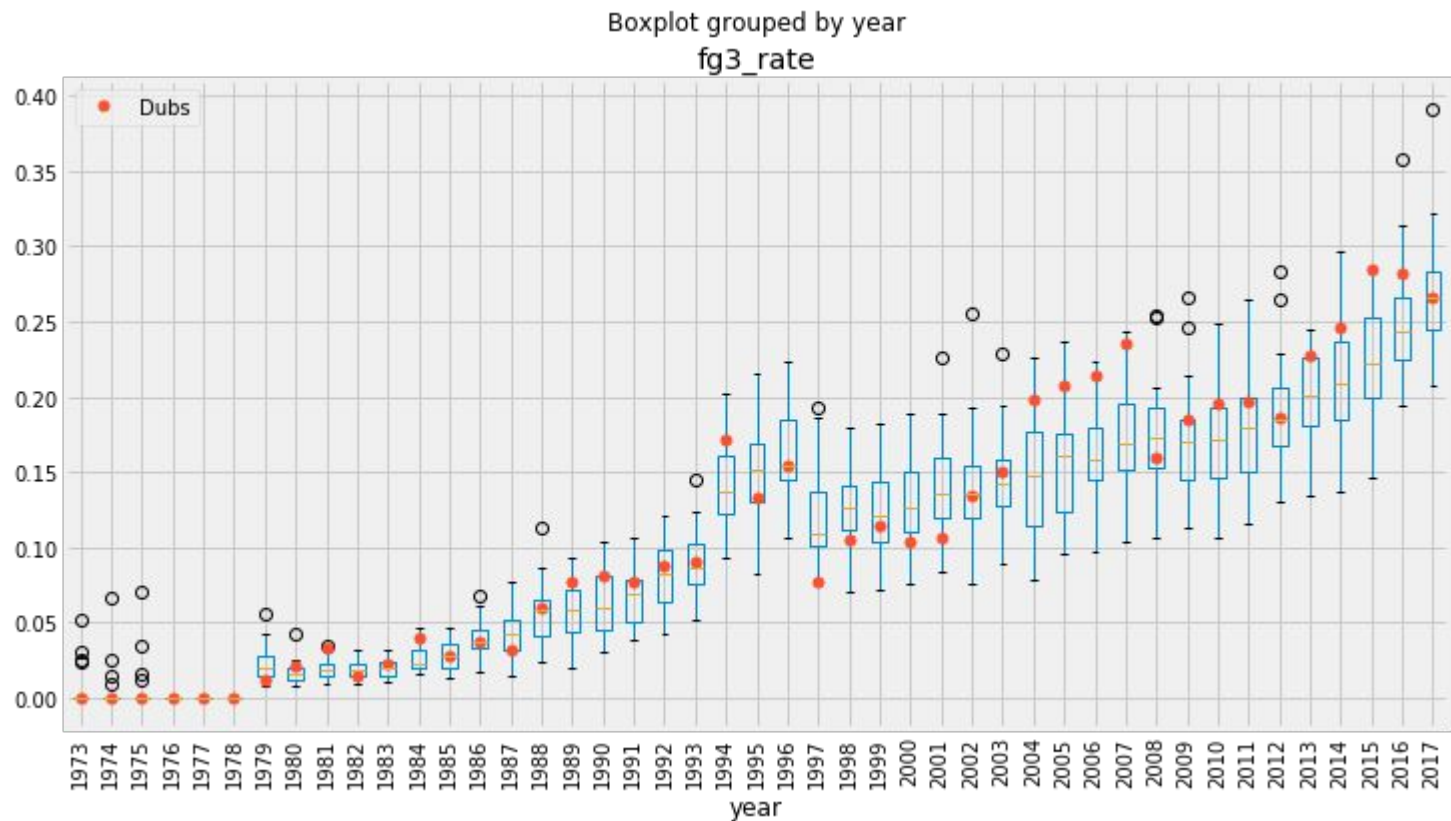
The value of the shot doesn't matter. We could change the 3pt shot to a 4pt shot and nothing would change



