Novel NBA Draft Design for Anti-Tanking Behavior

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https://github.com/MikeBao99/CS136-NBA-Draft-Sim

1. Abstract

Receiving the highest draft pick is a desired outcome of any NBA team in the annual draft. "Tanking" - the strategy of intentionally losing to get better draft picks - has recently become a pressing issue that has negative implications on the league. Our goal is to experiment with redesigned draft mechanisms to make tanking a non-optimal strategy for teams. We compare the current draft mechanism with the proposed draft mechanism to be implemented starting from 2019 onwards. We also experiment with changing the probability distributions that determine the draft order of the teams and how they are determined so that teams have a more even chance of receiving better draft picks. We establish the empirical existence of a tradeoff between team power rating variance and league susceptibility of tanking. Additionally, we find that several of our proposed mechanisms significantly improve upon the current and 2019 NBA draft mechanisms. In particular, by using a *2nd Worst* mechanism or *5 Year Weighted Average* mechanism, we are able to largely eliminate advantages gained by tanking teams while keeping the league balanced and competitive.

2. Introduction

The ultimate goal of every NBA team is to win the championship in either the current year or in the next few years - doing so would bring increased fans, publicity, and revenue from ads and sponsorships. However, only 16 of the 30 teams in the league make the playoffs each year. While playoff teams focusing on winning the championship receive increased media coverage and ticket sales, the 14 non-playoff teams are more focused on the annual draft - an opportunity for these teams to draft the best players coming out of either high school or college to improve their team strength.

The current NBA draft operates on a pseudo-random serial dictatorship: teams that have a worse win-loss record in the previous year have a higher chance of selecting a player earlier in the draft. While this design gives all 14 non-playoff teams a chance to receive the top draft pick, the lower-ranked teams have a disproportionately higher probability to do so. This current design is susceptible to "tanking" strategies from teams - teams intentionally lose to have a higher

chance of getting the top draft picks. Price et al. [2] found that teams that have been mathematically eliminated from the playoffs lose 14% more games when doing so increases their chances in the draft. While some teams only begin to tank after they have been eliminated from playoff contention, other teams start off the season intending to tank when once-in-a-generation players, such as Lebron James, publicly declare their intent on entering the draft. In addition to increasing the strength of the team, the top draft picks also lead to increased revenue in following years according to Price et al. [2]. Recently, the Philadelphia 76ers have become famous for tanking; between 2014 and 2017, they received two 1st picks and two 3rd picks. Mark Cuban, owner of the Dallas Mavericks, publicly stated that, "I'm probably not supposed to say this...We [aren't] competing for the playoffs. Losing is our best option." [3] For these words, the NBA fined Cuban $600,000 since tanking presents a huge issue to the league: teams that tank bring both unhappy fans and decreased revenue from ticket sales and large sponsorships.

Our paper explores certain redesigns of the draft that reduce or eliminate tanking.

3. Model

3.1 Model Assumptions

We assume that the purpose of each year's draft is to re-balance the strength of the teams; we want bad teams to have opportunities to improve or win in the coming years, and we want to prevent the same few teams from dominating the league for extended periods of time. This would make the game outcomes more unpredictable and exciting for fans following the NBA.

3.2 Teams

Our models run around the idea of "truthful" teams versus "dishonest" teams. Truthful teams have incentive to win no matter what the circumstances are, while dishonest teams employ the tanking strategy. We represent this distinction by assigning each team a *power* - while each team has a true power that reflects their true strength, the power they report represents how well the team chooses to perform that season. We also add 10% noise to the reported power to represent that expected performance can vary from actual performance in games. We annually normalize the true powers of all teams so that the average power is 100.

Dishonest teams falsely report 0 if their true power lies below the average true power of all teams. This models the idea that if teams are likely not making the playoffs, their best strategy under the current mechanism is to tank and hope to get better draft picks.

3.3 Rookies

For the purposes of our simulation, we assume 30 rookies are drafted each year. We assign each rookie a *score*: these scores can range from 10 to 30. Since teams' powers are normalized to 100, certain rookies can account for up to 30% of a team's power. This is realistic since rookies that are drafted early usually join weaker teams and contribute substantially to the team's performance. We also assume that rookies improve a team's strength linearly - teams can choose to pick rookies that benefit them and complement their existing strengths and weaknesses.

