

NBA ANALYSIS REPORT

AN OVERLOOK IN THE EVOLUTION OF THE NBA SINCE THE THREE-POINTER

The National Basketball Association (NBA) has been the premier professional basketball league in the world for decades. With its high-flying dunks, flashy passes, and intense competition, the NBA has captured the hearts and minds of basketball fans around the globe. In this report, I will evaluate the trends in NBA franchise performance by examining the average statistics per game over time. By analyzing the statistical trends of NBA teams over the years, I hope to gain insights into the changing landscape of the league and identify potential factors that have contributed to these changes.

It is worth noting that the primary objective of this project was to explore statistical and software tools. As a student, I aspire to achieve significant results. However, it would be remiss of me to suggest that my work could surpass the contributions of the thousands of dedicated analysts who have devoted their careers to shedding light on this beloved game. So it is important to be clear that my conclusion could not be the most accurate and other explanations for the phenomena observed could be achieved in a more in-depth analysis.



QUESTIONS AND OBJECTIVES

The questions that guided this analysis at its inception were “How has performance evolved in the league, comparing the best performers and worst ones?” and “How, disregarding teams, tendencies in one stat affect other ones?”.

To look for answers I used the per-game stats from the www.basketball-reference.com database for the NBA since the introduction of the three-pointer in the 1979-80 season. Earlier seasons were excluded because the new scoring possibility was believed to be such a significant change that comparing performances before and after could obscure correlations. This does not rule out other regulation changes, but the three-pointer was interpreted as a more profound revolution, so I focused on the league after its implementation.

To answer the first question, I separated the league into two categories based on performance and plotted the averages against each other, along with the league average. I compared the top 25% of performers to the bottom 25%. As I was looking for the best at a specific aspect of the game rather than overall team success, I did not consider team position in the season or whether the same teams were in the top or bottom group for different stats. Teams were ranked by performance for each stat, and the groups were created accordingly.

The hypothesis is that the top and bottom groups will encounter a delay in their performance. The graph is expected to show a gradual improvement among the bottom 25% such as in three-point rate or turnover, with a reversed correlation for negative stats.

To answer the second question the method is simpler to apply. My goal was to find correlations, so I ran a Pearson test. This test measures the strength and direction of the linear relationship between two variables, classifying them between 1 and -1. I calculated the test for every stat combined with every other stat. And again, I based my analysis on overall league performance by comparing the average per-game statistic of all franchises in one stat with another all-franchise average.

While coding this brute force method is simple, many of the correlations are redundant or unimportant to include in this report. For instance, correlations between three-point and overall points or between offensive and defensive rebounds are not interesting. Appendix C contains a list of all correlations that were analyzed.



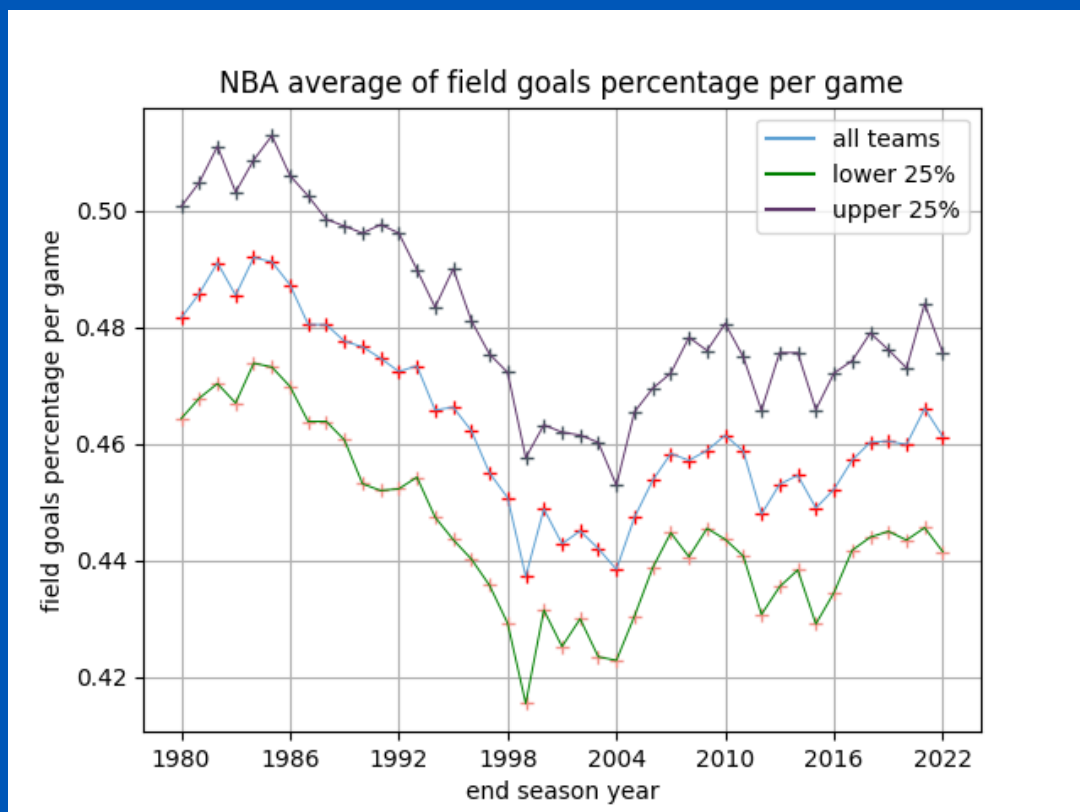
TOP-AGAINST-BOTTOM ANALYSIS

My first step was to import the website data as an `xlsx` files and then allocate the statistics into objects using the `openpyxl` module. These objects corresponded to each season and contained a single parameter per statistic. The naming convention of the objects reflected the year in which the season ended; for instance, 1980 represented the 1979-1980 season. In total, I created 42 season objects, each with 22 arrays.

Next, an array was created in the code with the average of each stat for that year, including the overall, top 25% and bottom 25% averages. To accomplish this, additional functions were necessary, namely `low_quartile_avg` and `top_quartile_avg`, which were implemented to facilitate selections and calculations.

For the data visualization, I utilized `matplotlib` which is a user-friendly library for creating X-Y plots. My goal was to ensure the generated plots were easily comprehensible and self-explanatory. Throughout this project, I made several improvements to the code to ensure a cleaner and more concise plotting process. It's worth noting that the initial approach used in the first case was somewhat forceful and has since been improved.

The python file `chunks.py` is the one that contain this first piece of code. A sample of the results is shown here, note that you can find all the graphs of this stage in Appendix A.



The test results were quite intriguing, as they showed that there was no significant delay between the top and bottom performers. This indicates that the hypothesis put forward in the previous section was incorrect. The graphs demonstrate a "shadow" effect, where all the lines exhibit similar variations, but there is a consistent gap between them.

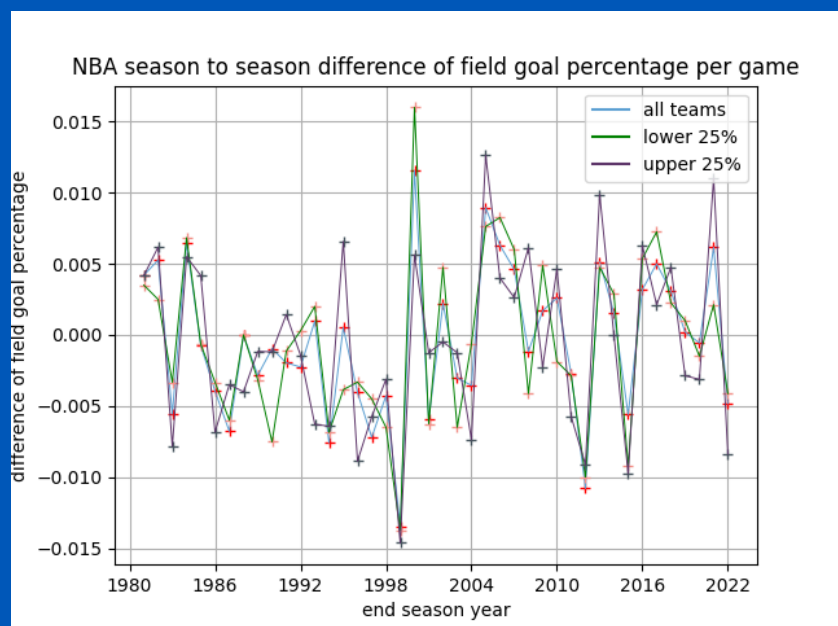
Considering the results, I proposed a new hypothesis regarding per-game performances in the NBA league during the regular season. There appears to be a general tendency across the league, with both high-performance and low-performance teams exhibiting similar patterns of variation in their statistics over time.

To verify this new hypothesis, it is necessary to conduct another test. Merely observing that the graphs show similar variations is not sufficient to support such a claim. Therefore, I have decided to conduct a new test in which I will plot not the average of the groups (top, bottom, and all) but their variation between the current and previous year. If the lines align, it should be sufficient to confirm the new statement.

For that, I coded a new file, `difference.py`, which is similar to `chunks.py` but has a bit extra code to calculate the variations arrays, and plots accordingly. Again, a sample of the results is shown here, all the graphs can be seen in Appendix B.

The graphs support the new hypothesis as the variations of all three groups align despite some alternating differences that are not significant. This confirmation suggests that the steps taken by the Association to maintain balance in the league go beyond simply alternating which team is winning the games. Instead, it creates an environment where all teams follow the game tendencies without much differences in their knowledge of what should be done.

It is worth noting that this conclusion applies to statistics that can result from various game strategies or actions. Teams can score points in different ways, commit turnovers or personal fouls in a variety of situations. Thus, this leveled environment applies to what teams are generally trying to improve, whether it be their 3-point rates, turnovers, or ability to prevent offensive rebounds. However, little can be said about the specific methods used to achieve these improvements.



CORRELATIONS IN THE STATS

Performing a Pearson correlation test in Python was straightforward, as numpy includes a built-in function for this purpose. Simply loading the arrays from the previous analysis was sufficient to generate a matrix that can be easily printed out. As with other cases, a new file named "correlation.py" was created, and a list of all correlations is presented in Appendix C.

Following the analysis of all possible correlations, I filtered out any correlation that was greater than 0.9, regardless of whether it was a positive or negative. While previous research has indicated that a correlation of 0.5 is considered high, my attempts have shown that most stats are correlated. I believe these connections arise from the nature of the analysis, where the variables are all intertwined in a single game and have great influence in each other.

Furthermore, I removed redundant correlations, such as FG and FG attempted, and added others that did not meet the 0.9 threshold but could contribute to the hypothesis being developed. The selected correlations are listed below:

- Correlation of 0.91 between TOV_avg and PF_avg
- Correlation of 0.92 between TwoP_attempted_avg and TOV_avg
- Correlation of -0.84 between ThreeP_attempted_avg and TOV_avg
- Correlation of 0.85 between TOV_avg and FT_attempted_avg
- Correlation of 0.88 between PF_avg and OR_avg
- Correlation of 0.95 between TwoP_attempted_avg and OR_avg
- Correlation of 0.91 between OR_avg and FT_attempted_avg
- Correlation of -0.94 between ThreeP_attempted_avg and OR_avg
- Correlation of 0.89 between TOV_avg and OR_avg

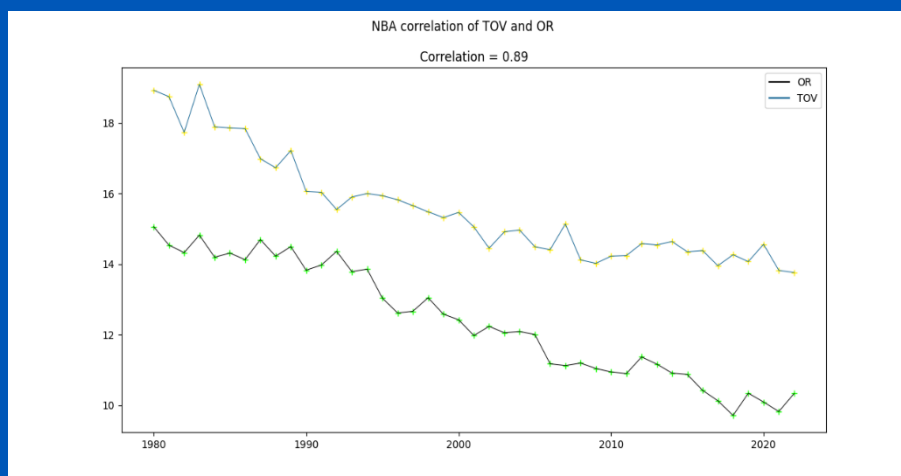
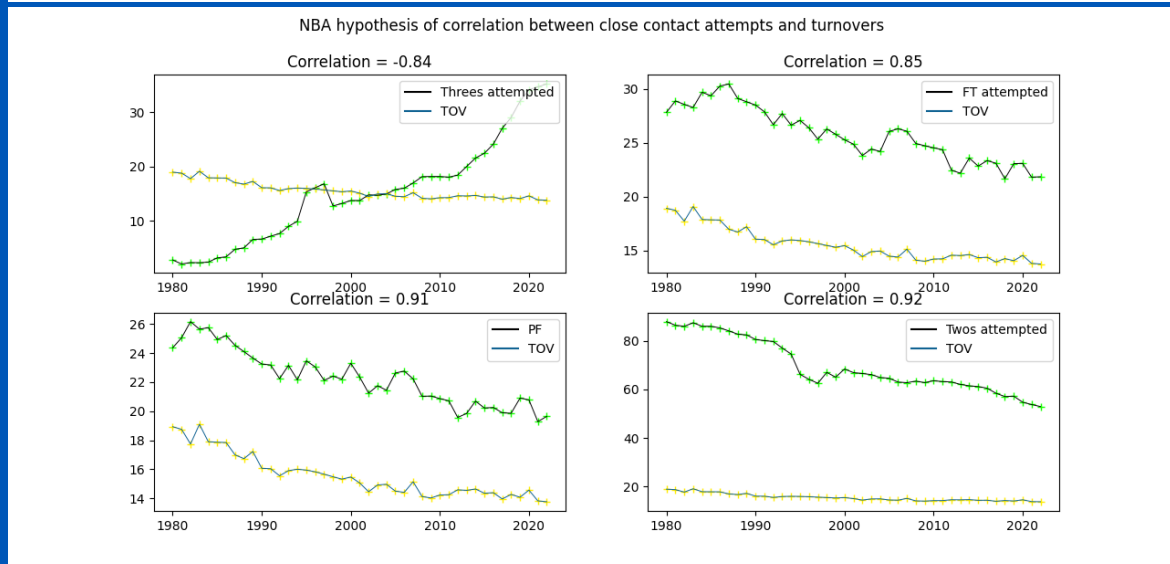
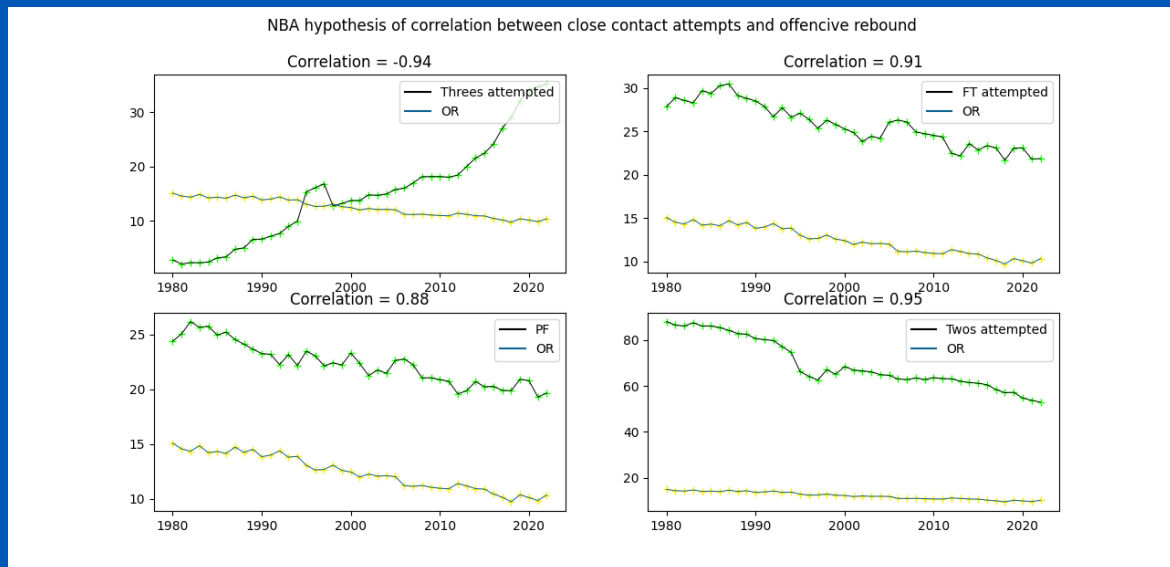
Based on the analyzed correlations, my hypothesis suggests a connection between inside-the-ring plays and both turnovers and offensive rebounds.