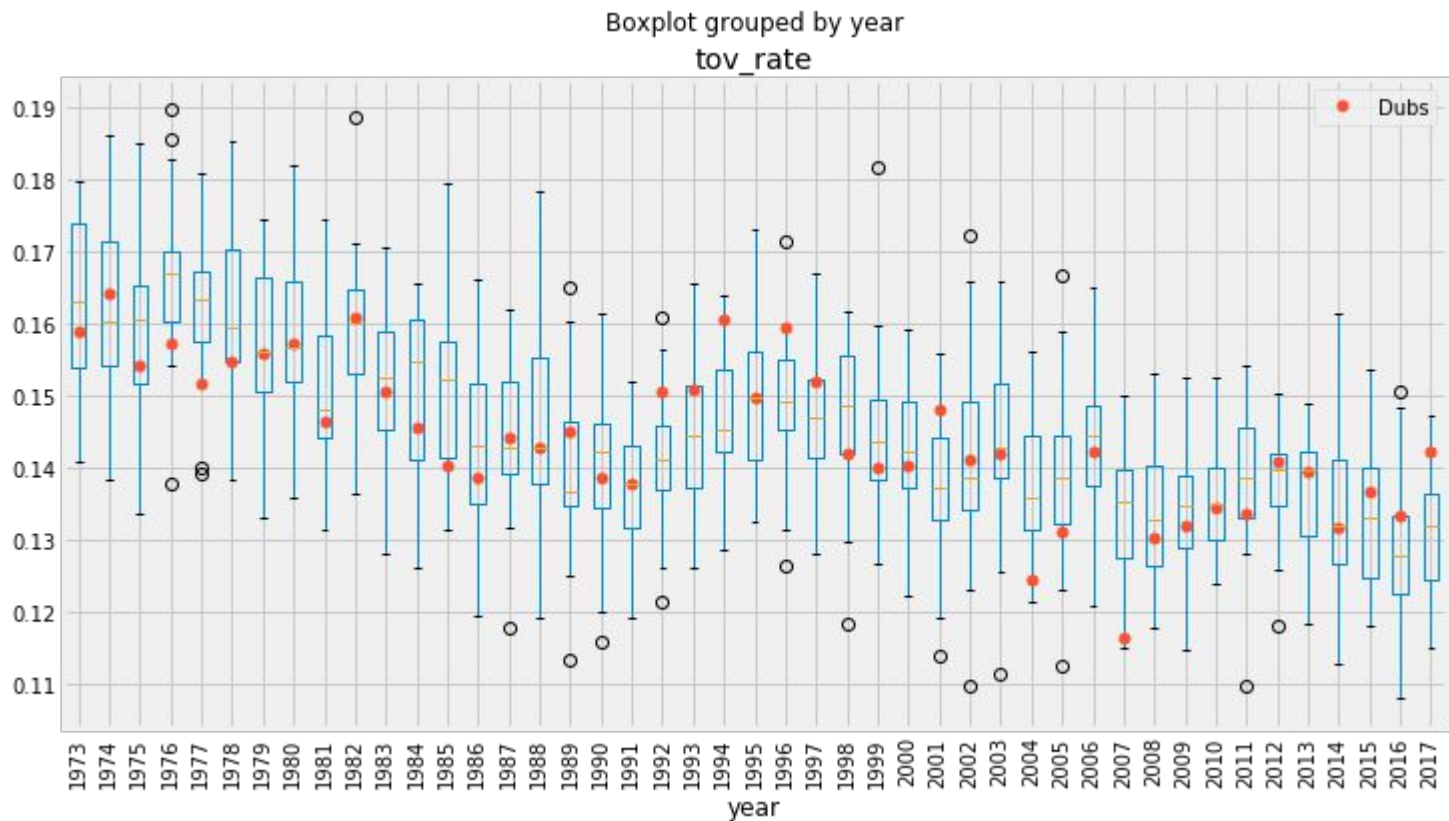
# A Changing League

- Across teams within an era, a metric with a higher correlation is better
- Across eras, the gameplay changes so the metrics can change in correlation