Furthermore, we randomly sample the scores of rookies in a particularly way. The top 5 rookies have scores between 26 and 30, the next 5 rookies have scores between 21 and 24, and the last 20 rookies have scores between 10 and 17. The top 5 draft picks are analyzed heavily through extensive pre-draft workouts and are often considered in a tier of their own. Empirically, 11 of the last 15 *Rookie of the Year Awards* have gone to one of the top 5 draft picks [5]. Scores for the next 5 picks are assigned for similar reasons, with a small but noticeable difference compared to the first 5 picks. However, rookies drafted from position 11 onward are typically less well-analyzed, and their strengths usually lie in a much narrower range of values.

3.4 Current vs. New NBA Mechanism Simulations

In this simulation, we compare results from running the current NBA draft mechanism and the new mechanism that will be implemented starting with the 2019 draft. Specifically, we look at teams' performances over the years. The main difference is the change in probability distribution, described below.

3.4.1 Current NBA Mechanism

The current probability distribution used for determining draft order is

$$[250, 199, 156, 119, 88, 63, 43, 28, 17, 11, 8, 7, 6, 5]$$

For example, the lowest-ranked team will get to select first with probability 0.250, the second-lowest-ranked team with probability 0.199, and the third-lowest-ranked team with probability 0.156. If two teams have the same win-loss record, we average the probabilities such that they have equal chances within the draft.

This distribution is used to assign the the order for the first three picks. Once the first three picks are assigned, the remaining draft order is deterministic, as each team prefers drafting

the rookies with higher skill levels. The lowest-ranked remaining team gets the 4th pick, while the highest-ranked team gets the 30th pick [4].

Once we determine the draft order of the 30 teams, we assign the rookies to the teams, assigning the rookie with the highest score to the team with the highest draft pick and so on. We update the power of each team, re-normalizing annually so that the average power is 100.

3.4.2 2019+ NBA Mechanism

From the 2019 draft onwards, the NBA has decided to change the probability distributions to the following so that the absolute worst team does not have a strict advantage over other teams in the draft.

[140, 140, 140, 125, 105, 90, 75, 60, 45, 30, 20, 15, 10, 5]

This change is designed such that the three worst teams in the league now only have a 42% combined chance of getting the first pick - as opposed to 60.5% in the old draft. The goal is to reduce the extent of tanking since the allocations between the three worst teams are equivalent, disincentivizing tanking behavior that puts a team in absolute last place.

3.5 Probability Manipulations Simulations

We experiment with changing the probability distributions from above that determine draft order to further disincentivize tanking.

3.5.1 Smoothed Probability Distribution

We change the probability distribution to be

[120, 120, 110, 100, 100, 90, 75, 60, 45, 40, 40, 40, 30, 30]

This change in the distribution is meant to reflect the NBA's initial instincts in changing the probability distribution such that teams have less of an incentive to tank, given that they have similar chances of getting the first few draft spots regardless of their exact record. We also envision that this could have the effect of allowing teams to engage in behavior like refusing to lose against particular teams or rivals. With the smoothed distribution, we hope that the lowest-ranked teams are actually weak teams instead of tanking teams because the benefits from being the absolute worst teams are marginal. Given that their chances for the draft change marginally between the first and sixth spots, the teams have more of an incentive to compete and try their best, even if they might not necessarily have the best team. This change will allow weak teams to still have a chance at top draft picks and still have a chance of competing against strong teams in future years.

3.5.2 "2nd Worst" Mechanism

In all probability distributions we have discussed thus far, having the worst record among all teams gives at least a weakly greater probability of getting the top draft pick. If teams are already eliminated from playoff contention, they have an incentive to lose as many games as possible. We do not expect a huge difference in lost revenue or reduced fans even if they lose more games.

To counter this scenario, we decide to significantly reduce the probability of receiving the top draft pick for the lowest-ranked team with the following distribution.

[20, 140, 140, 140, 100, 100, 100, 100, 30, 30, 30, 30, 20, 20]

While this distribution may be introduce some "strategic" behavior near the end of the season where teams consider the records of other teams and try to lose as much as possible without being the worst overall team, we hope that teams will be motivated to win their games out of fear of being ranked absolute last.

3.6 Averaging Techniques Simulations

A second simulation assigns probabilities for draft order based on the (possibly weighted) average win-loss records of the past five years. Our hope is that if teams wish to tank, they will need poor results for multiple seasons in a row which will lead to significant loss of fans. This tradeoff removes much of the short-term benefits received from tanking.