Inside-the-ring plays often result in turnovers due to offensive fouls, traveling violations, or loss of ball possession. The physicality of layups and pivot plays contribute to these high-risk situations for turnovers.

Also, this type of play tends to involve more players being positioned near the basket and inside the ring, particularly the player who has just attempted to score and is typically situated directly beneath the basket. These conditions could lead to a greater number of offensive rebounds per game.

Therefore, based on our data, my final hypothesis suggests that statistics related to close scoring attempts, will correlate with both turnovers and offensive rebounds. Conversely, statistics that deviate from this style of gameplay should display an inverse correlation with both stats. Also, it's only fair to assume that turnovers and offensive rebounds should display a correlation with one another.

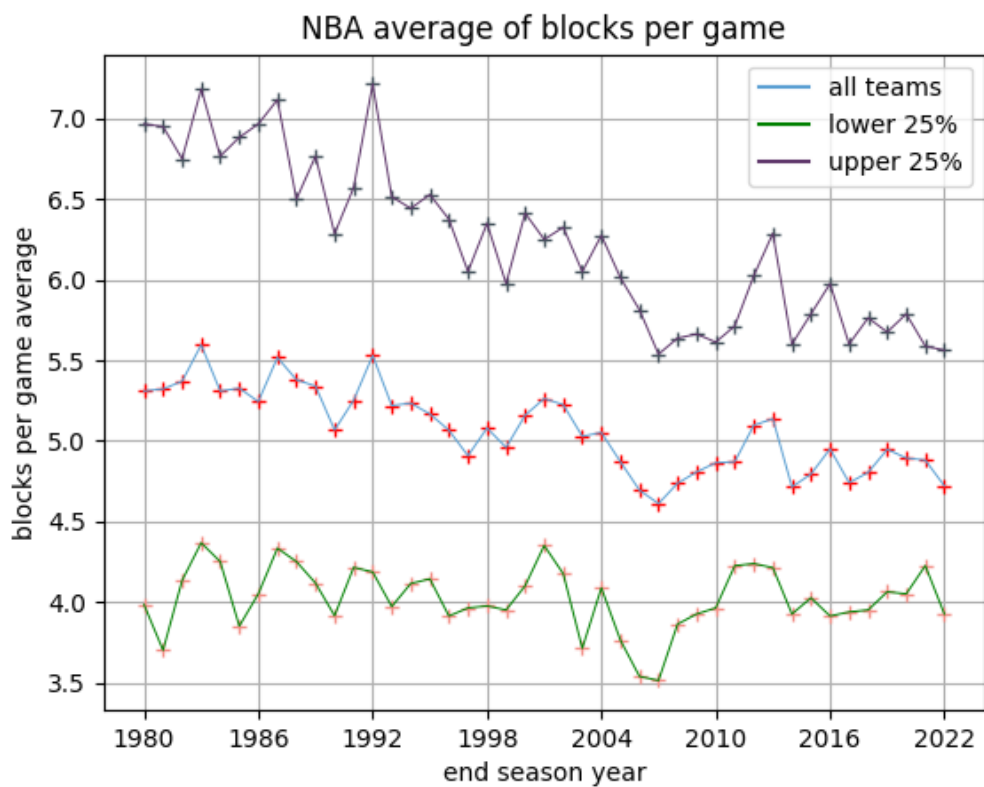
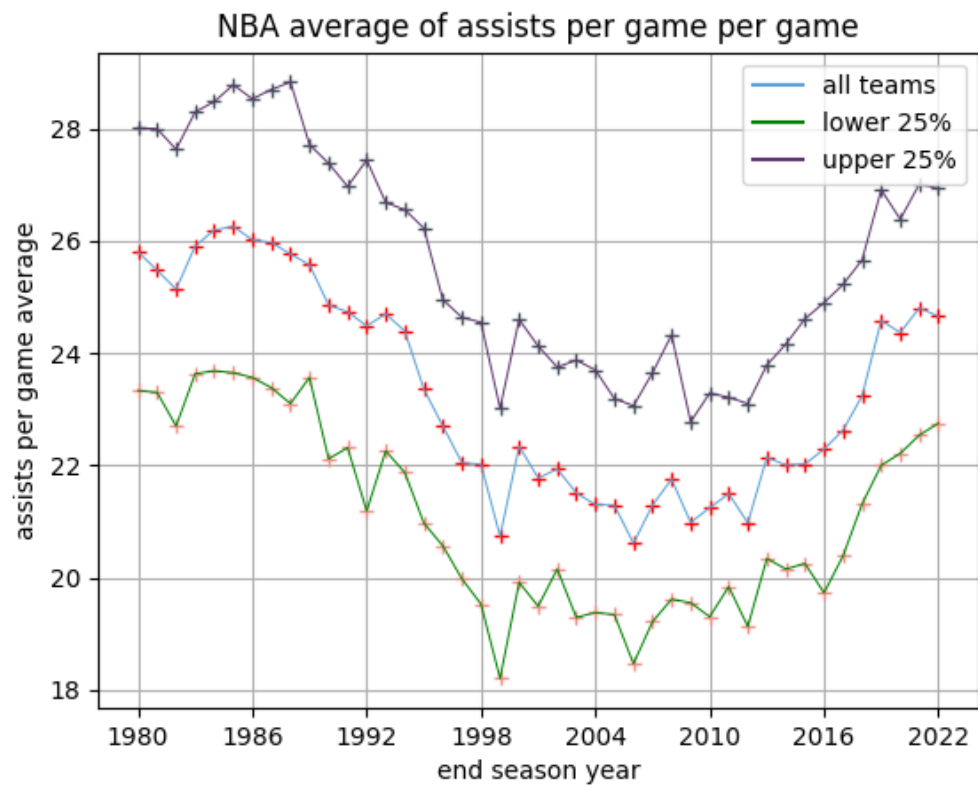
To strengthen this hypothesis, I plotted the statistics listed above:



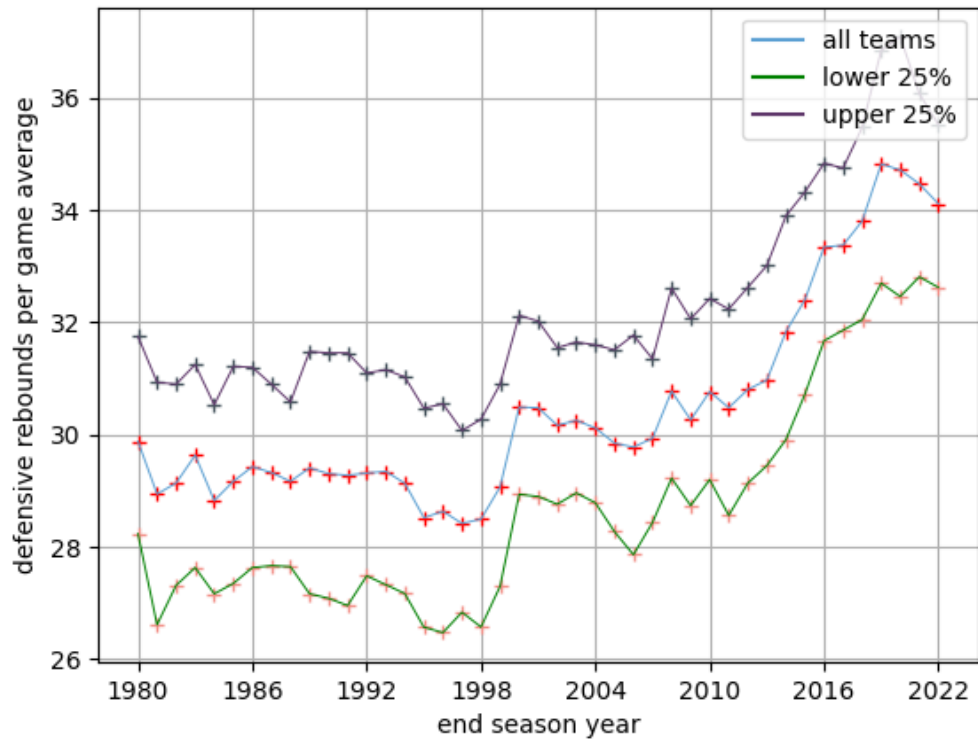
The data does support all the suggested correlations, but a more detailed analysis would be beneficial to provide a stronger statement. While this project will not undertake a deeper

examination, a recommended approach would be to review video footage of turnovers and offensive rebounds to confirm if they do indeed occur primarily in near the rim situations.

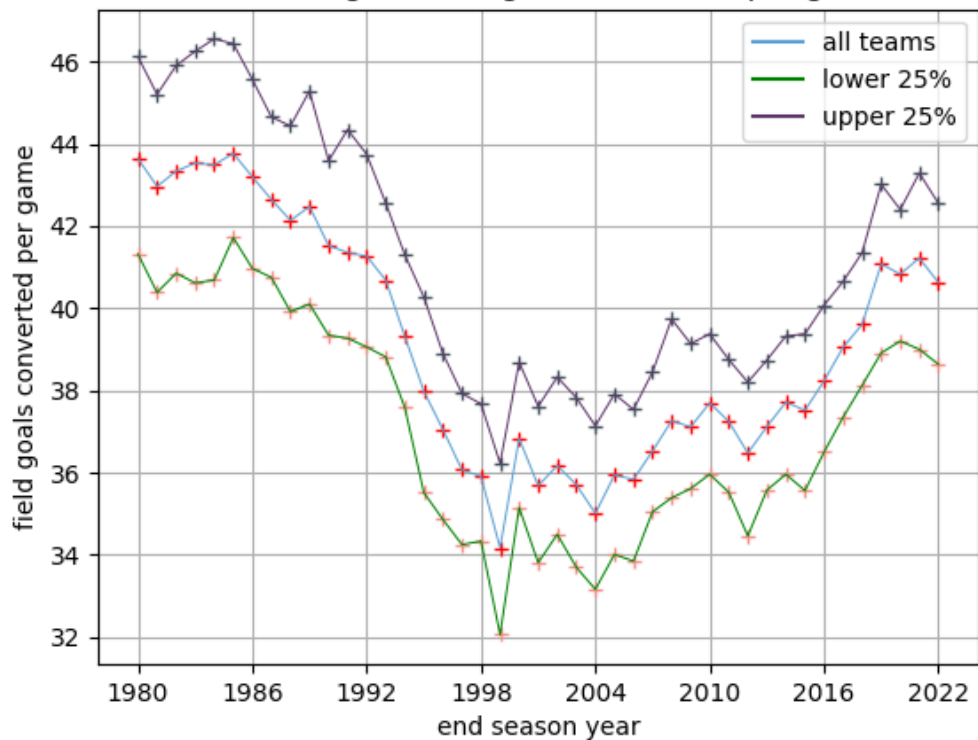
APPENDIX A

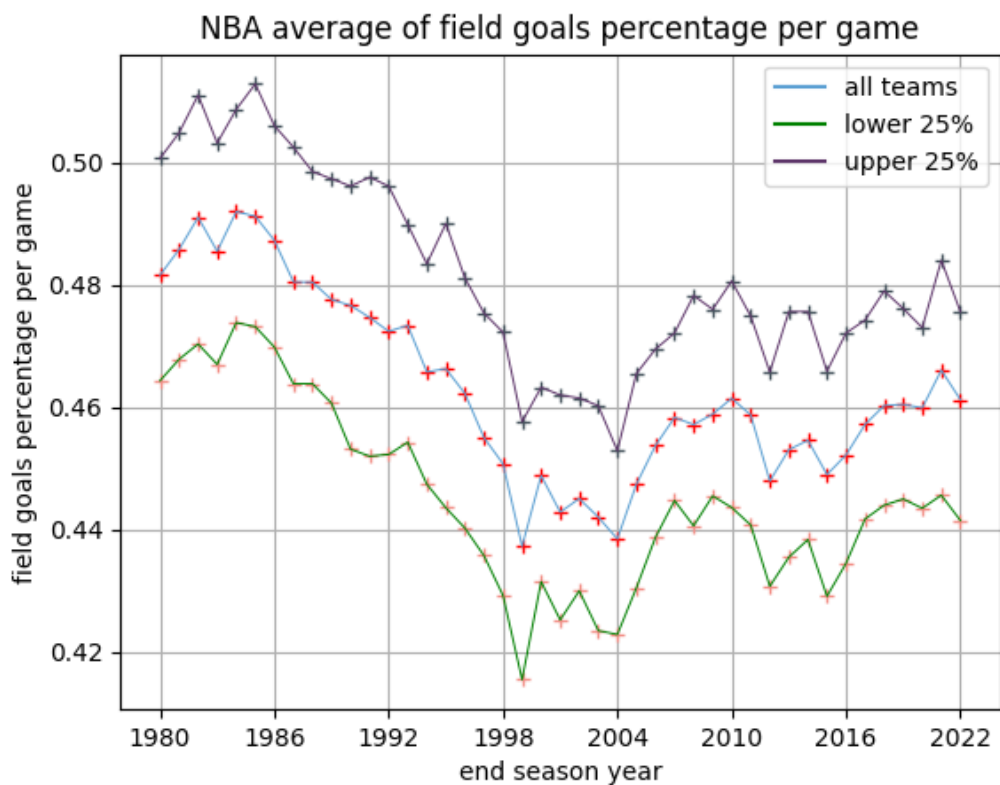
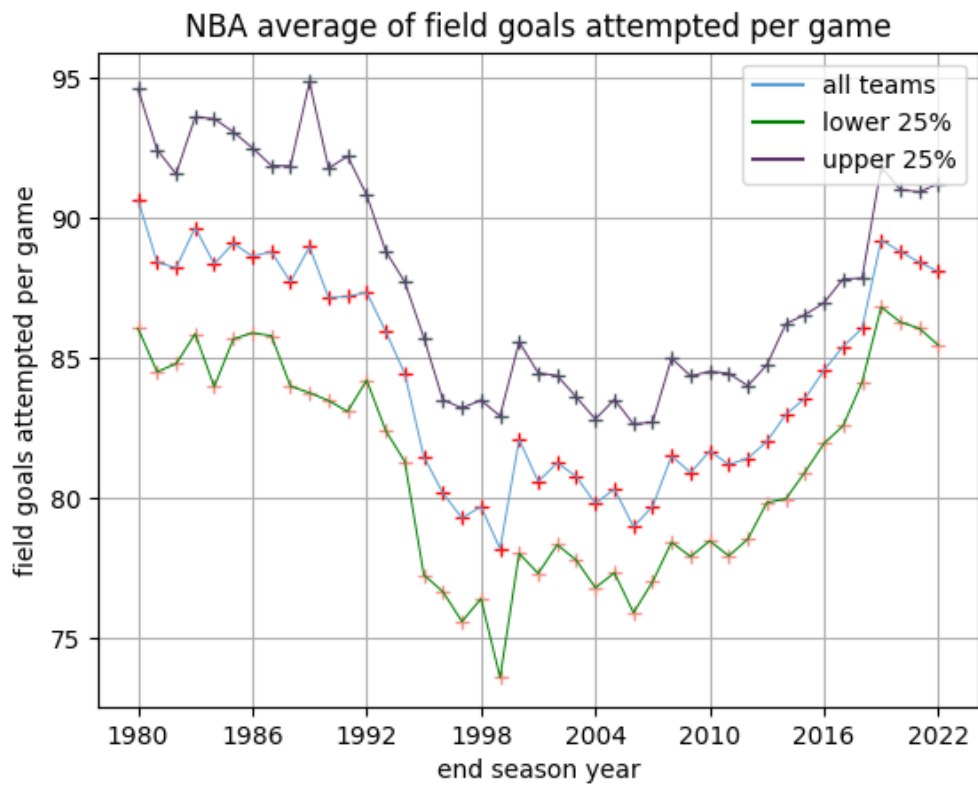


