

OPTIMAL SQUARE PRICES FOR FOOTBALL POOLS

Joseph Richardson & Mohsin Md Abdul Karim *with* Dr. Joseph DeMaio



INTRODUCTION

Are you interested in learning how to play Football Squares? Traditionally, squares are randomly assigned, but what if players could choose their own squares? Which square would be the most desirable, and how much would it be worth? Join us, and we'll show you how probability can be used to play smarter.



Figure 1: Football Squares Board

Football Squares is a popular betting game tied to NFL or college football scores. In a typical game, participants buy squares on a 10x10 grid (Figure 1), each representing the ones digit of the final score for the home team and the ones digit for the away team. If the game's final score matches your square, you win.

Furthermore, in 1994, the NFL introduced the two-point conversion rule, allowing teams the option to attempt an additional two-point score after a touchdown. Could this rule have affected the value of the most desirable squares?

METHODS

DATA COLLECTION & PROCESSING

Historical NFL scores, from 1978 – 2023, were collected from footballdb.com. The scores data was processed into a grid of Football Square frequencies (Figure 2) using Python.

CALCULATING OPTIMAL SQUARE PRICE

To determine the optimal price for each square, the probability of each square's occurrence is first calculated, then multiplied by the board value of \$100. This results in the optimal square price, representing the expected worth of each square based on historical data. Figure 2 illustrates this calculation.

DISCUSSION

DIGIT DISTRIBUTION ANALYSIS

Figure 2 is a heat map showing the frequency of Football Squares, where the most golden squares represent the highest frequencies, while most squares display lower frequencies.

NFL SCORING METHODS

NFL scoring methods explains the patterns of golden squares. Table 1 summarizes NFL scoring methods. Seven is the most common point, which is scored by an offensive touchdown followed by an extra point. Extra points were attempted for about 95% of offensive touchdowns.