3.7 Rewards and Penalties

For each model, we assign utilities to each team based on their performance in the season. The playoff champion gets +10 utility, the runner-up gets +8 utility, the other two semi-finalists get +5 utility, and all other playoff teams get +3 utility. Non-playoff teams also get -2 utility. Each playoff consists of 15 best-of-7 series, and so teams that participate in the playoffs get increased revenue from ticket and merchandise sales.

Currently, there are no punishments from the league for teams that perform exceedingly poorly beyond losing fans and ticket sales. However, we propose a mechanism that actively punishes NBA teams that finish in the very bottom of the rankings. This punishment could come in the form of team relegations, monetary fines, or mandatory administrative changes within the team. We model this as a -2 utility for incurring these punishments by finishing in the bottom five in the rankings.

4. Data and Results

For each of the existing and proposed mechanisms, we implemented and ran the mechanism on thirty NBA teams initialized with a power rating of 100. Twenty-five of these teams are standard teams that do not ever tank and five of these teams are programmed to tank when their power rating is lower than 100, implying that they have little chance of performing well in that season. Realistically, we will only have a few teams each year with the ability to tank, so we only expect one or two of these each year after the first few years. This reflects the nature of some teams - even if they have low power, the players on the teams do not like the idea of intentionally losing games.

In each of these simulations, we record the average standard deviation in yearly power ratings among the thirty teams. Additionally, we also record the average utility of standard (truthful) teams and tank (dishonest) teams, using the concept of utility defined above.

Mechanism	Standard Deviation	Standard Team Ave. Utility	Tank Team Ave. Utility	Tanking Utility Differential	Standard Team Ave. Ranking	Tank Team Ave. Ranking
2018 NBA	3.774	1.956	3.018	1.062	14.61	13.74
2019 NBA	3.831	2.000	2.802	0.802	14.66	13.51
2018 NBA w/ Penalty	3.781	1.756	2.420	0.664	14.67	13.43
Prob. Smoothing	3.870	1.7968	2.232	0.435	14.62	13.68
2nd Worst	3.790	1.814	2.128	0.314	14.54	14.29
3 Year Average	4.738	1.789	1.854	0.065	14.54	14.08
5 Year Average	6.392	1.855	1.542	-0.313	14.37	14.99
5 Year Weighted	5.298	1.848	1.562	-0.286	14.36	14.93

Table 1: Recorded statistics for each existing and proposed mechanism. All proposed models implement the reward/penalty system outlined in section 3.7.

5. Analysis and Discussion

We will use the 2018 NBA draft mechanism as our baseline model. This mechanism achieves a relatively low standard deviation between team power ratings of 3.774. However, tank teams perform significantly better than standard teams in this model. There is an average of 1.062 utility differential between teams that tank and teams that don't. This utility differential is significant enough to heavily incentivize teams to tank.

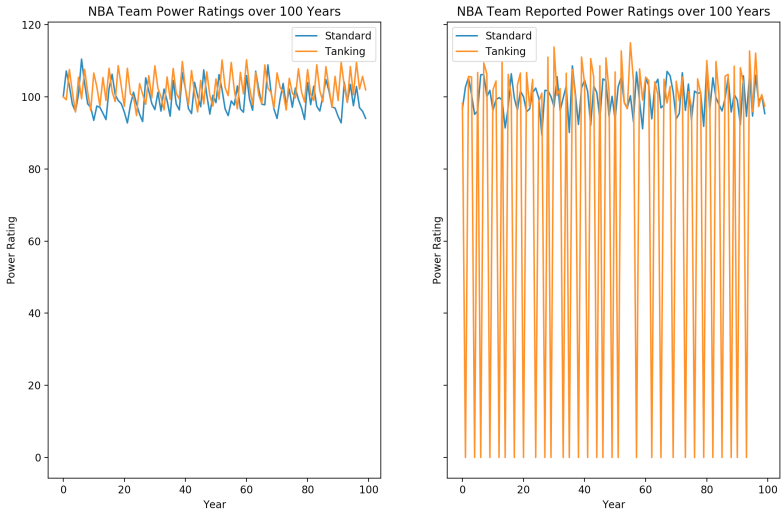

Figure 1: 2018 NBA Draft Mechanism. True and reported power ratings of a randomly selected standard team and randomly selected tanking team over one hundred years.