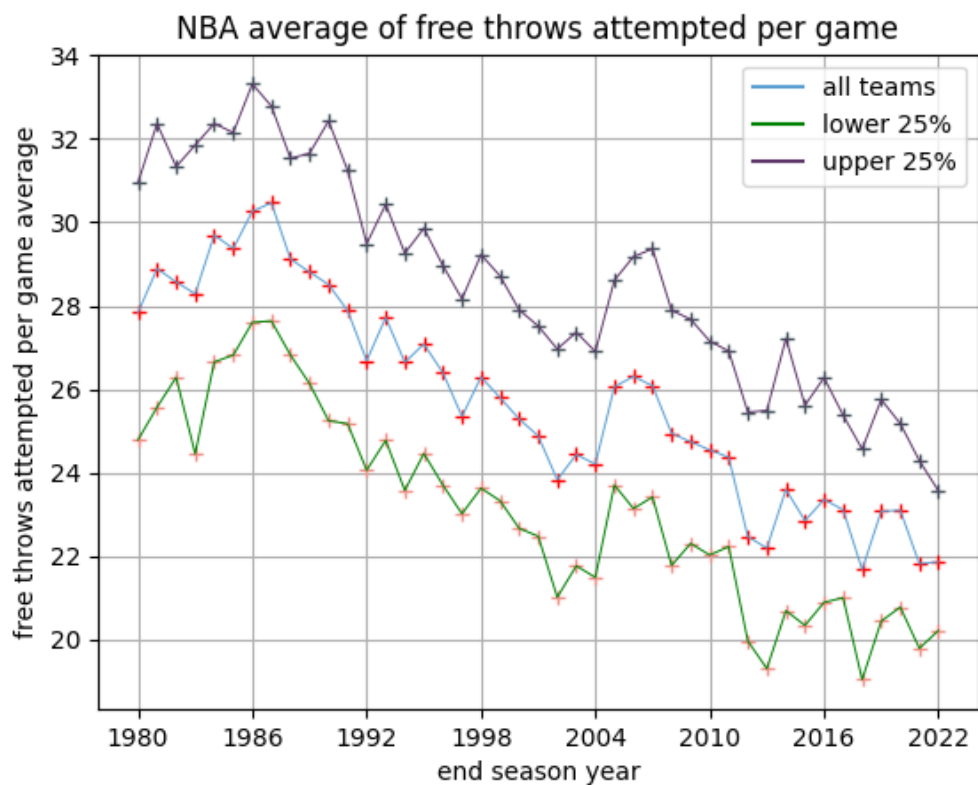
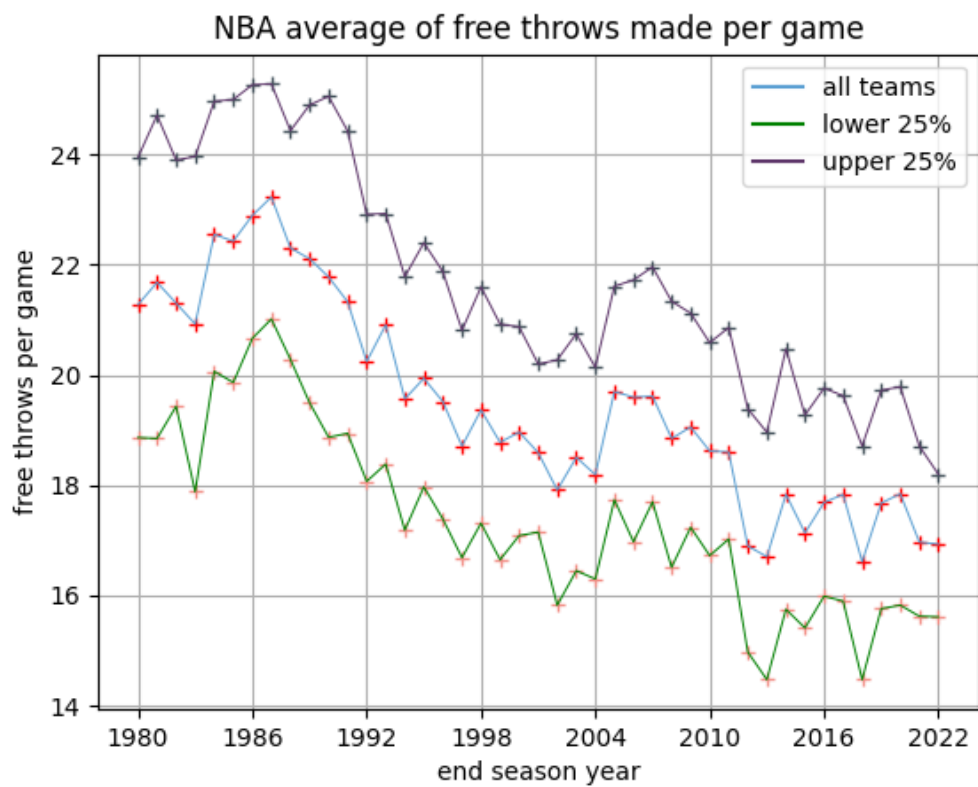
NBA average of defensive rebounds per game per game

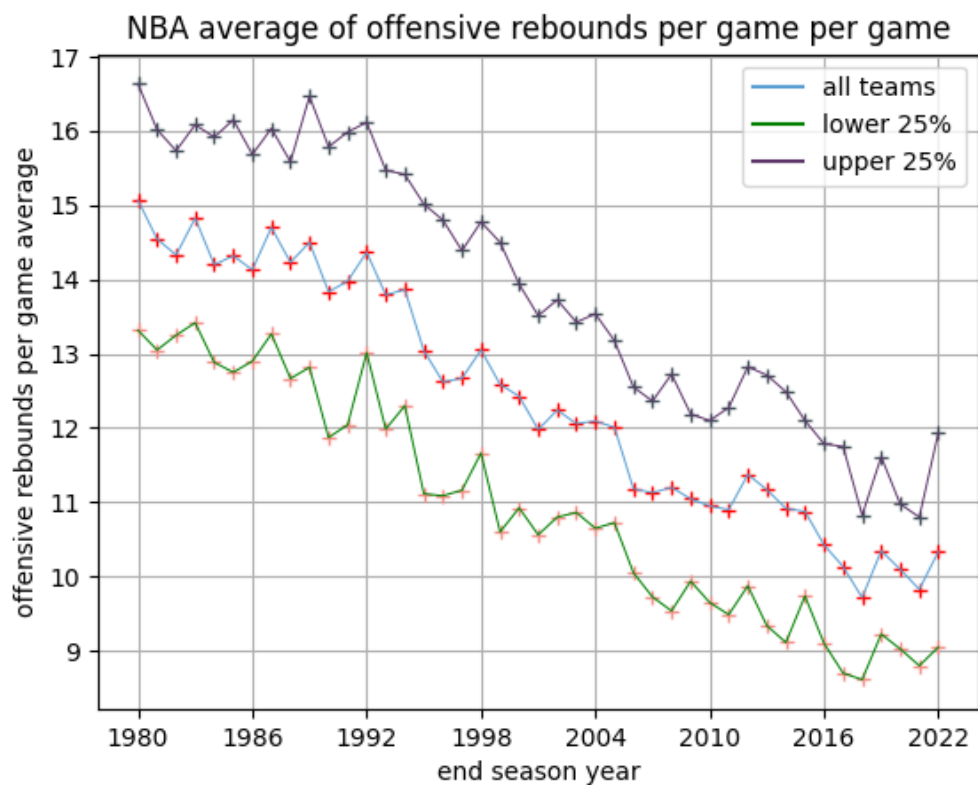
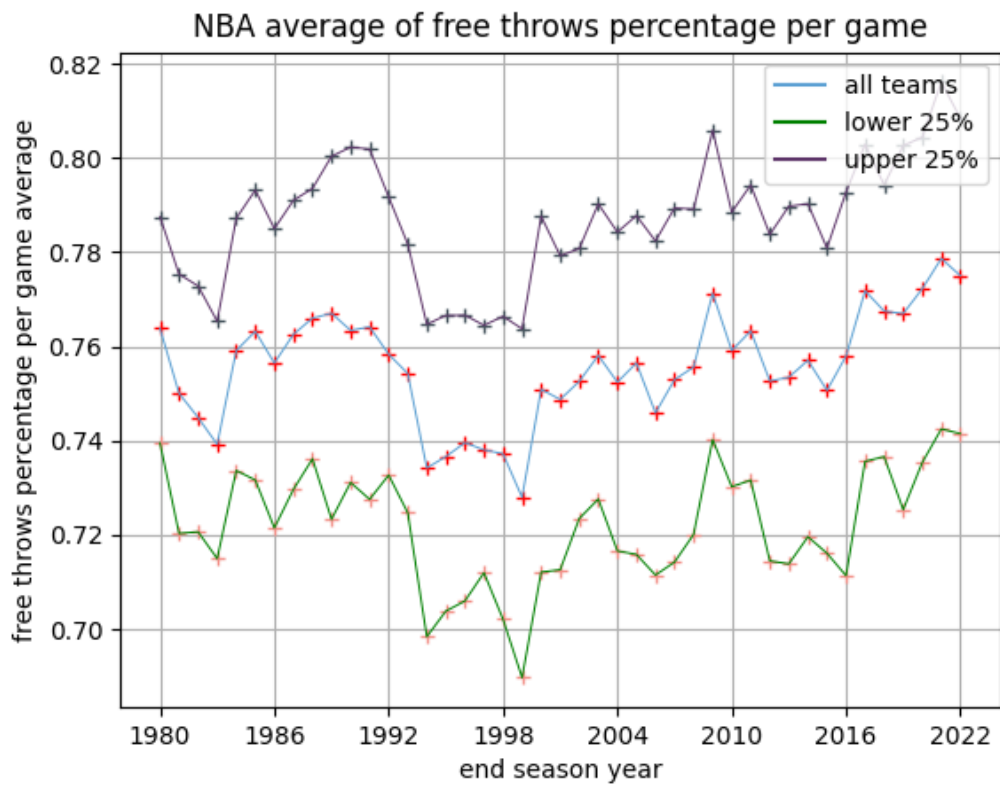