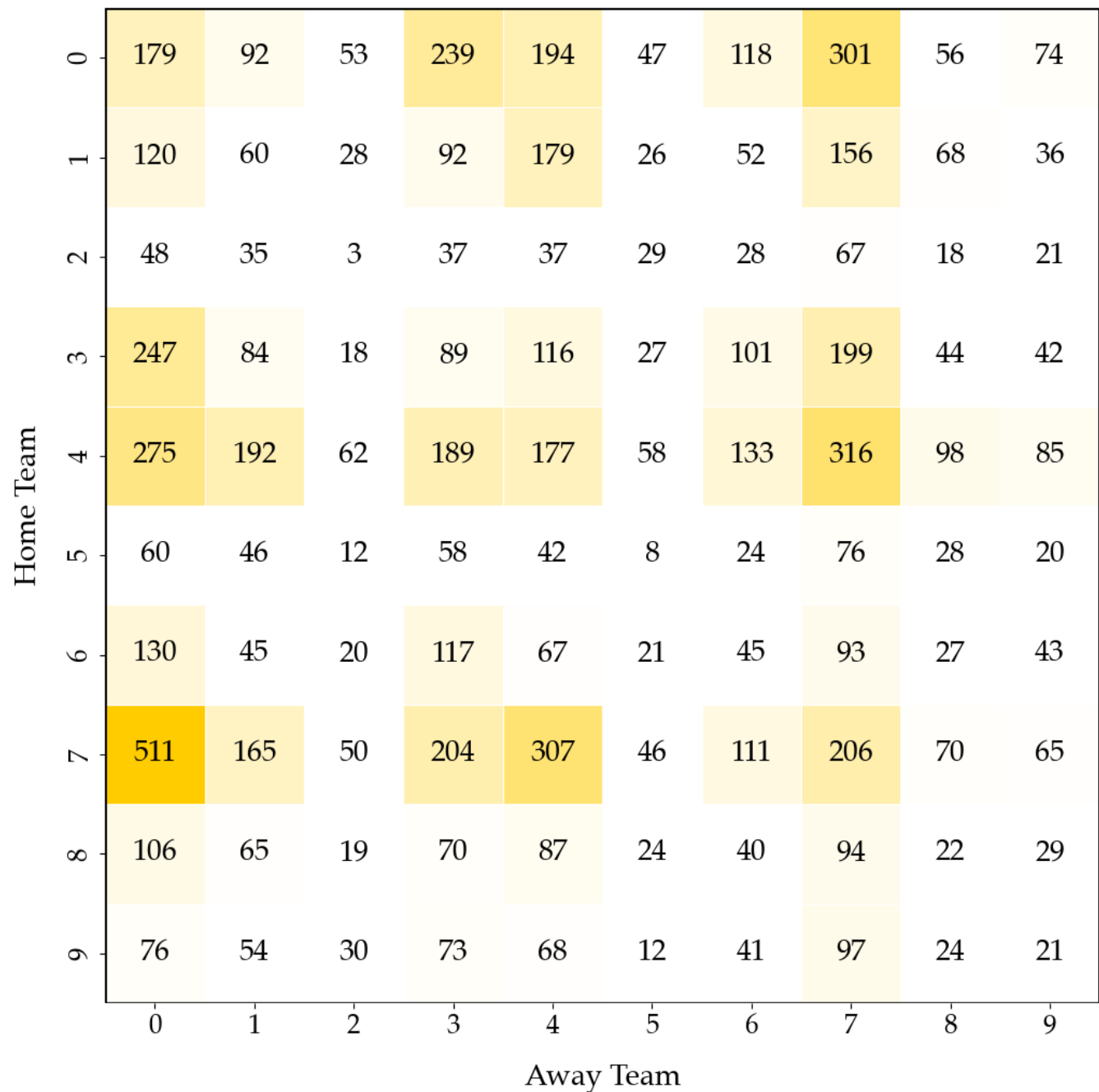


Figure 2: Win Frequencies for Football Squares, 1978 - 2023

HOME/AWAY BIAS ADJUSTMENT

Figure 4 reveals a symmetry in optimal square prices, though the away team numbers appear to vary from those of the home team, suggesting a potential home-and-away bias in scoring frequencies. This bias was corrected, as shown in Figure 5, to provide a balanced view of square values.