As of 2019, the NBA will be transitioning to a new draft mechanism. From our simulations, this draft mechanism yields a slightly higher average standard deviation between power ratings of 3.831. This is to be expected since the worst performing teams are slightly less likely to receive top draft picks compared to the 2018 draft system. Thus, bottom-tier teams will, on average, require more years of rebuilding before they are competitive again. However, we can see a decrease in the attractiveness of tanking using this mechanism. We see a utility differential between tanking and non-tanking teams of 0.802, which is much smaller than the differential we saw in the 2018 mechanism. This is also expected behavior since tanking yields a comparatively lower probability of attaining top picks under the 2019 mechanism. Nevertheless, this differential is still a significant enough so that teams will be somewhat incentivized to tank when their power rating is too low to be competitive.

We implement the NBA's 2018 mechanism with utility punishments for teams that finish in the last five slots. We see that the variance is marginally different, but that average utility for both standard teams and tanking teams is lower. The new utility differential becomes .664, which shows an improvement in closing the gap between the standard teams and the tanking teams. However, we notice that the tanking teams still rank higher than the standard teams on average. These results are indicative of both tanking teams and poorly performing NBA teams being punished and thus getting lower utilities on average. Since no team is expected to be dominant forever, it makes sense that all teams will be impacted by these poor performance fines.

Moving into our proposed models, we see that our Probability Smoothing model succeeded in decreasing incentives to tank while maintaining a relatively low variance between team overall power ratings. Since the Probability Smoothing model is just a step further than the changes implemented by the 2019 NBA mechanism, our results that the variance increases slightly from 2019 and the utility from tanking decreases are very justifiable. In addition, the incorporation of bottom-tier team penalties further closes the utility gap between tanking teams and standard teams. However, there is a noticeable 0.435 point differential between tanking teams and standard teams that could easily incentivize teams doing poorly to switch to a tanking strategy.

Our 2nd Worst mechanism that incentivizes teams to finish at the second worst position but not the worst position did somewhat better than the Probability Smoothing model. The mechanism was able to achieve a variance between teams that was lower than the Probability Smoothing model and still achieve a lower incentive for tanking. This can be attributed to the fact that tanking teams gain less average long-term utility from finishing in last place via tanking. This makes sure that tanking teams do not end up incredibly strong even after tanking for several consecutive seasons and cannot gain too much additional utility from tanking in general.

Looking at models that employ a multi-year averaging algorithm, we notice a general tradeoff between relatively high standard deviations between power ratings and strongly decreased incentives for tanking. The 3 Year Average mechanism yields a standard deviation of 4.738, nearly a point higher than that of the 2018 NBA mechanism. Although this increase in average standard deviation will result in more games being complete shutdowns that are not exciting to watch, the mechanism combats this negative change by decreasing incentives to tank. Using this draft mechanism, teams that tank have an average of 0.065 point utility increase

compared to standard, non-tanking teams. This utility differential is small enough that most teams would be indifferent between tanking and playing truthfully.

The 5 Year Average mechanism is an even greater exaggeration of the costs and benefits of the 3 Year Average mechanism. The average standard deviation increases to a staggering 6.392 while there is a 0.313 point utility cost for tanking. Thus, even though there is an even greater power differential between individual teams in the league, there is a large incentive to report power ratings truthfully and play at one's best.

The 5 Year Weighted Average mechanism is the "best of both worlds". It yields a moderately high average standard deviation between team power ratings of 5.298. However, it still results in a significantly decreased average utility for tanking, yielding an average utility decrease of 0.286 points for tanking. This decrease in utility is large enough to be noticeable to teams and should immediately deter any possible tanking within the league. This behavior is understandable because the 5 Year Weighted Average mechanism gives greater weight to recent years, allowing for a faster rebuild process for actually declining teams while still punishing tanking teams that alternate between playing well and playing extremely poorly.

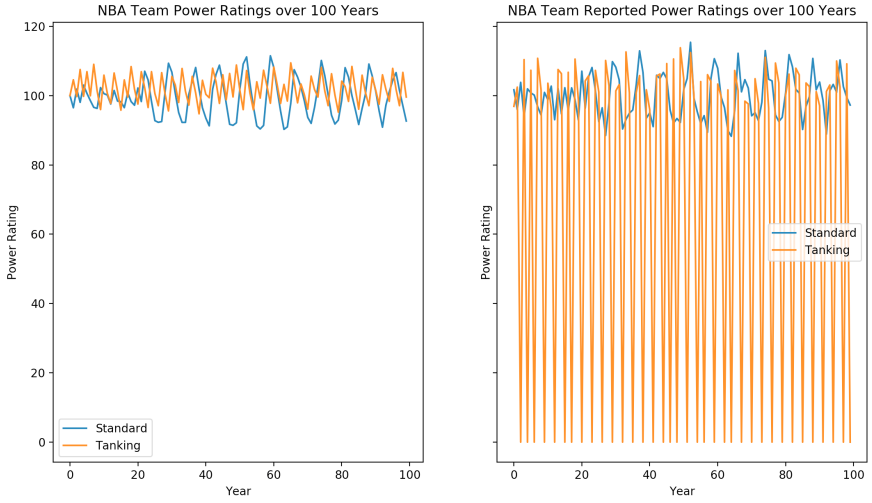

Figure 2: 5 Year Weighted Average Mechanism. True and reported power ratings of a randomly selected standard team and randomly selected tanking team over one hundred years.