NBA average of field goals converted per game

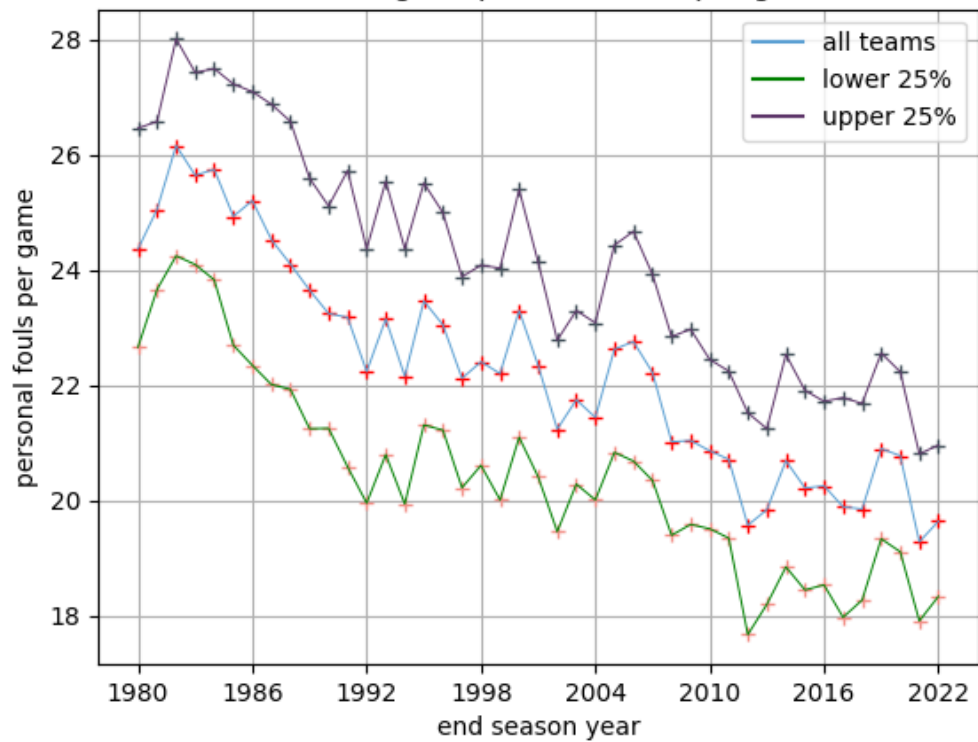




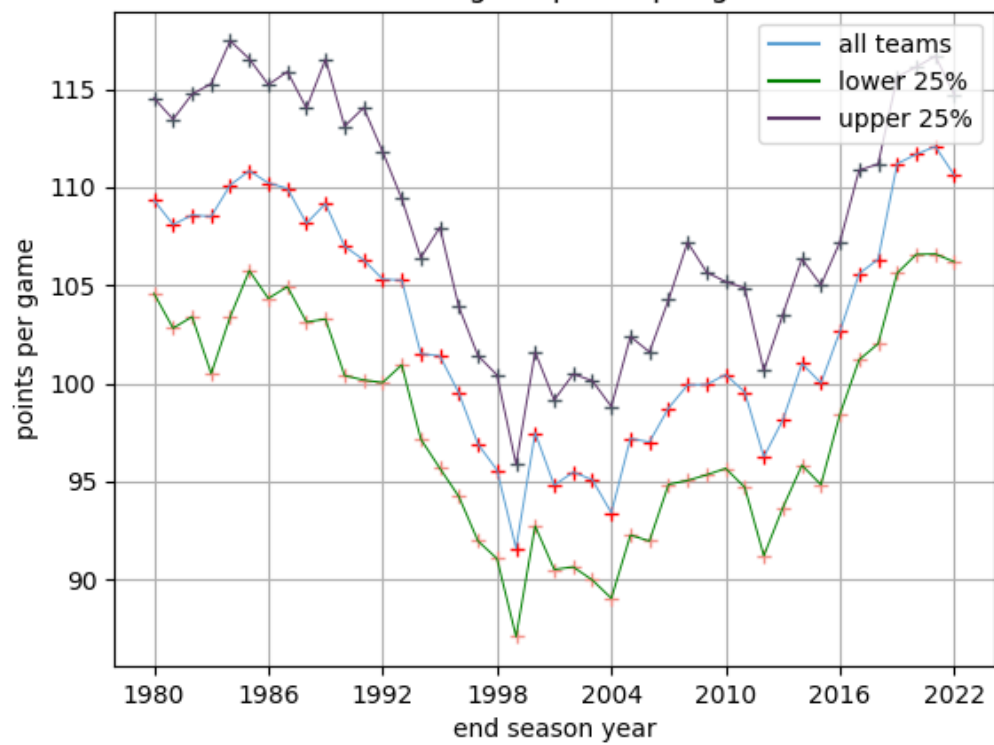


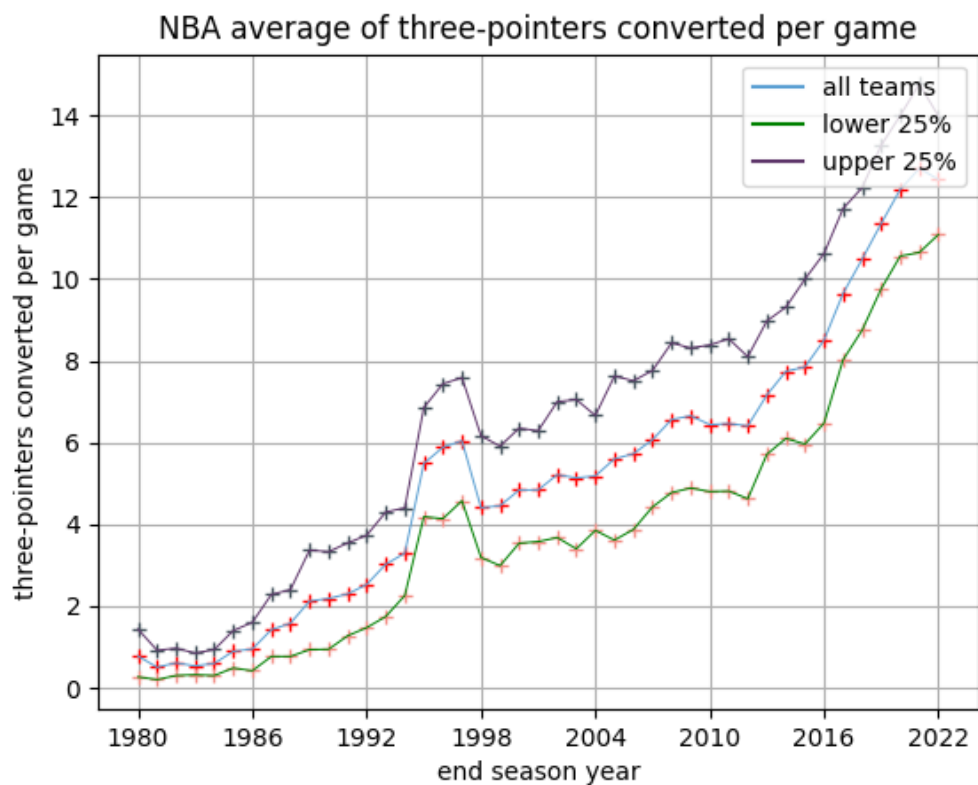
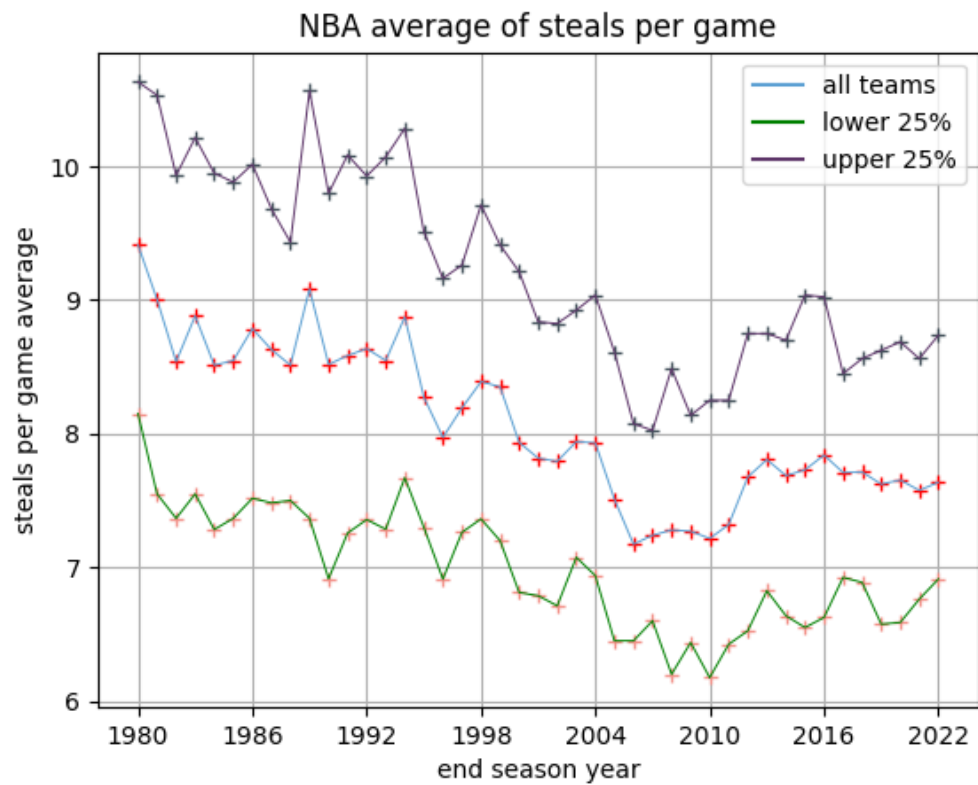


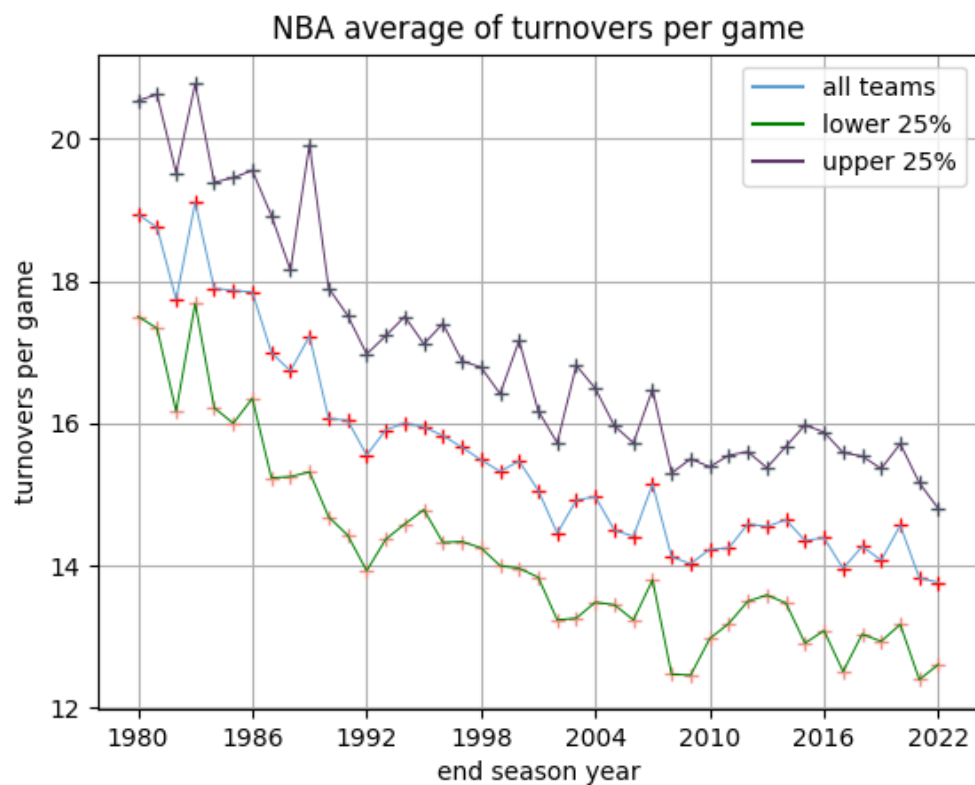
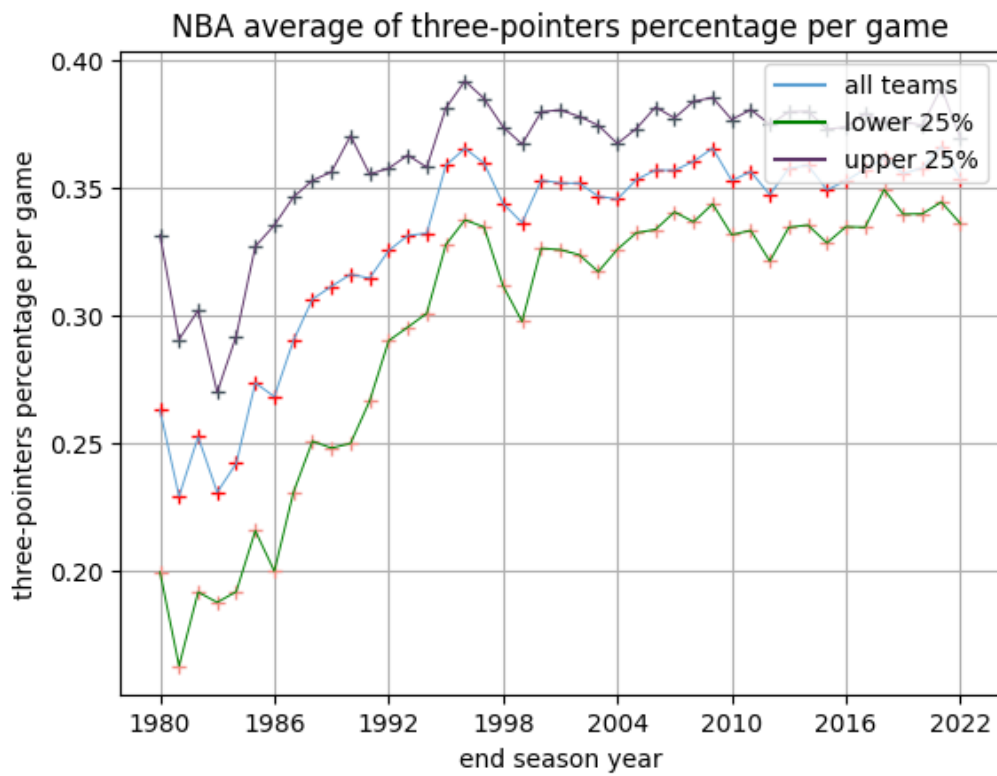
NBA average of personal fouls per game

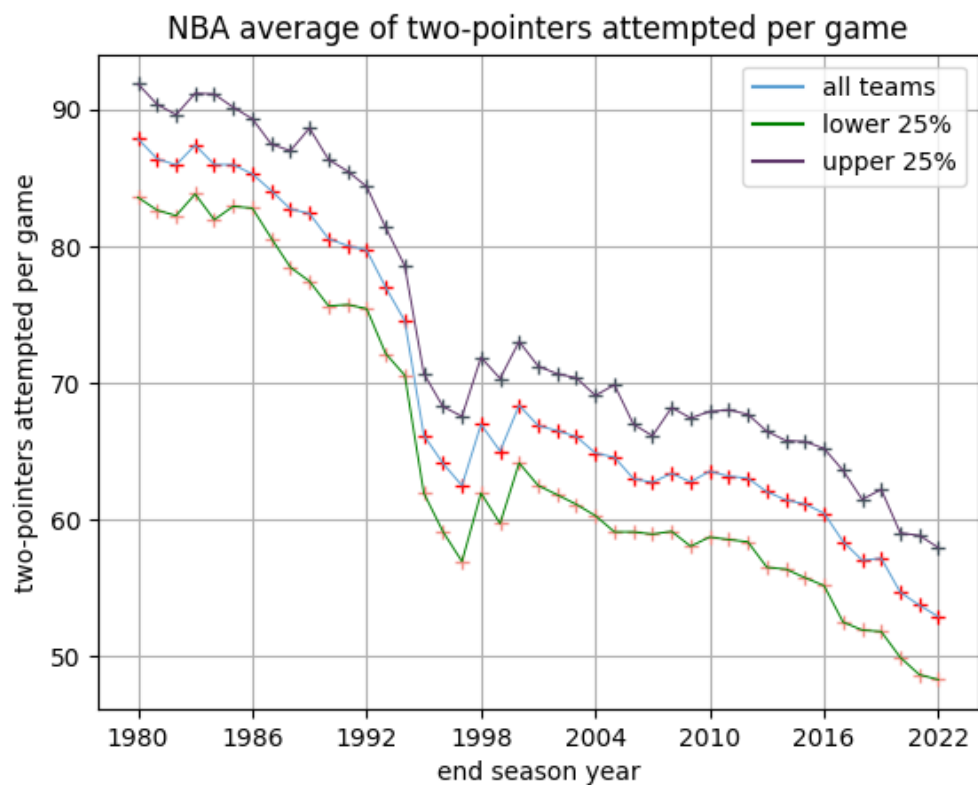
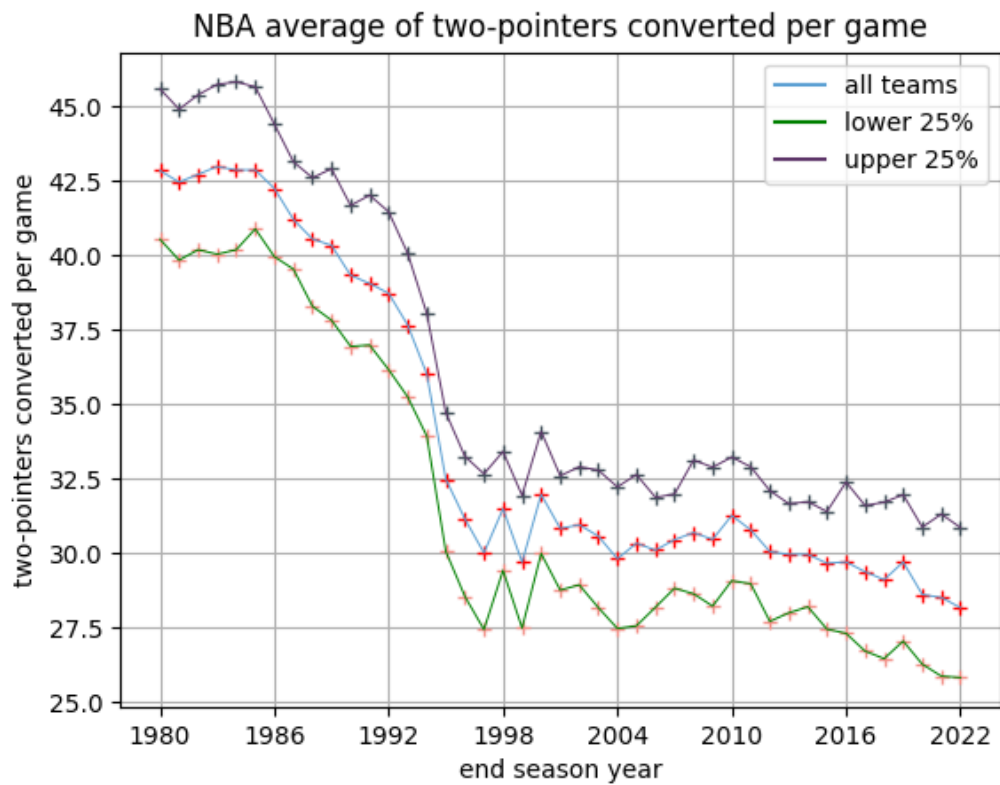