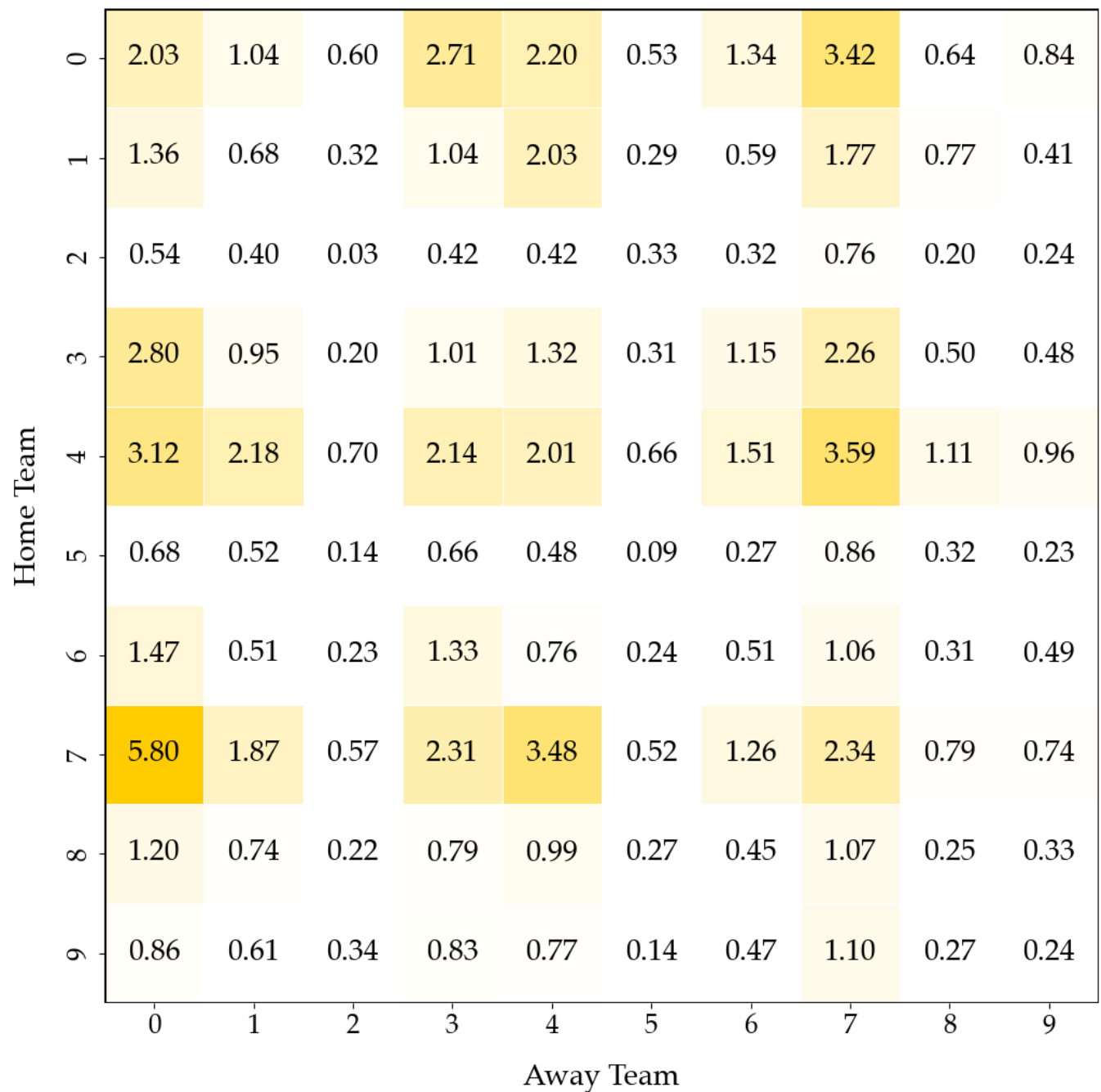


Figure 4: Optimal Square Prices, 1978 - 2023

Score Type	Points Scored	Percent of Total Plays
Safety	2	0.8%
Field Goal	3	38.5%
Touchdown Only	6	8.4%
Touchdown + Extra Point	7	50.8%
Touchdown + Two-Point Conversion	8	1.4%

Table 1: NFL Score Methods & Their Probabilities

FOOTBALL SQUARES DISTRIBUTION

Early multiples and combinations of NFL Points—such as 7, 10, 13, and 14—result in elevated frequencies for certain Football Squares digits. Figure 3 shows this digit distribution, with 7 as the most frequent, followed by 0, 4, and 3.