Finally, note that each of our mechanisms are capable of rapidly converging team strengths even when current team strengths are very widely spread, as shown in Figure 3. We initialize team strengths to span from a low of forty-five to a high of one hundred fifty-five. However, within

three years of running our mechanisms, we see that the spread of team strengths has already converged to between ninety and one hundred ten. This analysis showcases the ability of each of our mechanisms to take quick action even in the hugely varied NBA power rating landscape.

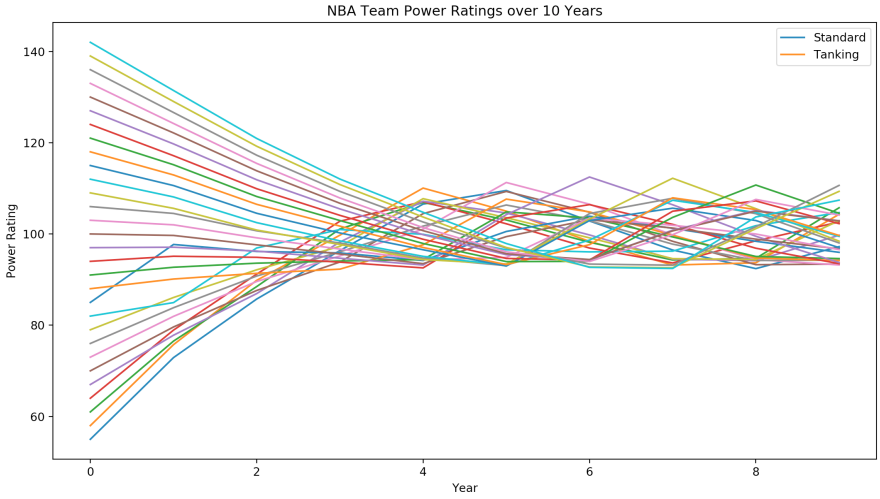

Figure 3: Demonstration of rapid convergence in overall true team power ratings even when initial distribution of team power ratings is widely spread

6. Conclusion

Our work compares the outcomes of the current NBA draft mechanism with those of our modified mechanisms in the hopes of reducing tanking strategies in the NBA. Our models reinforce our hypothesis that there is an inevitable tradeoff between team power rating variance and advantages gained from tanking. However, given our goal to minimize the league power variance while disincentivizing tanking strategies, we find that assigning probability distributions based on the *5 Year Weighted Average* mechanism highly discourages tanking, introducing the NBA to a new era where performance is strategy proof. The *2nd Worst* mechanism also maintains a low standard deviation in teams' strength while significantly decreasing the advantages gained from tanking. Overall, we conclude that both mechanisms are better than the current NBA mechanism and the 2019 NBA mechanism in the long run. However, because both models will increase variance between team power rankings, fan outlash in the short-term may be a costly factor preventing the NBA from immediately switching to our proposed mechanisms. Future work could involve designing a mechanism that allocates probability based on how many games a team wins after it is eliminated from the playoffs as well as models that attempt to identify tanking behaviors and apply punishments for such win-loss patterns.

7. References

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[3] "Dallas Mavericks owner Mark Cuban fined $600K for public comments on tanking." *NBA.com*, Feb. 21, 2018, https://www.nba.com/article/2018/02/21/dallas-mavericks-owner - mark-cuban-fined-comments- tanking.