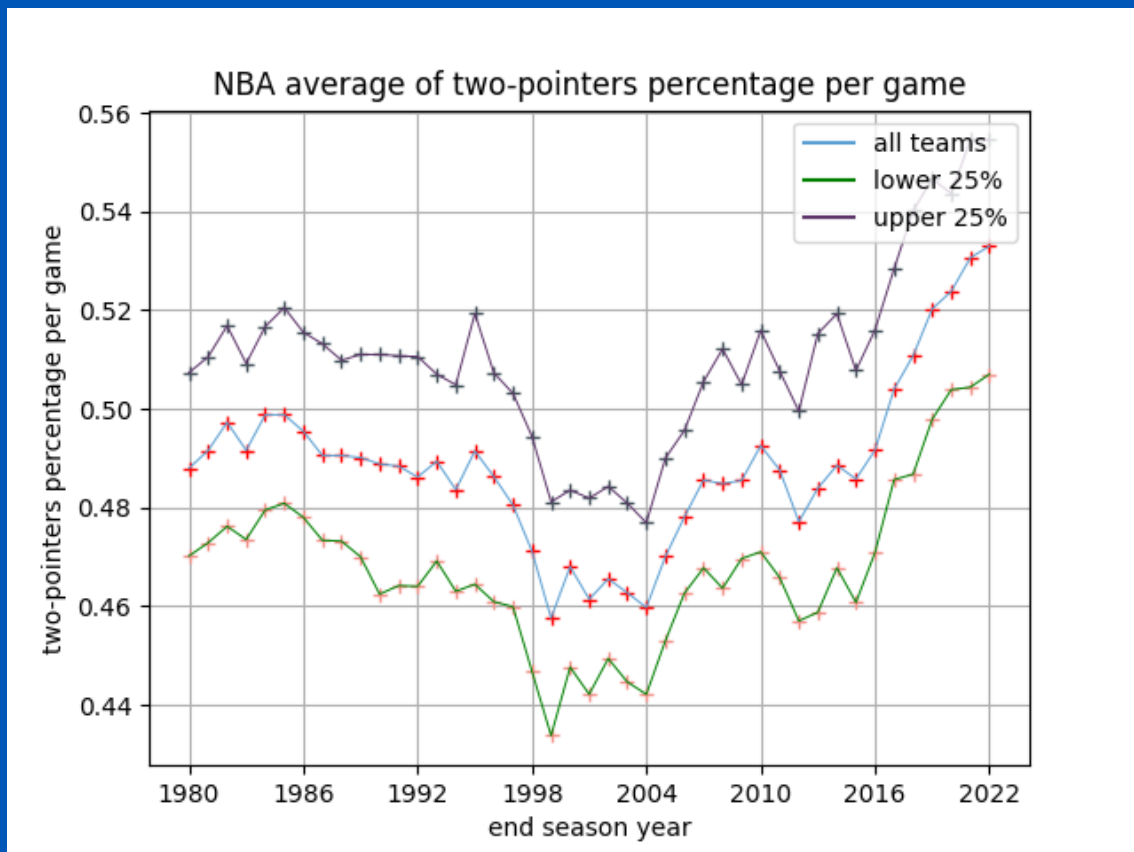
NBA average of points per game



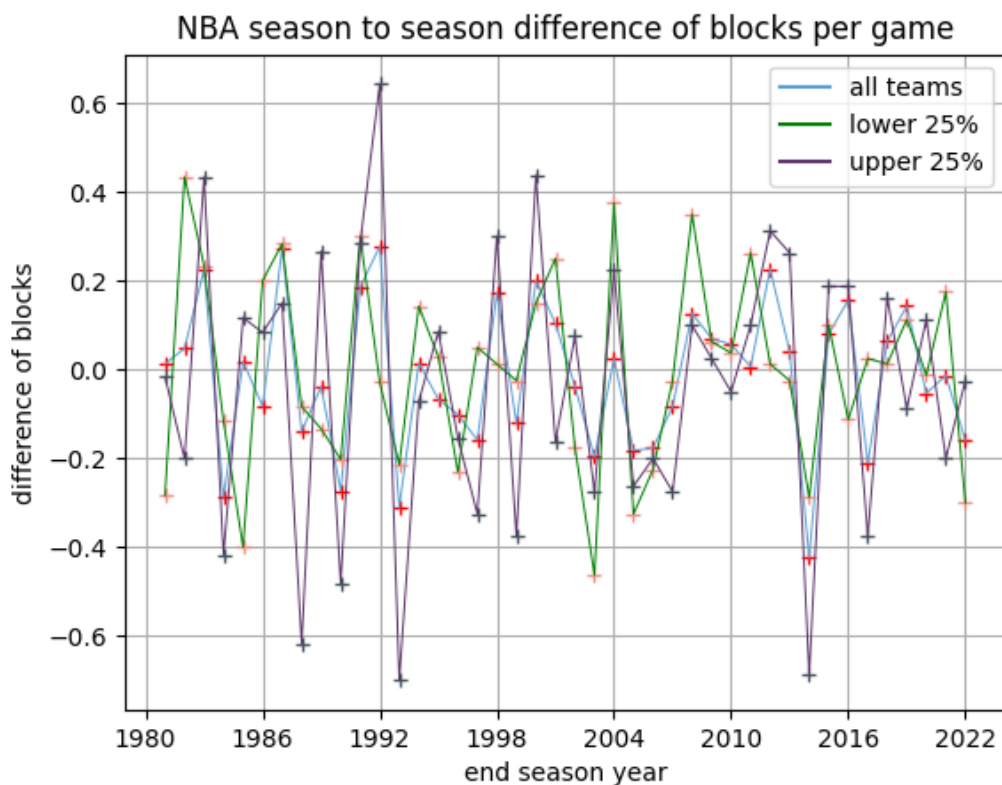
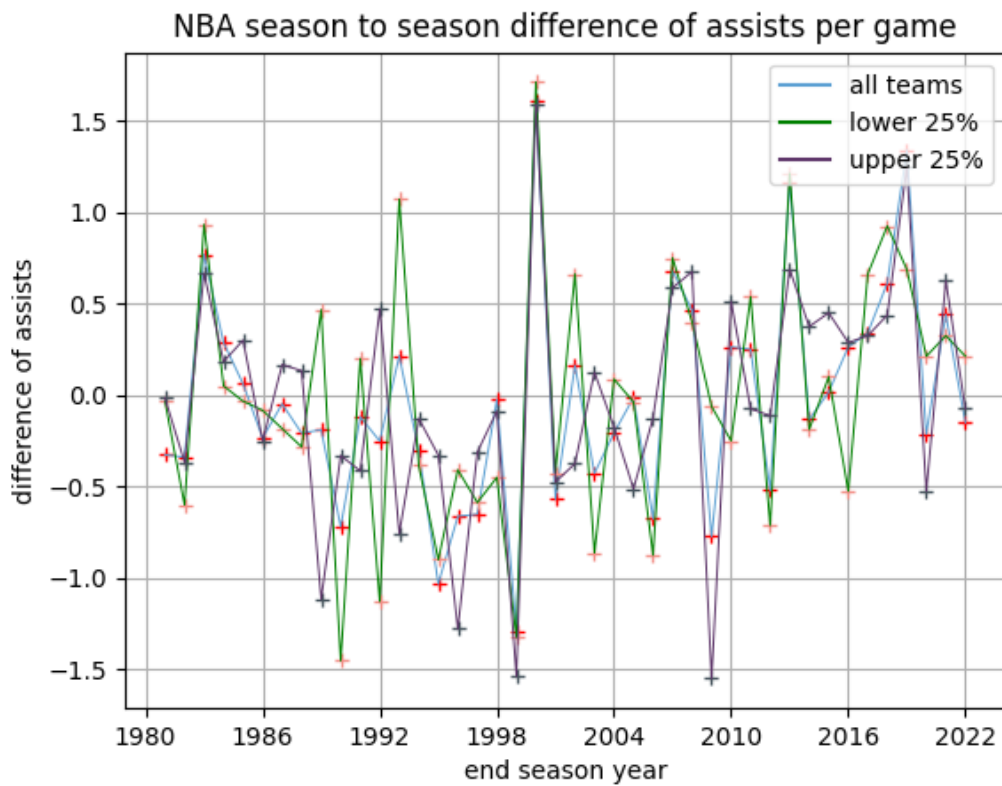




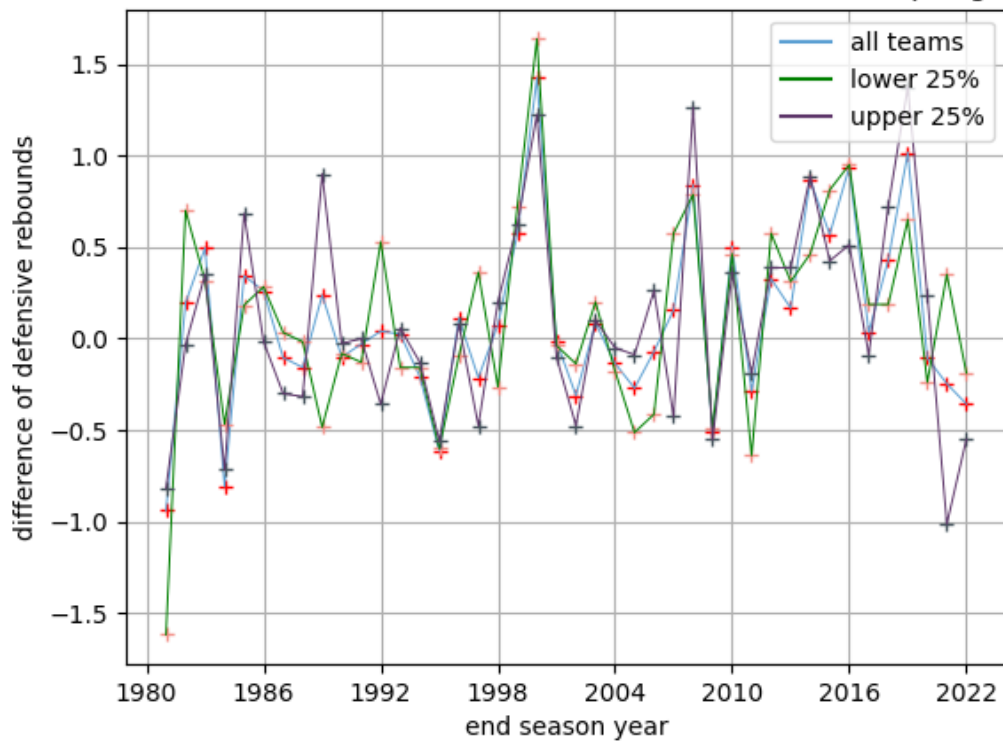




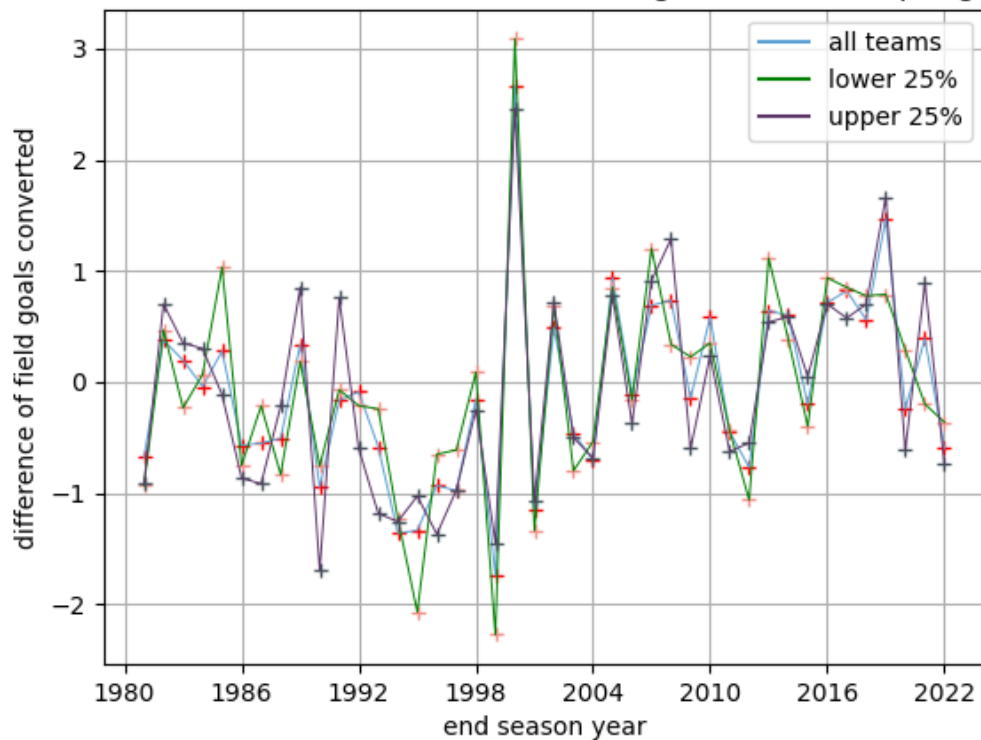
APPENDIX B



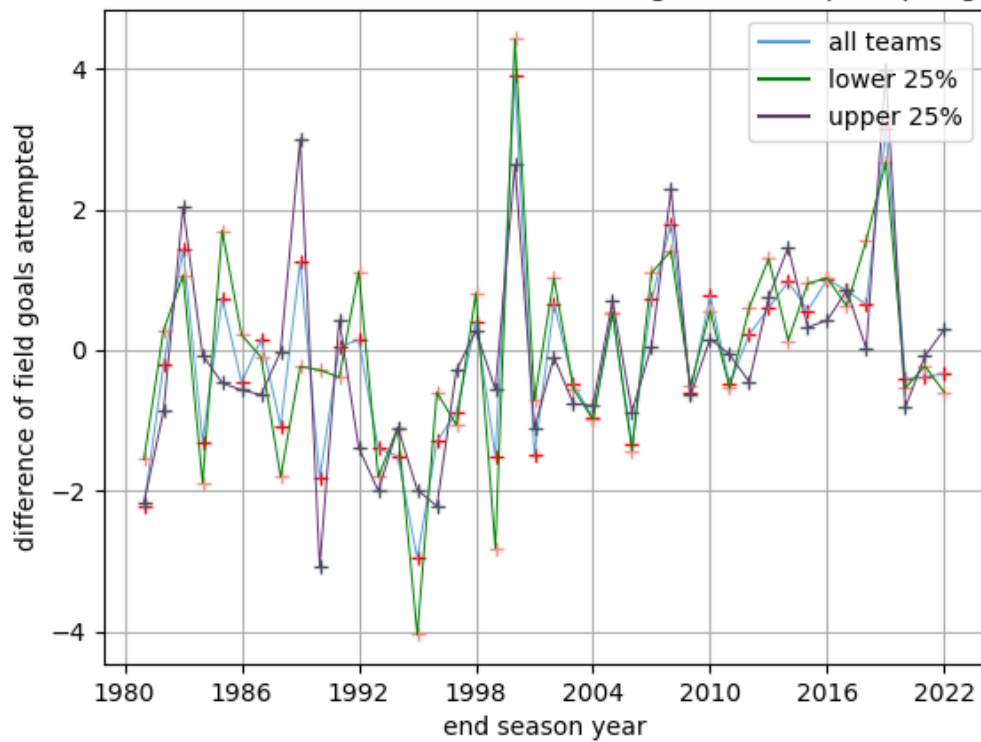
NBA season to season difference of defensive rebounds per game