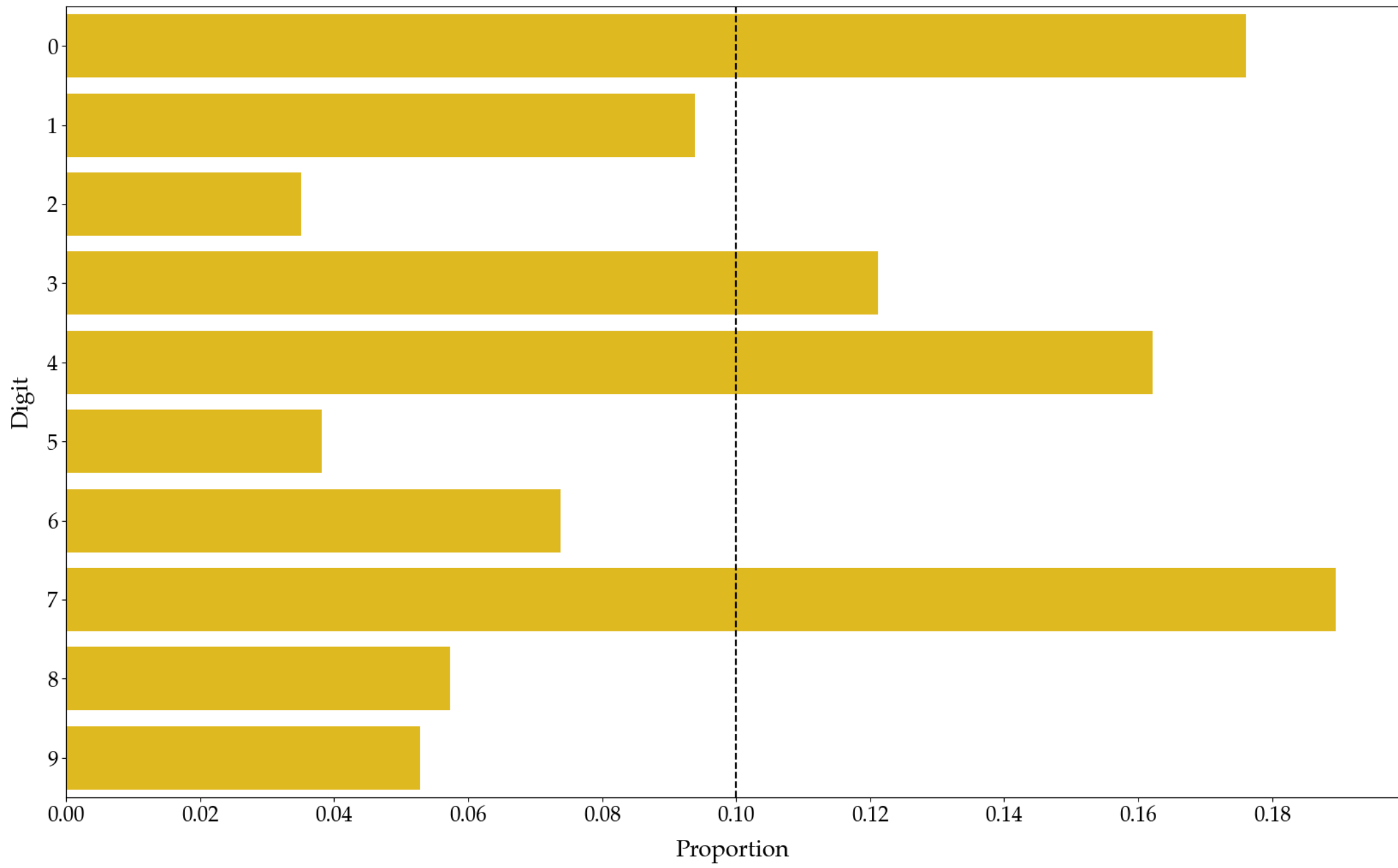


Figure 3: Football Squares Digit Distribution

IMPACT OF TWO-POINT CONVERSION

To examine the impact of the two-point conversion rule, refer to Figure 6, which shows the bias-adjusted differences in optimal square prices between the periods 1978-1993 and 1994-2009. While most values changed only by a few cents, some squares saw substantial shifts, with the highest showing a 79-cent difference.