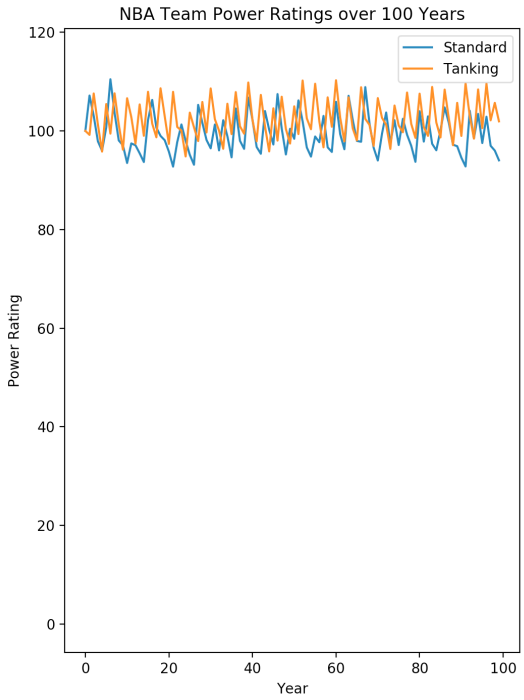
[4] Buckley, Zach. "Explaining How the NBA Draft Works and Draft Order Is Determined." *Bleacher Report*, Bleacher Report, 3 Oct. 2017, https://bleacherreport.com/articles/2708900 - explaining-how-the-nba-draft-works-and-draft-order-is-determined

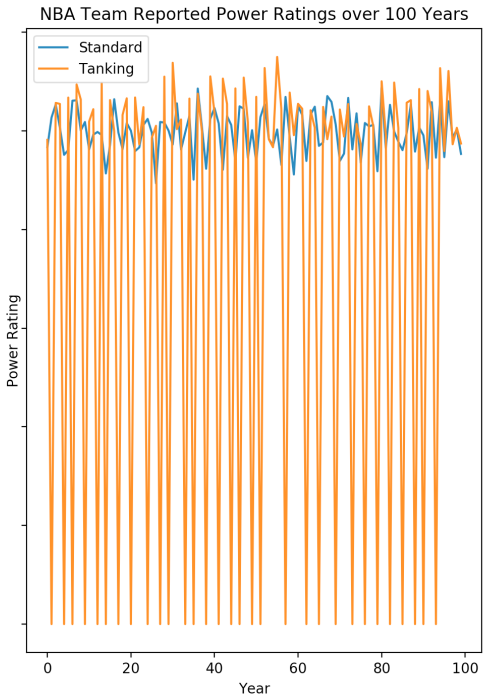
[5] "Wolves' Towns named 2015-16 Kia Rookie of the Year". NBA.com. May 16, 2016. Retrieved December 2, 2018.