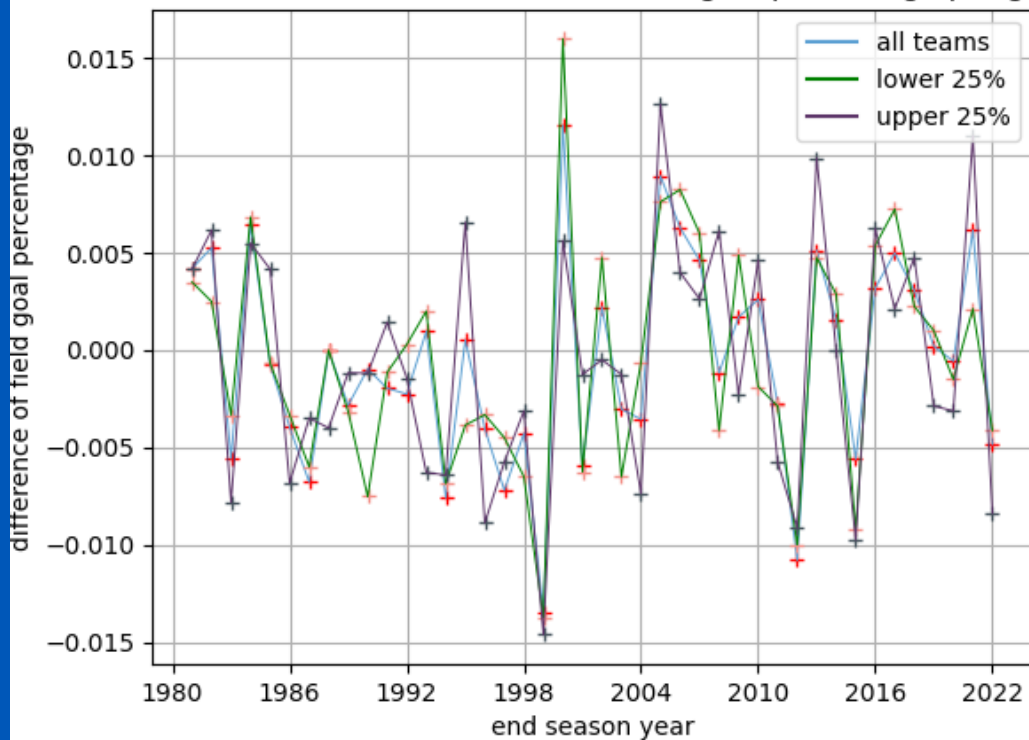
NBA season to season difference of field goals converted per game



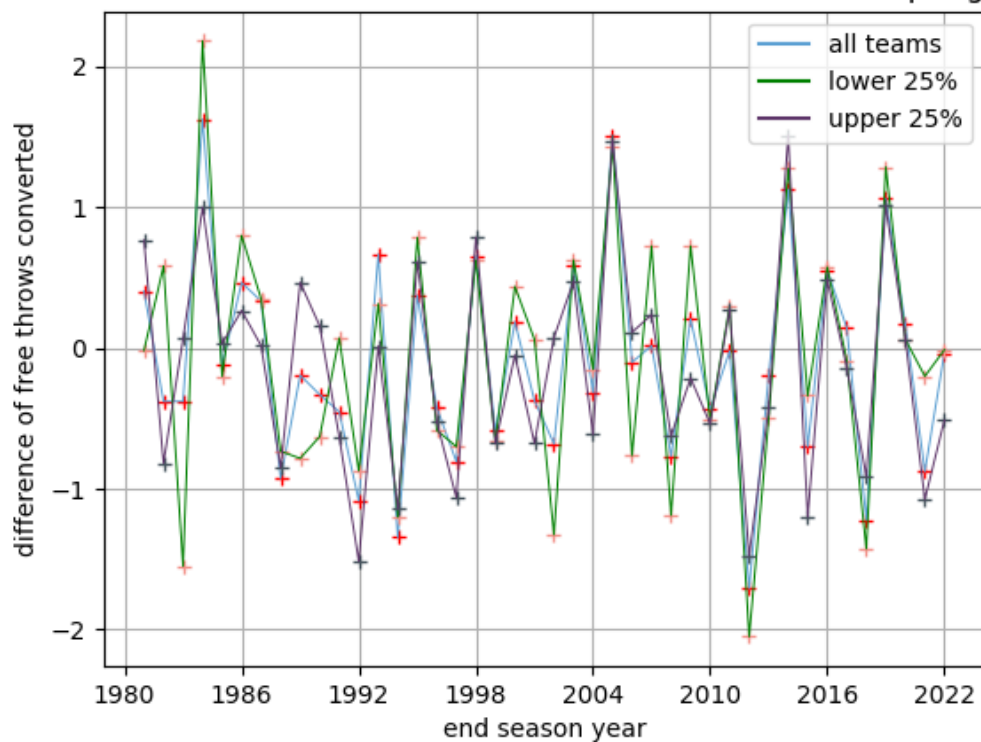
NBA season to season difference of field goals attempted per game



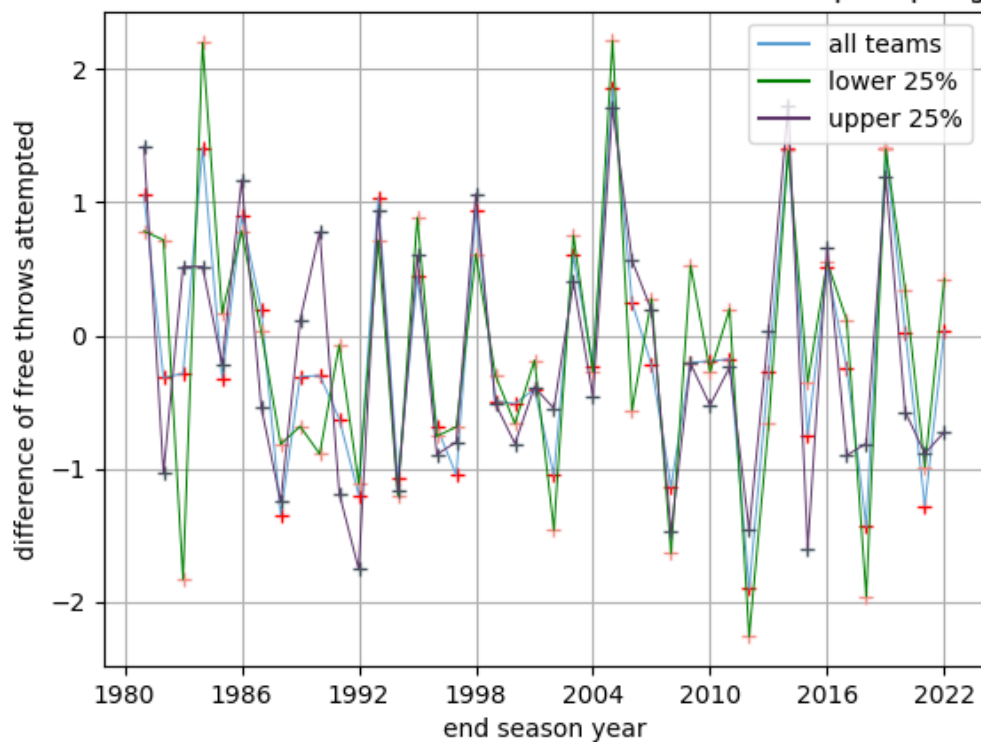
NBA season to season difference of field goal percentage per game



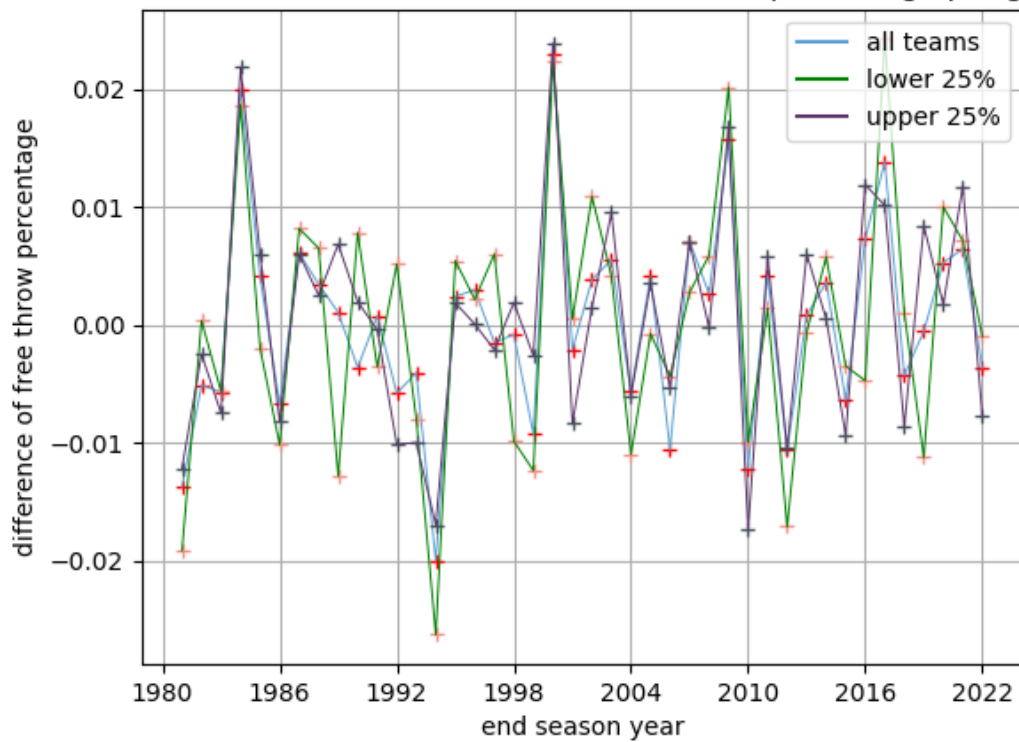
NBA season to season difference of free throws converted per game



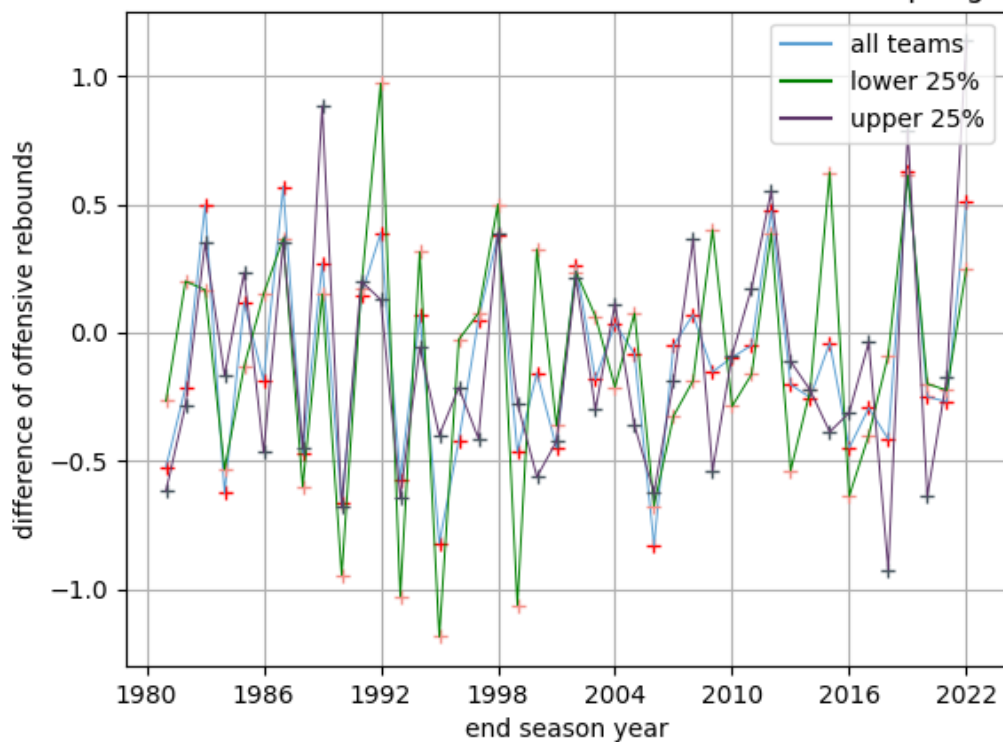
NBA season to season difference of free throws attempted per game

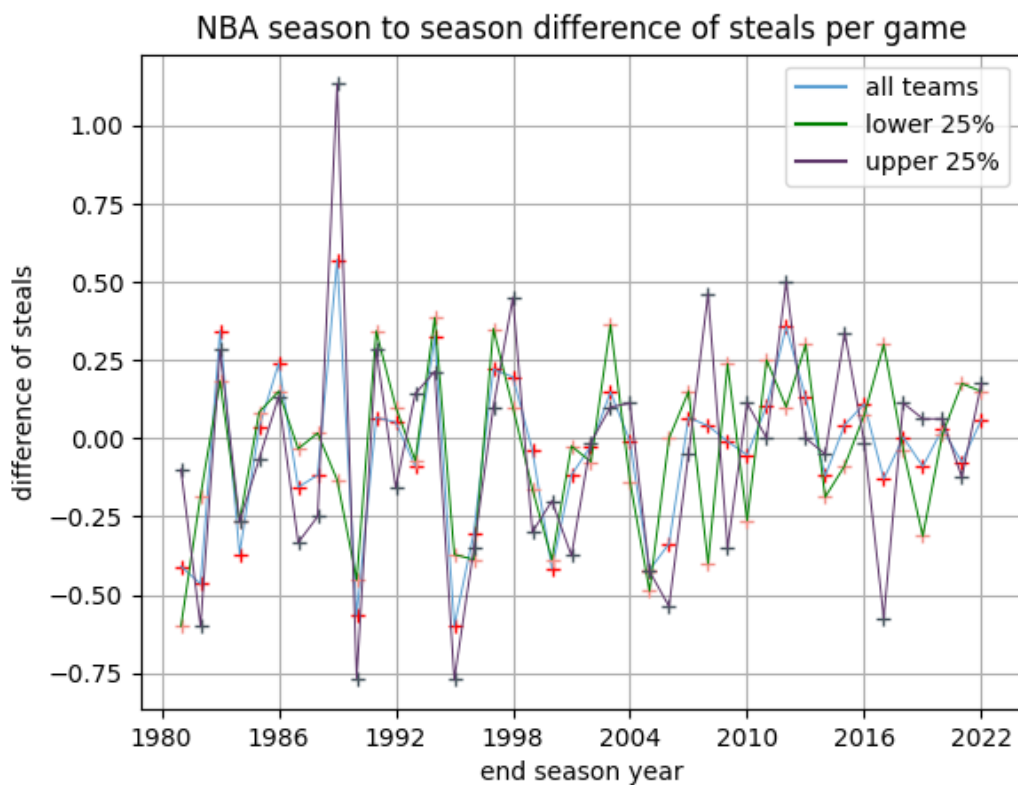
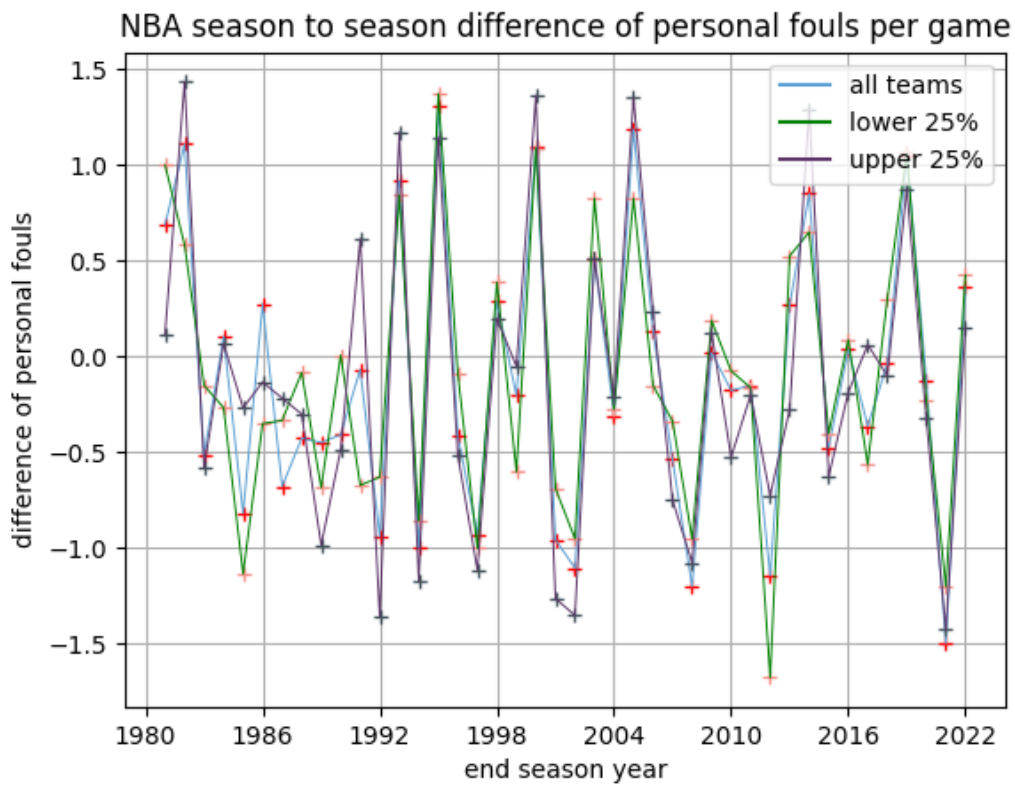