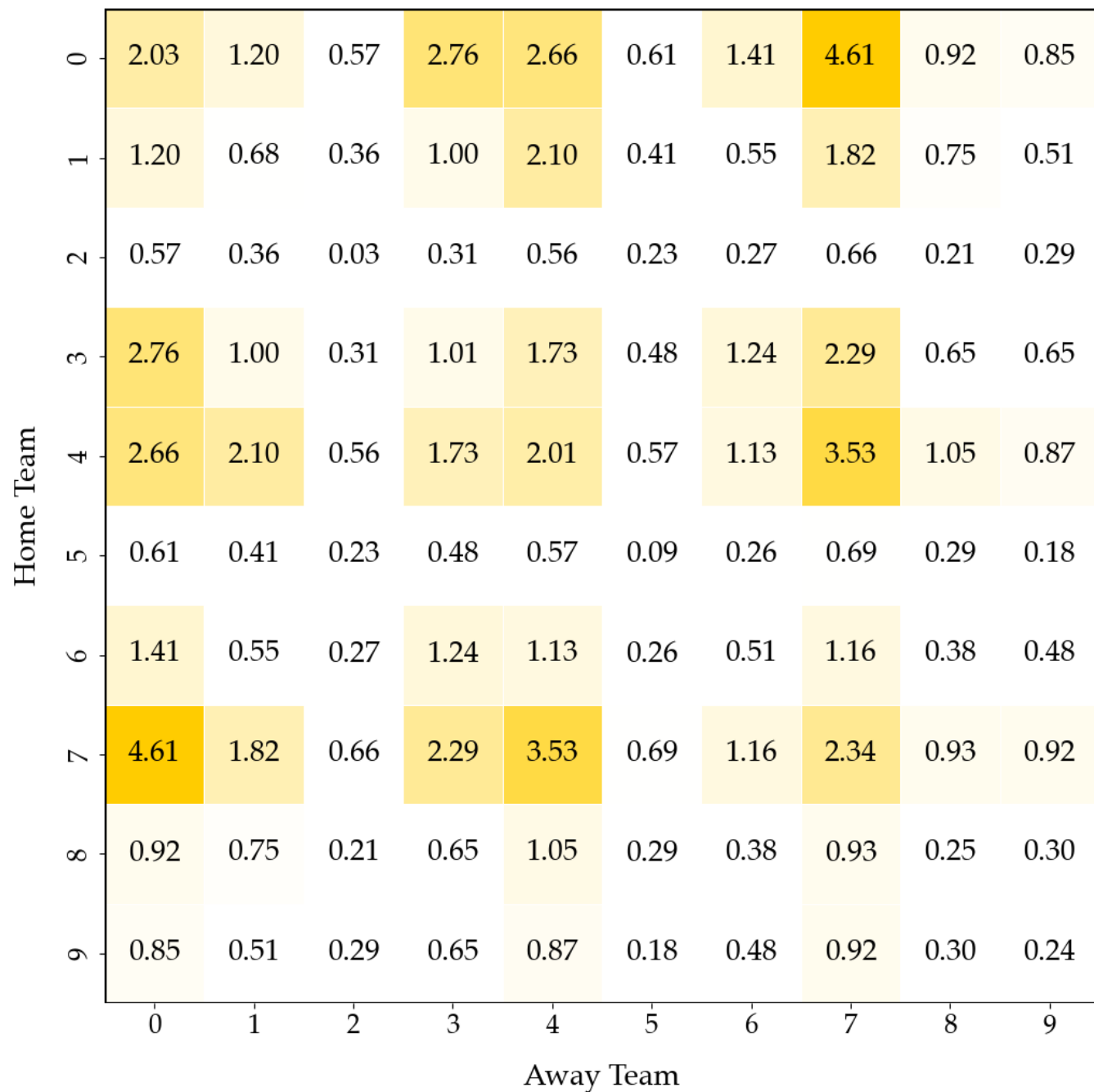


Figure 5: Bias-Adjusted Optimal Square Prices, 1978 - 2023

RESULTS

A *t*-test performed on the top 37 absolute differences in optimal square prices yielded a *p*-value of 0.042. This provides strong evidence that these differences were significantly different from zero, indicating that a substantial portion of the board experienced notable changes between the two periods.