8. Appendix

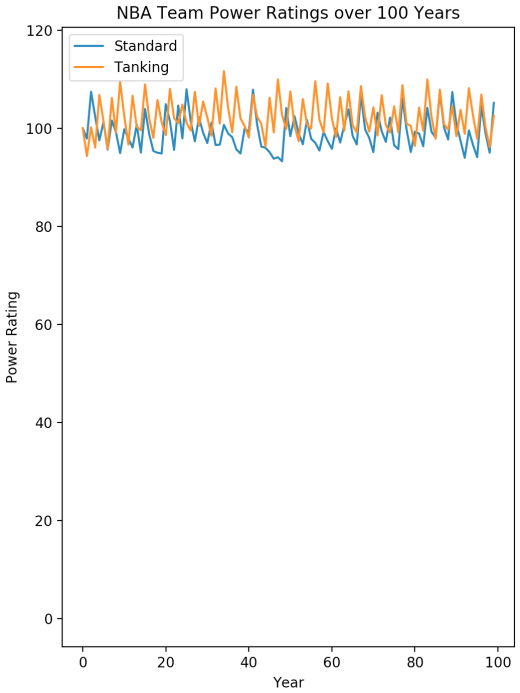
8.1. Graphs

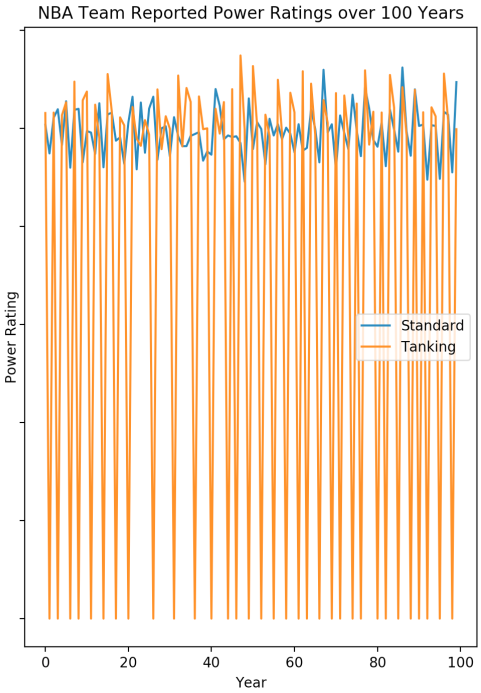
8.1.1 2018 NBA



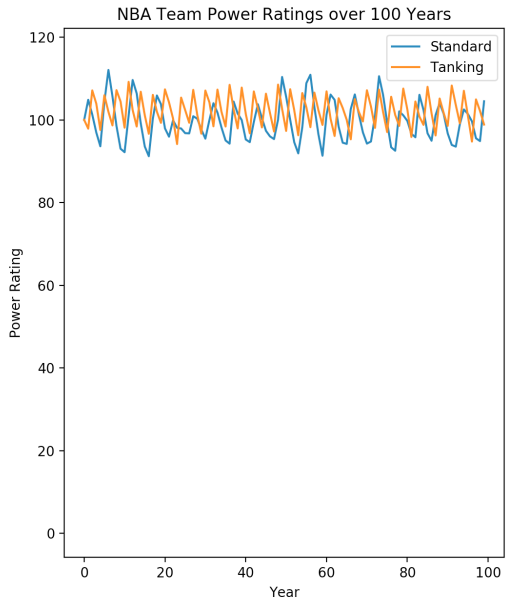


8.1.2. 2019 NBA





8.1.3. 3 Year Averaged


NBA Team Power Ratings over 100 Years
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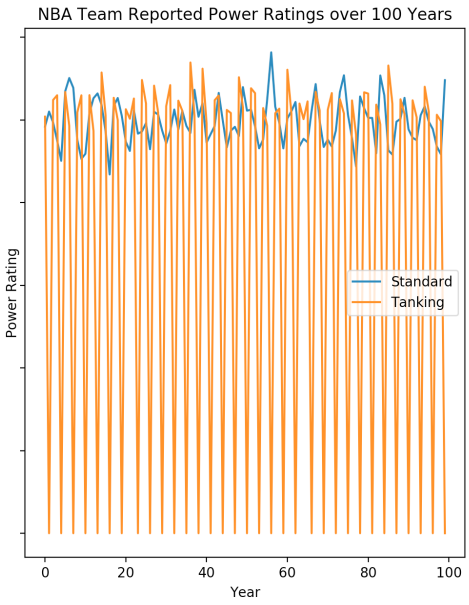
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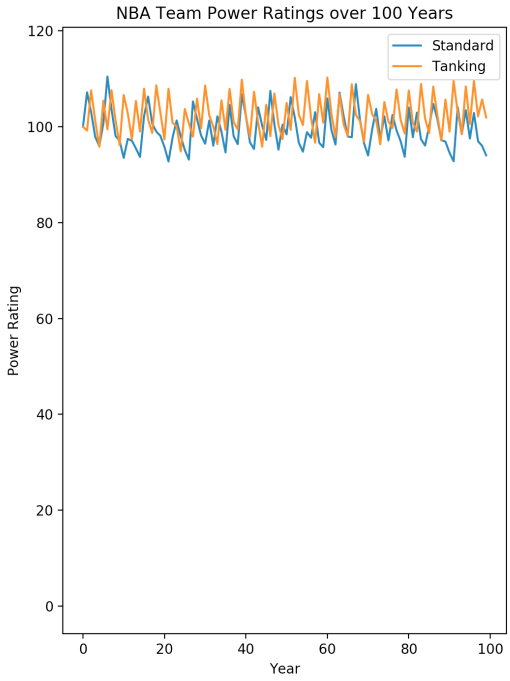