NBA season to season difference of free throw percentage per game

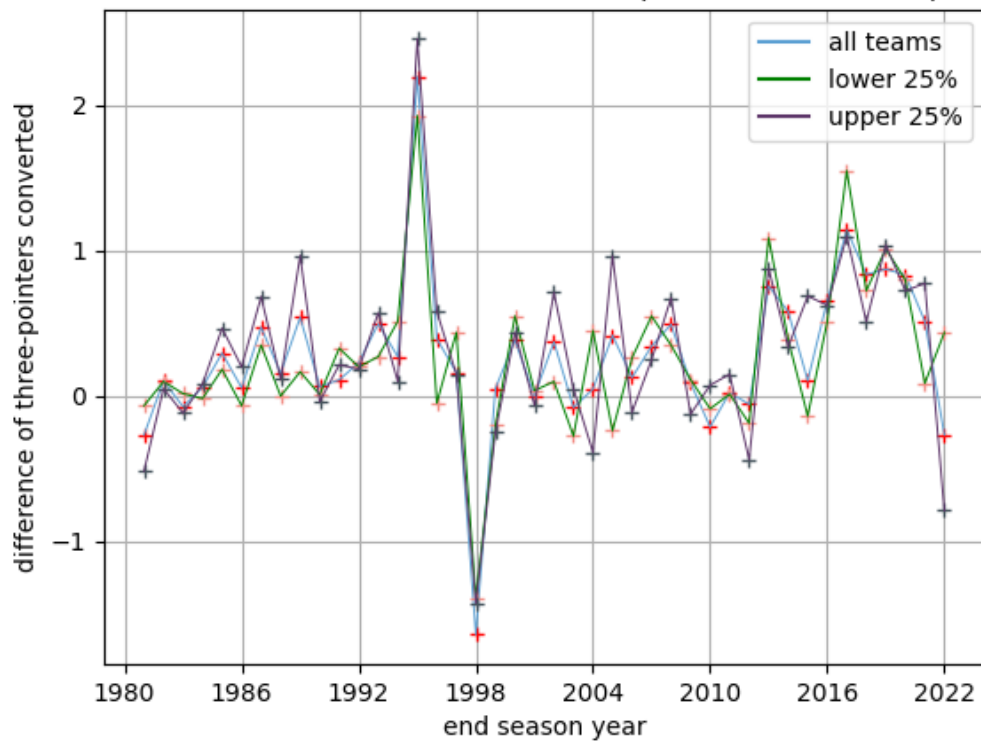


NBA season to season difference of offensive rebounds per game

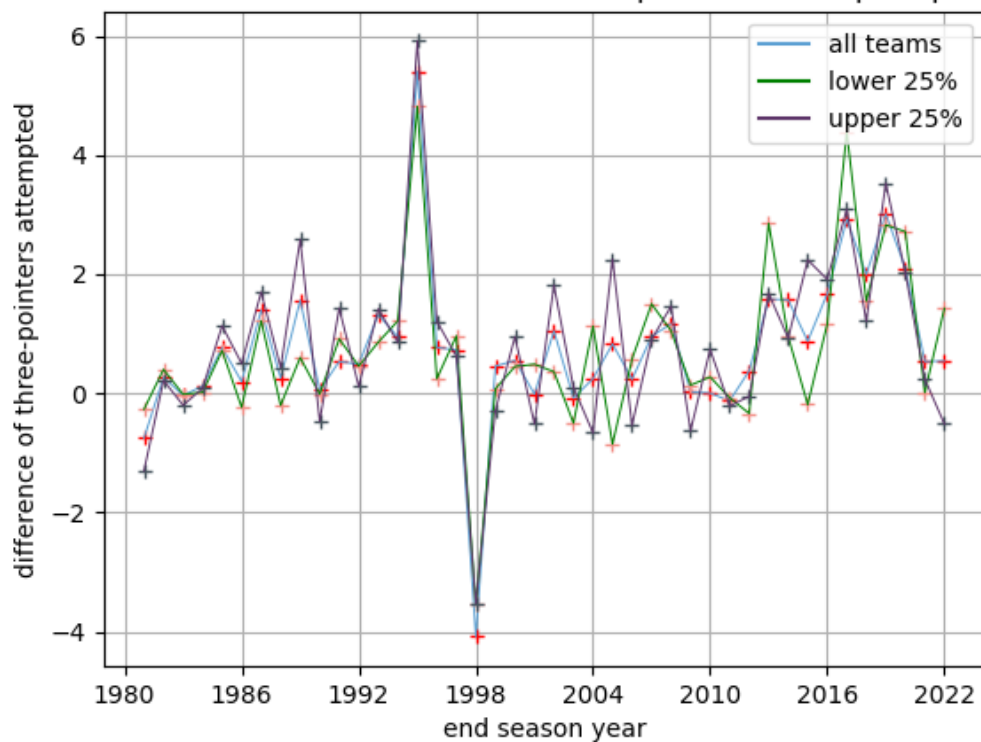




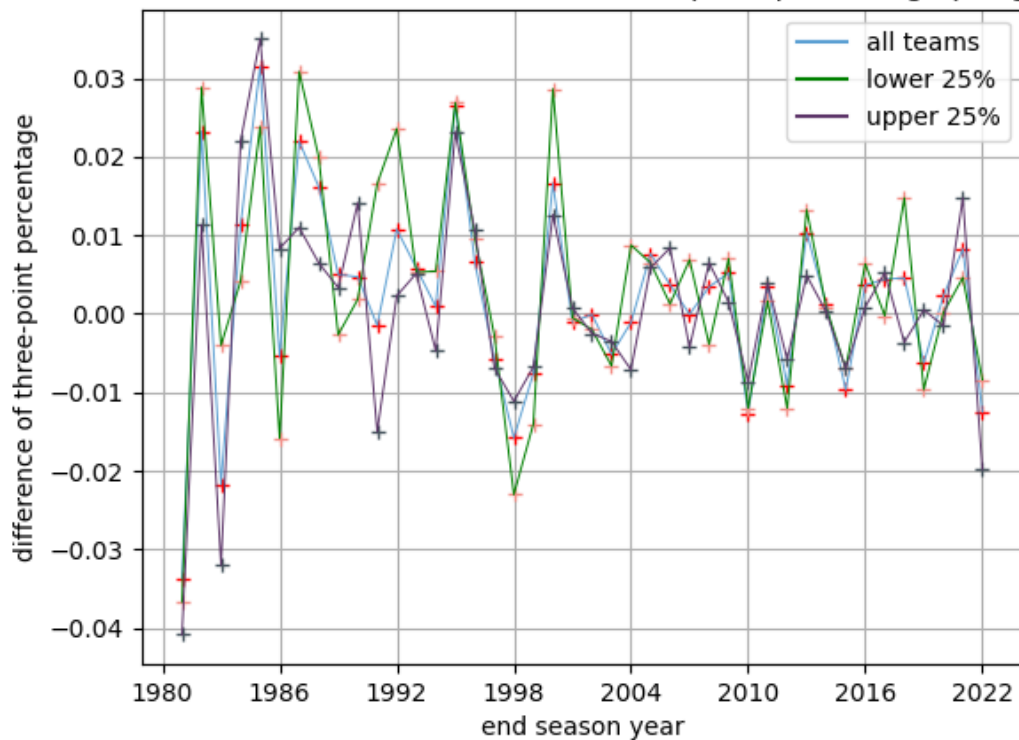
NBA season to season difference of three-pointers converted per game



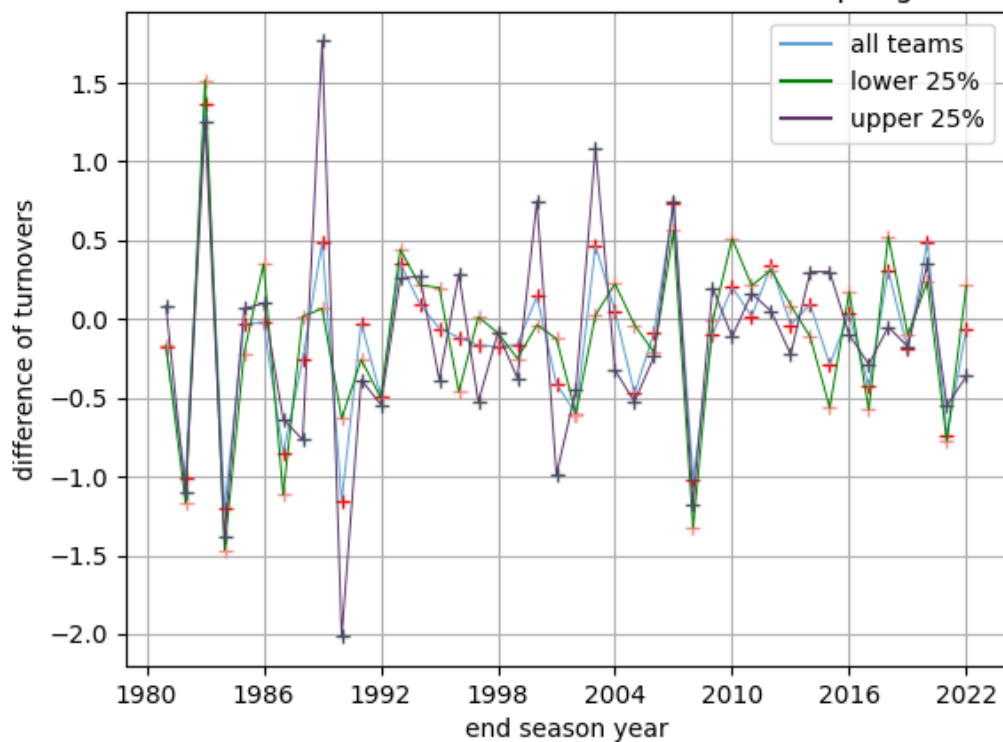
NBA season to season difference of three-pointers attempted per game



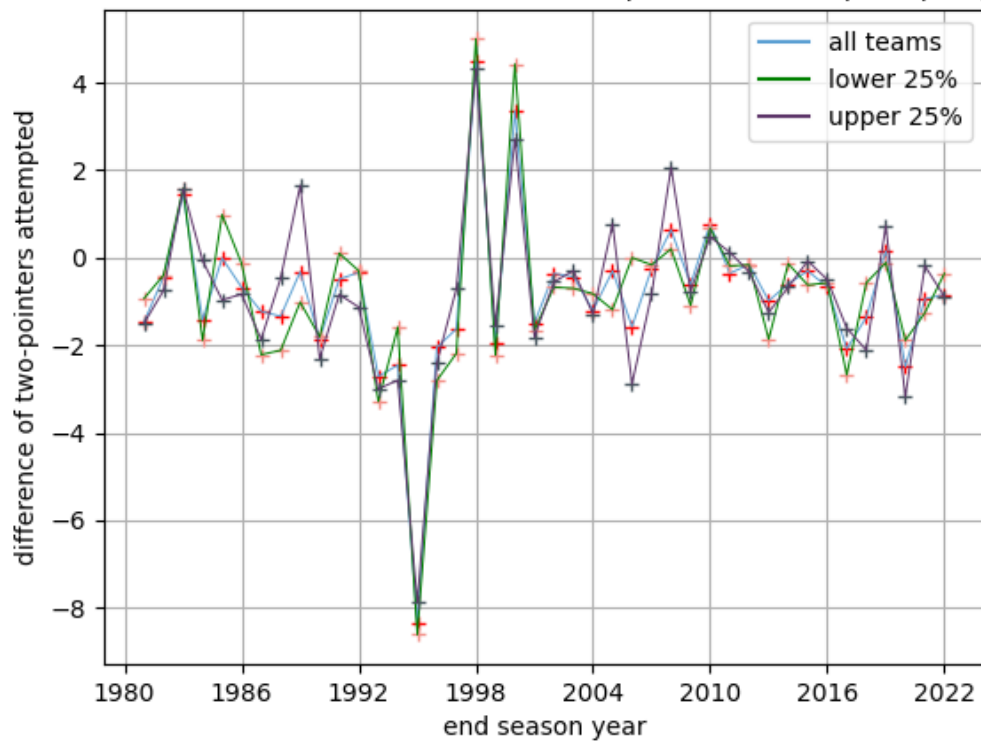
NBA season to season difference of three-point percentage per game