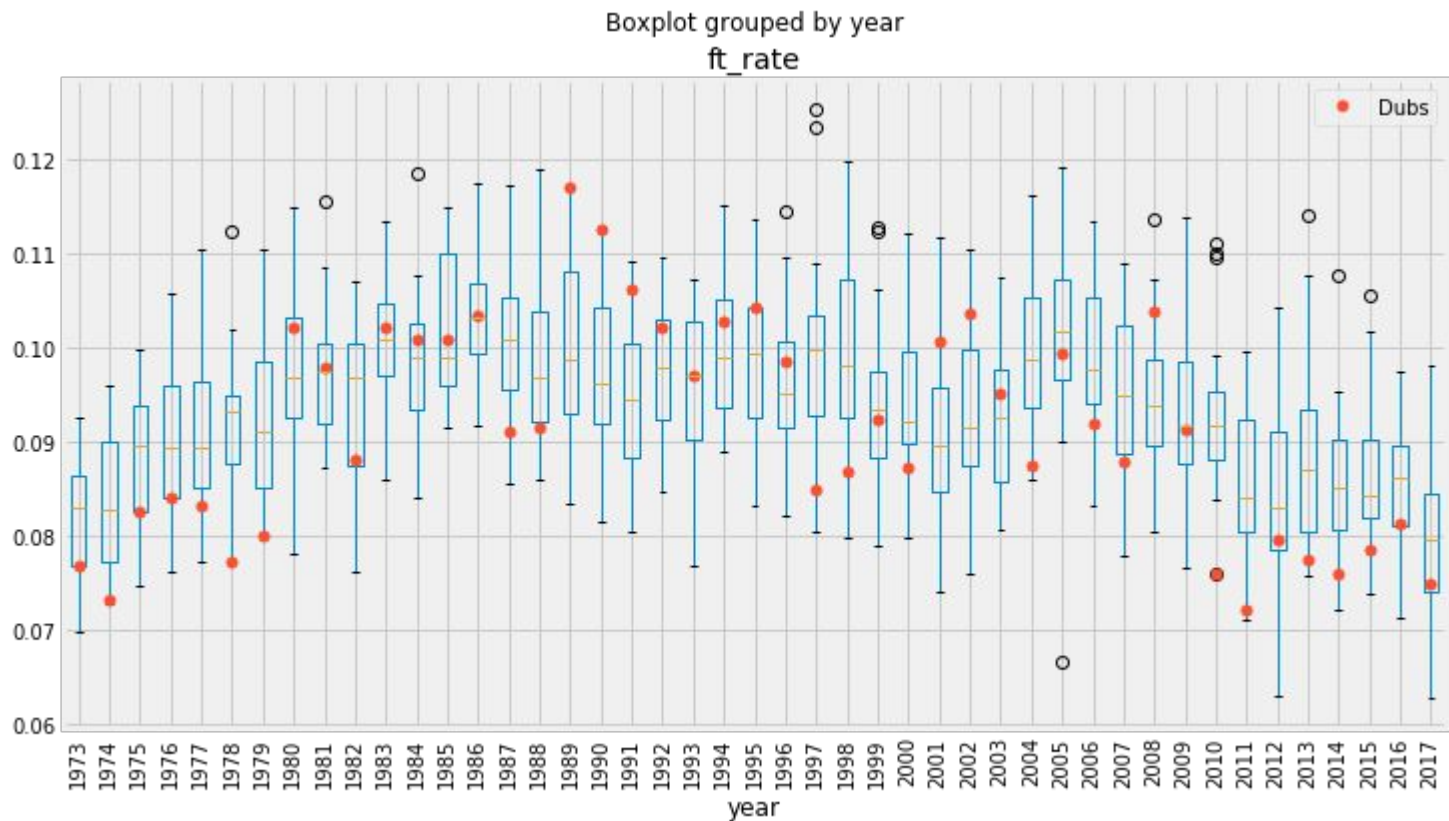
# A Changing League: FG3 Rate



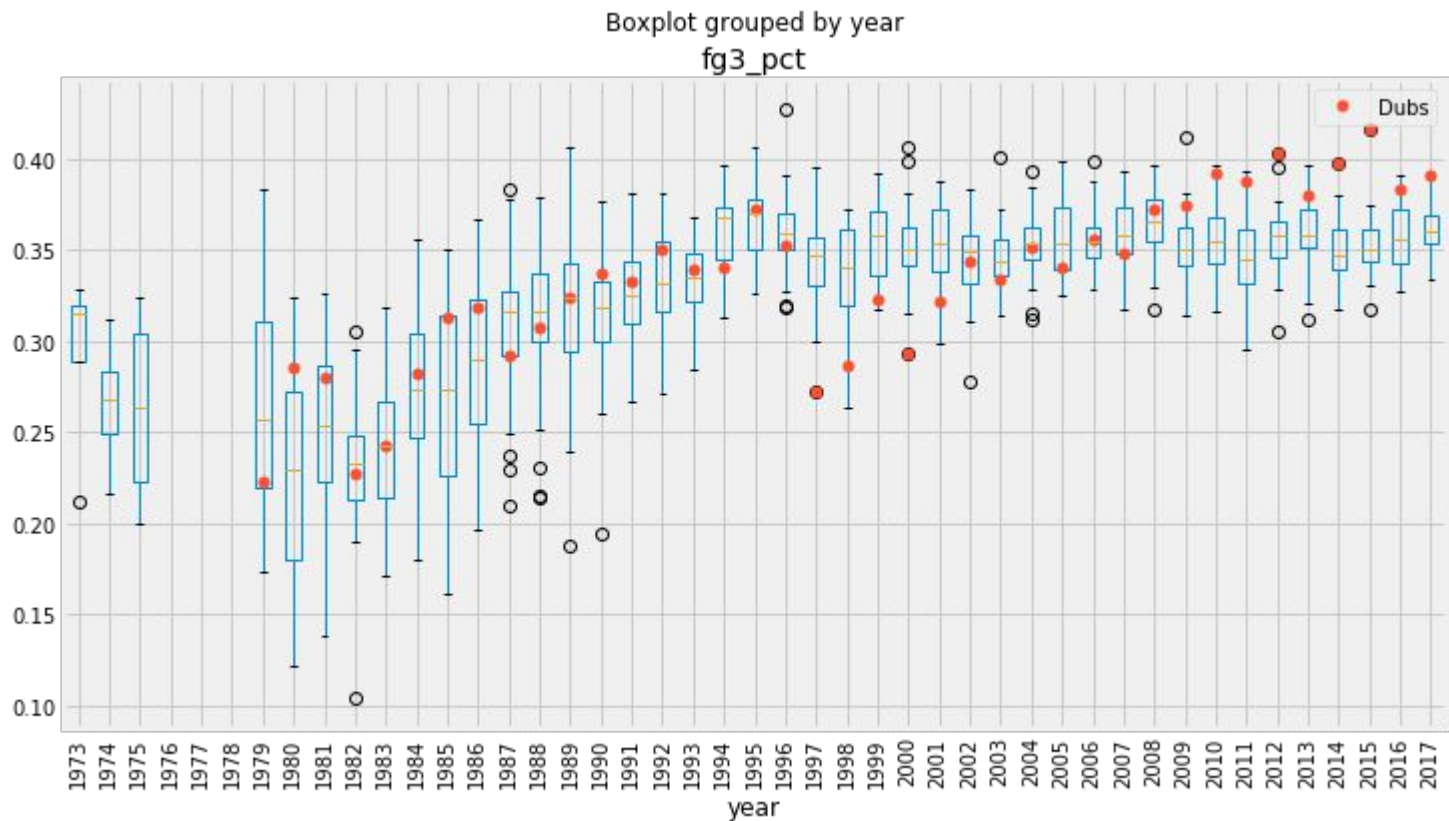
# A Changing League: TOV Rate



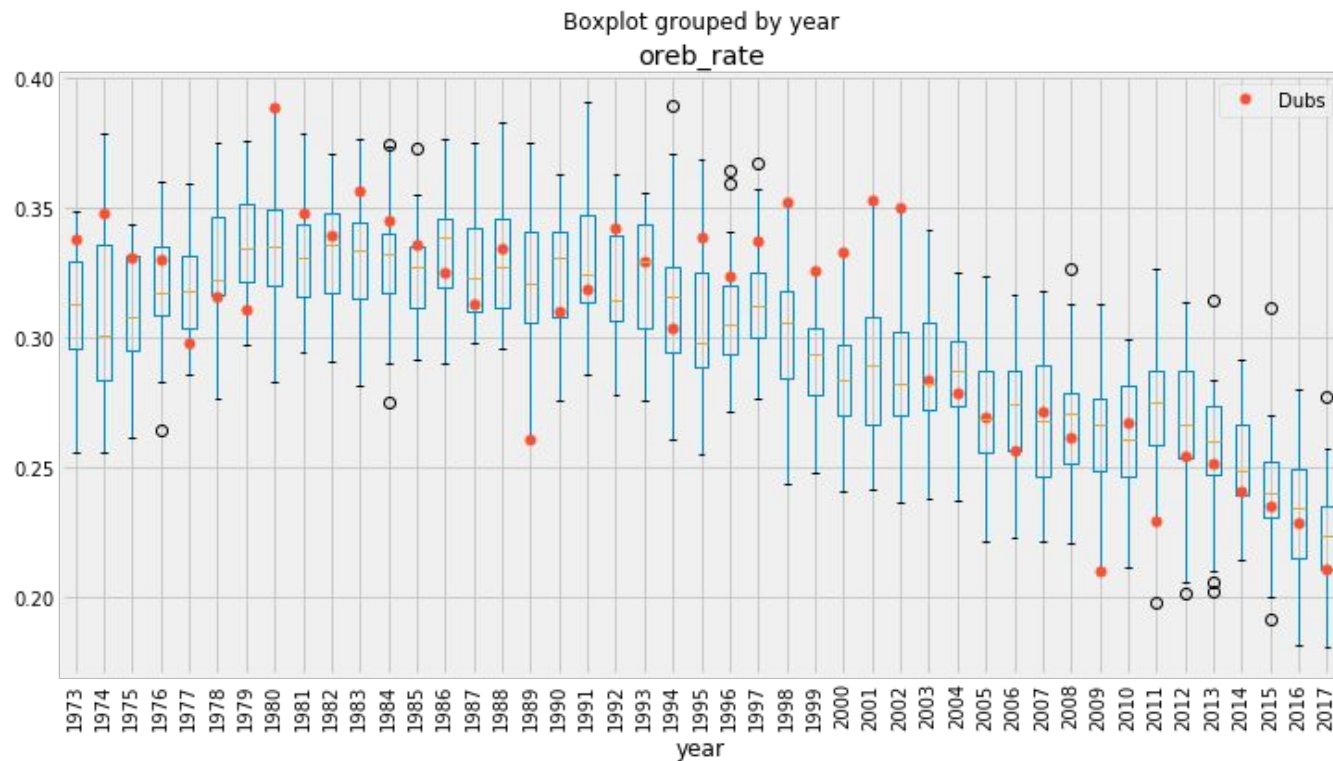
# A Changing League: FT Rate



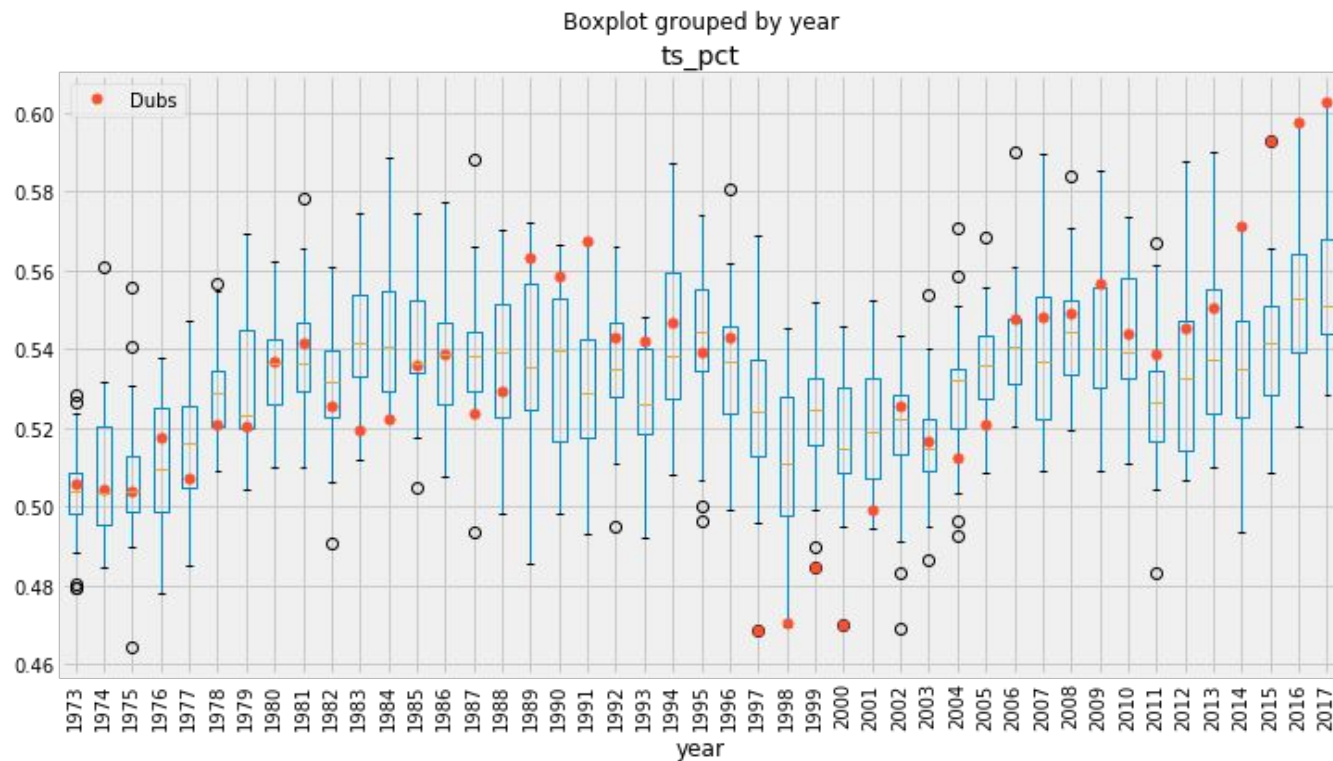