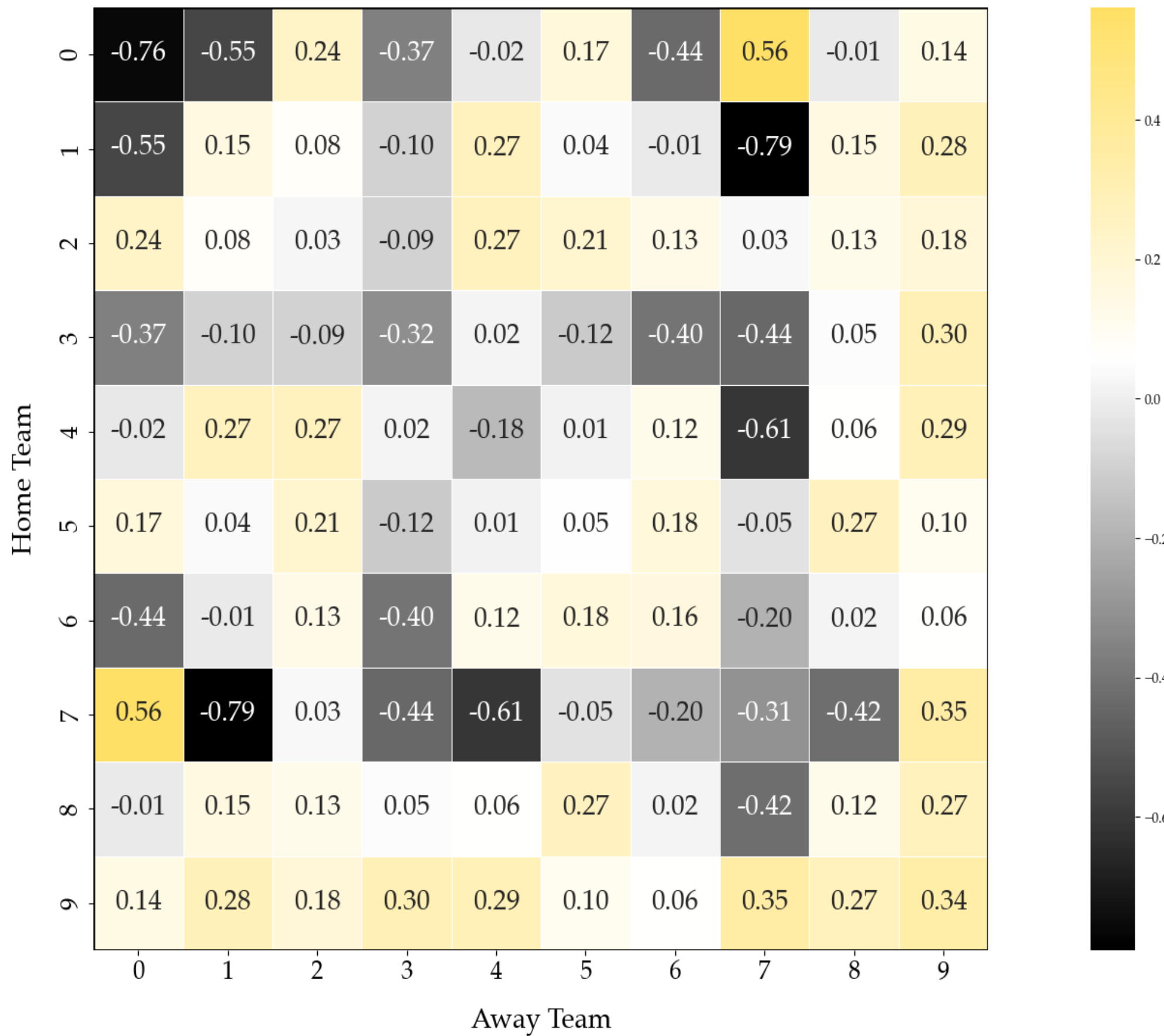


Figure 6: Bias-Adjusted Differences, Before vs After 1994

While most values in the bias-adjusted difference table (Figure 6) showed minimal change, focusing on the top 37 differences allowed for a clearer detection of the most substantial impacts of the two-point conversion rule.

CONCLUSIONS

This study examined differences in optimal square prices before and after the two-point conversion rule was introduced and found significant changes. Given that two-point conversions were attempted only 5% of the time with a 45% success rate, it's likely that other NFL rule changes and game factors also contributed to these patterns.

Future research could explore additional factors, such as weather conditions, dome presence, and game time, to determine their impact on scoring patterns and square prices. Analyzing scores by quarter or team-specific patterns, such as high fourth-quarter performance, may also offer further insights, especially for football squares based on quarterly scoring.

The QR code provides additional information on football squares and links to our references and GitHub repository.