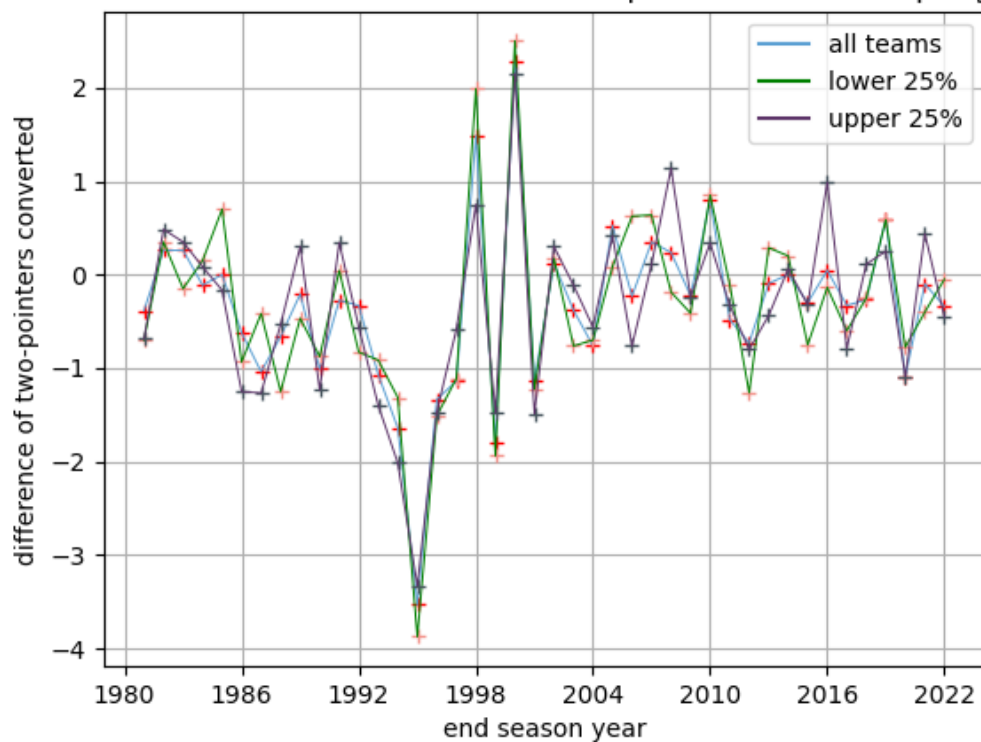
NBA season to season difference of turnovers per game

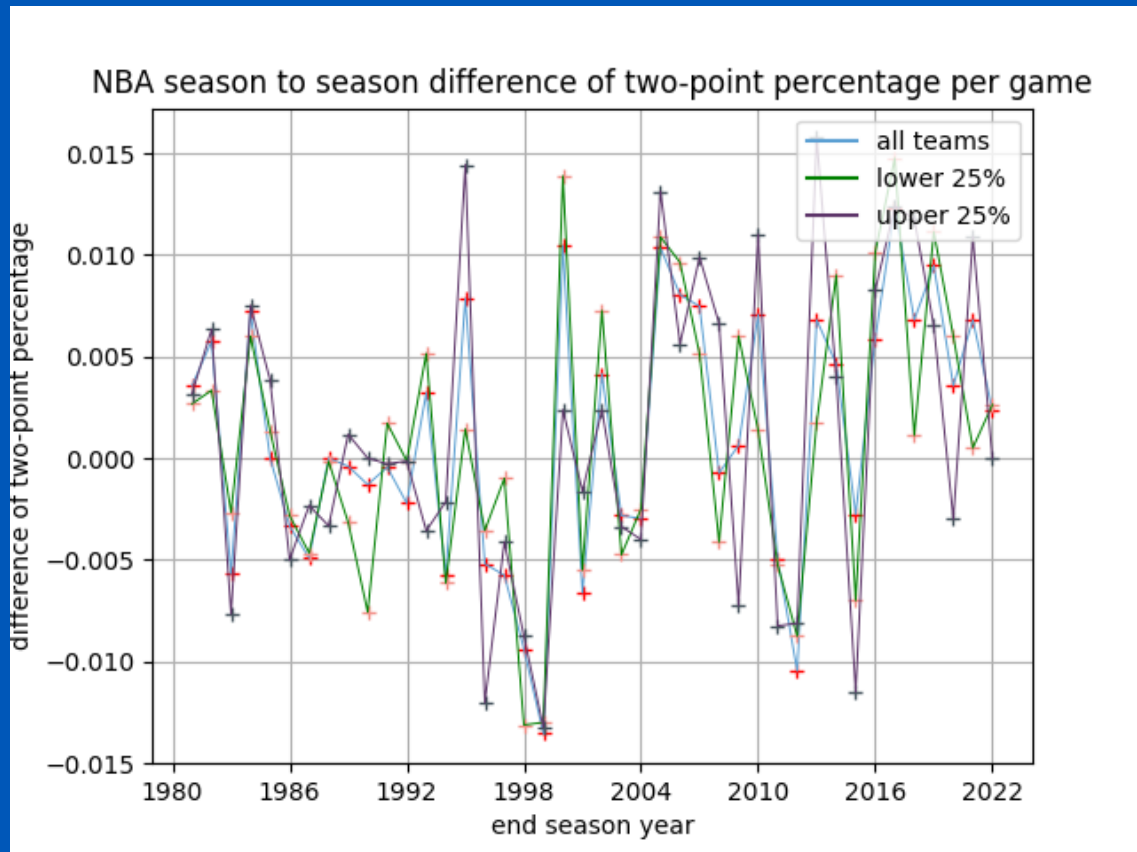


NBA season to season difference of two-pointers attempted per game



NBA season to season difference of two-pointers converted per game





APPENDIX C

Correlation of 0.9623558584009754 between FG_avg and FG_attempted_avg
 Correlation of 0.9324555435762188 between FG_avg and FG_rate_avg
 Correlation of -0.40231367502606574 between FG_avg and ThreeP_avg
 Correlation of -0.3951361096563055 between FG_avg and ThreeP_attempted_avg
 Correlation of -0.7610135636433714 between FG_avg and ThreeP_rate_avg
 Correlation of 0.8061969284916222 between FG_avg and TwoP_avg
 Correlation of 0.680698041125456 between FG_avg and TwoP_attempted_avg
 Correlation of 0.6130358305913227 between FG_avg and TwoP_rate_avg
 Correlation of 0.63414675810952 between FG_avg and FT_avg
 Correlation of 0.5591304673401795 between FG_avg and FT_attempted_avg
 Correlation of 0.3991203281445918 between FG_avg and FT_rate_avg
 Correlation of 0.5435725283817489 between FG_avg and OR_avg
 Correlation of -0.007237662347510794 between FG_avg and DR_avg
 Correlation of 0.9598501763015381 between FG_avg and AST_avg
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 Correlation of 0.5703530937213522 between FG_avg and BLK_avg
 Correlation of 0.6850663201169368 between FG_avg and TOV_avg
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 Correlation of -0.917912078189981 between ThreeP_rate_avg and TwoP_avg
 Correlation of -0.8940318189645063 between ThreeP_rate_avg and TwoP_attempted_avg
 Correlation of -0.07634986417980082 between ThreeP_rate_avg and TwoP_rate_avg
 Correlation of -0.7677909782272958 between ThreeP_rate_avg and FT_avg
 Correlation of -0.7632462731845426 between ThreeP_rate_avg and FT_attempted_avg
 Correlation of 0.07774594649850301 between ThreeP_rate_avg and FT_rate_avg
 Correlation of -0.7903906863117333 between ThreeP_rate_avg and OR_avg
 Correlation of 0.4338470643179249 between ThreeP_rate_avg and DR_avg
 Correlation of -0.7391661151916712 between ThreeP_rate_avg and AST_avg
 Correlation of -0.7684307988248131 between ThreeP_rate_avg and STL_avg
 Correlation of -0.7210823069034991 between ThreeP_rate_avg and BLK_avg
 Correlation of -0.9248124735374236 between ThreeP_rate_avg and TOV_avg

Correlation of -0.8316538262542355 between ThreeP_rate_avg and PF_avg
 Correlation of -0.534460906303946 between ThreeP_rate_avg and PTS_avg
 Correlation of 0.9807957793624675 between TwoP_avg and TwoP_attempted_avg
 Correlation of 0.0525298463877709 between TwoP_avg and TwoP_rate_avg
 Correlation of 0.9050276161726964 between TwoP_avg and FT_avg
 Correlation of 0.8866294218831368 between TwoP_avg and FT_attempted_avg
 Correlation of -0.01707805762229112 between TwoP_avg and FT_rate_avg
 Correlation of 0.9034888006247533 between TwoP_avg and OR_avg
 Correlation of -0.5569446189183852 between TwoP_avg and DR_avg
 Correlation of 0.805214944930051 between TwoP_avg and AST_avg
 Correlation of 0.8358441833958373 between TwoP_avg and STL_avg
 Correlation of 0.8052017820322037 between TwoP_avg and BLK_avg
 Correlation of 0.9202903493866508 between TwoP_avg and TOV_avg
 Correlation of 0.8697484042953696 between TwoP_avg and PF_avg
 Correlation of 0.5704546629869234 between TwoP_avg and PTS_avg
 Correlation of -0.14257109936019968 between TwoP_attempted_avg and TwoP_rate_avg
 Correlation of 0.9094552232016229 between TwoP_attempted_avg and FT_avg
 Correlation of 0.9085260465867131 between TwoP_attempted_avg and FT_attempted_avg
 Correlation of -0.1350867742456962 between TwoP_attempted_avg and FT_rate_avg
 Correlation of 0.9477849909589292 between TwoP_attempted_avg and OR_avg
 Correlation of -0.6706194704549825 between TwoP_attempted_avg and DR_avg
 Correlation of 0.6955248729755809 between TwoP_attempted_avg and AST_avg
 Correlation of 0.8429077501063502 between TwoP_attempted_avg and STL_avg
 Correlation of 0.8309865133330229 between TwoP_attempted_avg and BLK_avg
 Correlation of 0.9199387444165001 between TwoP_attempted_avg and TOV_avg
 Correlation of 0.8906891340542789 between TwoP_attempted_avg and PF_avg
 Correlation of 0.40592178444958027 between TwoP_attempted_avg and PTS_avg
 Correlation of -0.06819119954911439 between TwoP_rate_avg and FT_avg
 Correlation of -0.15857307168804952 between TwoP_rate_avg and FT_attempted_avg
 Correlation of 0.6177200819062655 between TwoP_rate_avg and FT_rate_avg
 Correlation of -0.25721574789343055 between TwoP_rate_avg and OR_avg
 Correlation of 0.6195414134264425 between TwoP_rate_avg and DR_avg
 Correlation of 0.54309011907056 between TwoP_rate_avg and AST_avg
 Correlation of -0.0503834084503542 between TwoP_rate_avg and STL_avg
 Correlation of -0.15061530059022502 between TwoP_rate_avg and BLK_avg
 Correlation of -0.041132456343346106 between TwoP_rate_avg and TOV_avg
 Correlation of -0.15408852087823635 between TwoP_rate_avg and PF_avg
 Correlation of 0.8257538051993142 between TwoP_rate_avg and PTS_avg
 Correlation of 0.9876419940182825 between FT_avg and FT_attempted_avg
 Correlation of -0.06622349060234298 between FT_avg and FT_rate_avg
 Correlation of 0.8784022861099288 between FT_avg and OR_avg
 Correlation of -0.6851679299419736 between FT_avg and DR_avg
 Correlation of 0.6629992441609369 between FT_avg and AST_avg
 Correlation of 0.7126503829327967 between FT_avg and STL_avg
 Correlation of 0.6657413624065547 between FT_avg and BLK_avg
 Correlation of 0.8303115342142829 between FT_avg and TOV_avg
 Correlation of 0.9102251890076821 between FT_avg and PF_avg
 Correlation of 0.4337782508611375 between FT_avg and PTS_avg
 Correlation of -0.22132013643398984 between FT_attempted_avg and FT_rate_avg
 Correlation of 0.9061588000883654 between FT_attempted_avg and OR_avg

Correlation of -0.7614178346620464 between FT_attempted_avg and DR_avg
Correlation of 0.604626235130423 between FT_attempted_avg and AST_avg
Correlation of 0.7287036993868149 between FT_attempted_avg and STL_avg
Correlation of 0.6792275167547829 between FT_attempted_avg and BLK_avg
Correlation of 0.8485003470086514 between FT_attempted_avg and TOV_avg
Correlation of 0.9384704965304415 between FT_attempted_avg and PF_avg
Correlation of 0.3368780195995117 between FT_attempted_avg and PTS_avg
Correlation of -0.31379939140546376 between FT_rate_avg and OR_avg
Correlation of 0.6003617470850874 between FT_rate_avg and DR_avg
Correlation of 0.2904448770094703 between FT_rate_avg and AST_avg
Correlation of -0.2119644424676651 between FT_rate_avg and STL_avg
Correlation of -0.18891799238579796 between FT_rate_avg and BLK_avg
Correlation of -0.23458050319178203 between FT_rate_avg and TOV_avg
Correlation of -0.30309366745438826 between FT_rate_avg and PF_avg
Correlation of 0.5763738622942622 between FT_rate_avg and PTS_avg
Correlation of -0.7874960506859318 between OR_avg and DR_avg
Correlation of 0.6252480886963611 between OR_avg and AST_avg
Correlation of 0.8911862508852216 between OR_avg and STL_avg
Correlation of 0.8537030529194165 between OR_avg and BLK_avg
Correlation of 0.8942369418736965 between OR_avg and TOV_avg
Correlation of 0.8820180324330713 between OR_avg and PF_avg
Correlation of 0.264847854289423 between OR_avg and PTS_avg
Correlation of -0.08668989929101839 between DR_avg and AST_avg
Correlation of -0.5204365653821231 between DR_avg and STL_avg
Correlation of -0.5302159513827442 between DR_avg and BLK_avg
Correlation of -0.5996274168886141 between DR_avg and TOV_avg
Correlation of -0.7072891381773199 between DR_avg and PF_avg
Correlation of 0.2696128023590046 between DR_avg and PTS_avg
Correlation of 0.7407288004587829 between AST_avg and STL_avg
Correlation of 0.6565472956323763 between AST_avg and BLK_avg
Correlation of 0.7192878527012498 between AST_avg and TOV_avg
Correlation of 0.6027517889595856 between AST_avg and PF_avg
Correlation of 0.8916307928121088 between AST_avg and PTS_avg
Correlation of 0.8158195314749219 between STL_avg and BLK_avg
Correlation of 0.8685298344902256 between STL_avg and TOV_avg
Correlation of 0.7196160798285804 between STL_avg and PF_avg
Correlation of 0.4190149850372219 between STL_avg and PTS_avg
Correlation of 0.7727607775465484 between BLK_avg and TOV_avg
Correlation of 0.7077574724743133 between BLK_avg and PF_avg
Correlation of 0.32475070933535816 between BLK_avg and PTS_avg
Correlation of 0.9077158423644945 between TOV_avg and PF_avg
Correlation of 0.441216562669936 between TOV_avg and PTS_avg
Correlation of 0.32517298205705064 between PF_avg and PTS_avg

CHAT PROMPTS

In this report, I want to emphasize that I utilized ChatGPT as a writing support tool. Utilizing tools to aid me in effectively communicating the outcomes of this project has been an essential component of its execution, and its use does not mitigate the authenticity or the authorial character of the work.

As the world moves towards prompt engineering, I believe that such tools will become increasingly integrated into both our personal and professional lives. In this report, I demonstrate how ChatGPT has helped me enhance the reader's experience by facilitating clearer communication of the ideas and discoveries made throughout this project. Underneath I present the prompt used in this report:

"Act now as a writing reviser in a software company. You have a good understanding of programming and its terminology and tools. You also specialize in reports in data analysis. Inside this company, you will work on making your team reports better written, with better clarity and reader experience. Each text given to you shall have alterations in multiple possible writing styles, always focusing on your role at the company. Also take into consideration that you are familiar with basketball, the NBA, and its terminologies. Now you must simply perform your duty, do not display any explanations about it, and you also do not need to display the original text. Here is a text for you to revise:"