# A Changing League: FG3%



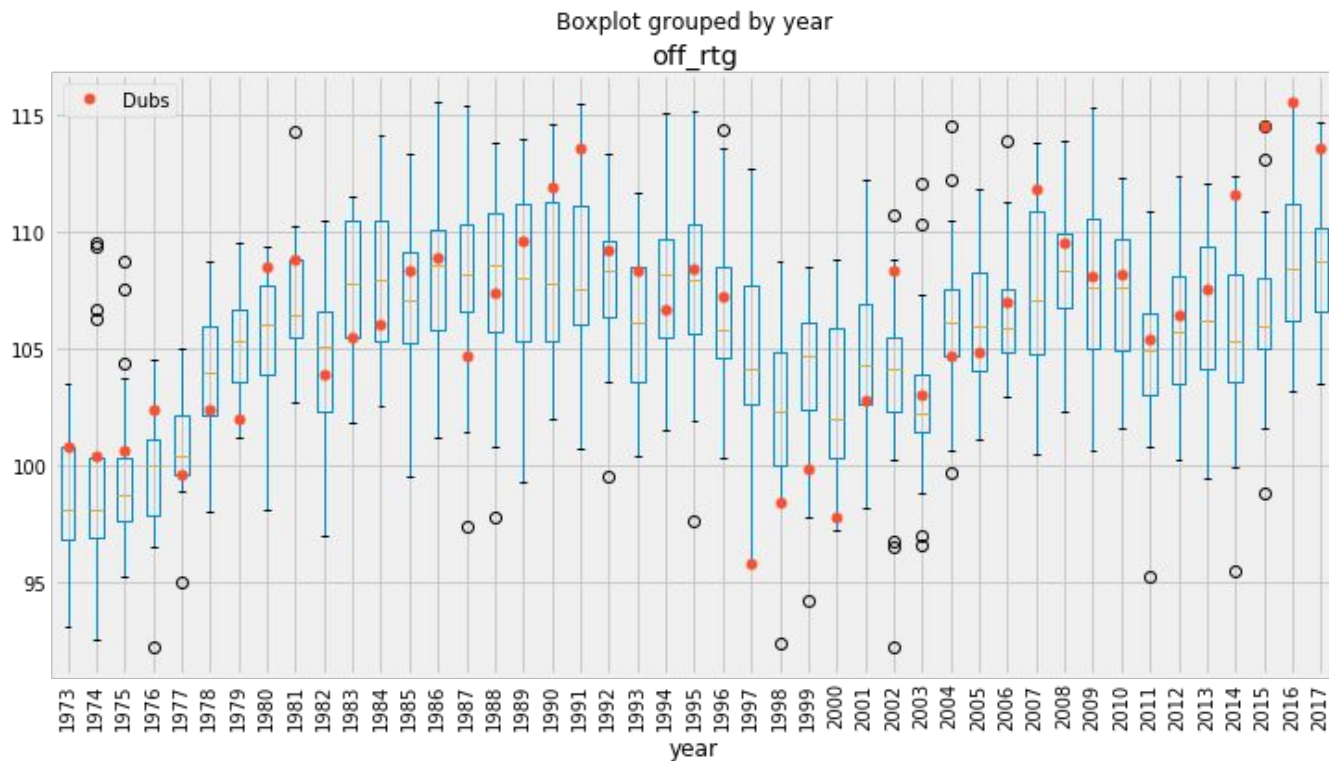
# A Changing League: Off. Reb. %



# A Changing League: TS%



# A Changing League: Off. Rating





# Summary

## → The changes across eras

- ◆ Teams are taking riskier/lower prob. shots (regardless of whether a 3 pointer has higher expected value)
- ◆ Teams are turning the ball over less
- ◆ Teams are grabbing fewer offensive rebounds
- ◆ Three effects that drive up correlation of the shooting percentages with Off. Rating
- ◆ The order should still be the same though,  $FG\% \leq eFG\% < TS\%$

# Summary

## → The changes across eras

- ◆ The metrics aren't better or worse due to changing era
- ◆ More an indication that play has evolved: with more 3s being shot, increasing the make % is more important; with fewer turnovers and off. rebounds all around, teams need to score more efficiently with their shots/FTs
- ◆ At the player level, this doesn't encompass everything on offense (picks, passing, etc), but to a certain degree it does reinforce that a very poor shooter/scorer can become a big liability if relied on too much