8.1.4. 2018 NBA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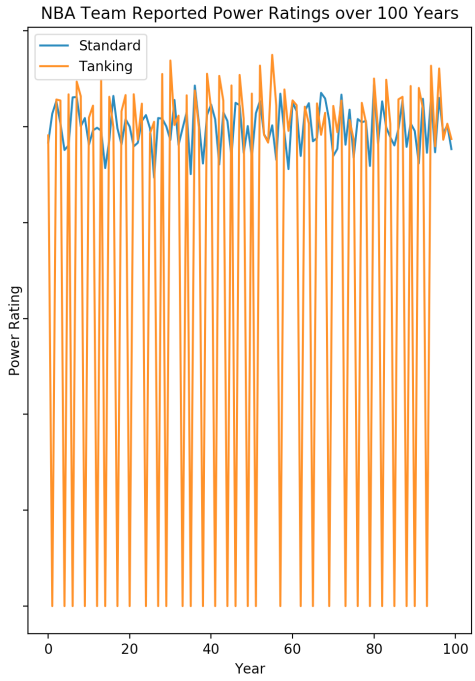
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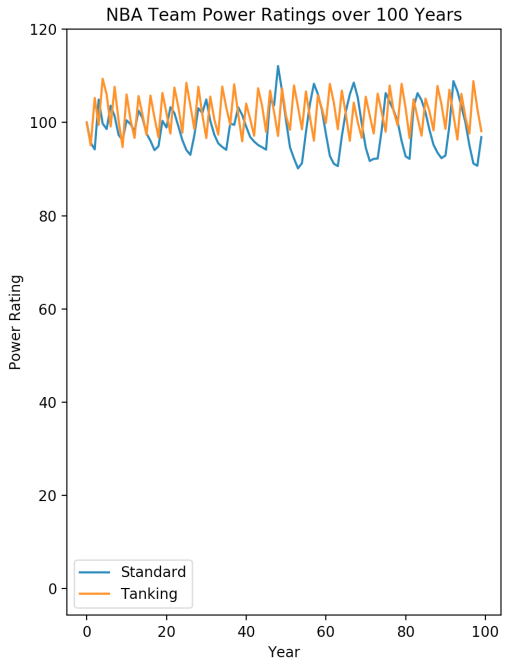
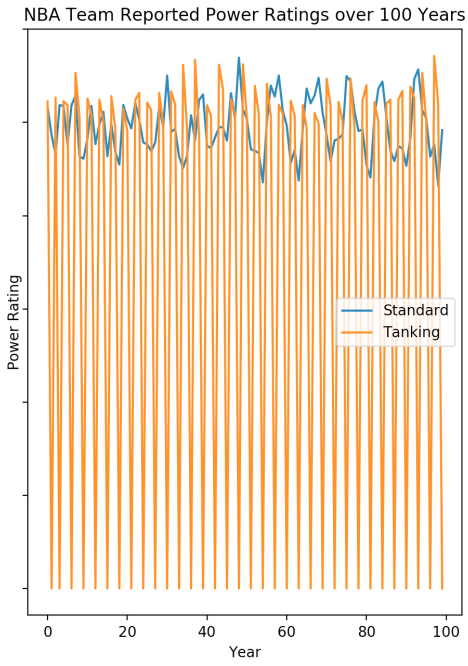
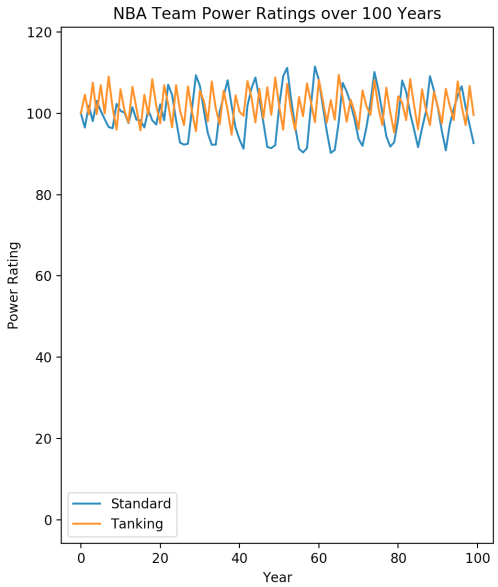
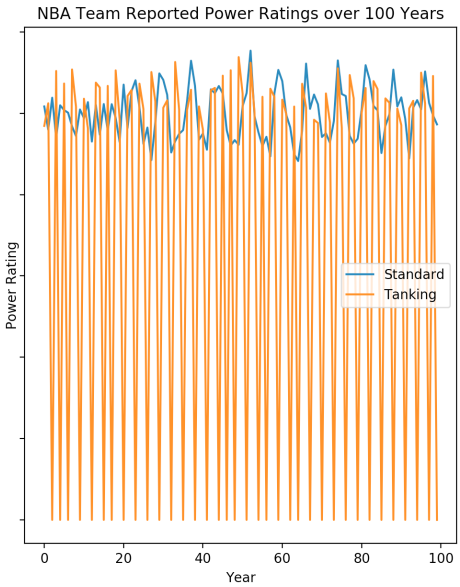
8.1.5. 5 Year Average





8.1.6. 5 Year Weighted





8.2 Data and Code

See all data and code in our Github repository: https://github.com/MikeBao99/CS136-NBA-Draft-Sim