If the Vegas line is always moving, what factors are held fixed?

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**ABSTRACT**

In this paper, the aspects that do not move the Vegas line, are examined using linear regression. 232 observations of college footballs games, from 2004 till 2007, are used to determine what Vegas chooses to disregard in their decision when making a dynamic line. The author has chosen to use a previously mined dataset to investigate what might be overlooked in the construction of the Vegas line. Three, uncorrelated factors, are the apparent stand of the inconsequential factors, not used in making this line move.

**1 INTRODUCTION**

According to Merriam-Webster, dynamic means to be marked by usually continuous and productive activity or change. The Vegas line is dynamic and adjusts according to wagers placed and updated player and team information. It is constantly impacted by changes that happen hourly in the world of sports. The emphasis that Vegas places on certain factors, is then reflected by the fluidity of the line. According to previous literature, by Witte (2016) and Mirabile (2016)1, Vegas uses a multi-factor approach in deciding on how to determine the true relationship between the margin of victory and the actual Vegas line. I will be using the estimation of that multi-factored approach and then negating those results, in order to determine those factor that have gotten overlooked. The object of this study was to forecast how Vegas determines their line and then whittle it down to which factors were then ignored.

Using various statistical indicators, from 2004 until 2007, the line for NCAA Football Bowl (FBS) will be determined. Variable selection processes will be used to find the set of regressors that make the best prediction in the line’s shift, as well as the complement of that set of regressors that will mark what is discounted in the movement of the Vegas line. 29 indicators are used while one response variable is used, the Vegas line. Ordinarily, using a 5% significance level is appropriate to determine being a valid model, but since the opposite is needed, a failure to reject the null hypothesis is needed. Three regressors were determined to not be statistically significant in the adjustment of the Vegas line. First, not being a conference member from either SEC, ACC, Big Ten, Big 12, or Pac-12, matters for line stability. Second, the teams must not be a rival of each other. Lastly, the favored team must possess no injuries. This suggests that the line does not move when all of these factors are in play, and it will be the same regardless of when one decides to bet on that game.

**2 DATA AND METHODOLOGY**

The dataset that was used was compiled by Dr. Mark David Witte and Dr. McDonald Paul Mirabile1, and used with permission. The home and away rating from Jeff Sagarin was also used in this dataset. He has devised a way to account for the team’s schedule difficulty and location and used that as a ranking, and then take in the individual skills of each player and classify those as predictors (which makes unbiased by using the Elo rating system). The Elo rating system was developed by Arpad Elo and he took the difference in ratings between two players, then that decided the outcome of the game. Points are then transferred from player to player in accordance to the game’s outcome. This system is self-correcting, and thus unbiased. The predictors and rankings are combined to form a rating system based on the teams either playing at home or away.

Many descriptive statistics were used in forecasting the Vegas line. There were 29 predictors in the full model. Akaike’s Information Criterion (AIC) and Bayesian Information Criterion (BIC) was then used to do a backwards selection of the best forecast of the Vegas line. This model selection was used multiple times in conjunction with the variance inflation factor to ensure there was no multicollinearity. Both criterions picked the same end model but best adjusted R2 was used to decided between them. The predictors that were left out of the initial selection process was also added in since those were the ones that did a poor job of predicting the movement of the line, which was what was needed.

Table: Descriptive Statistics

|  |  |  |  |
| --- | --- | --- | --- |
| Variable Name | Variable description | mean | Std Dev |
| line | Vegas line | 9.634199134 | 7.476147528 |
| etp | Estimated total points | 51.20779221 | 8.652475387 |
| fro1 | Favored rushing offense | 167.7665694 | 56.11390261 |
| fpo1 | Favored passing offense | 228.0517811 | 59.73622551 |
| fto1 | Favored total offense | 396.044032 | 63.40272768 |
| fso1 | Favored scoring offense | 29.53726519 | 7.566943138 |
| frd1 | Favored rushing offense | 133.8869726 | 42.74807975 |
| fped1 | Favored pass efficiency defense | 119.3015477 | 18.67959866 |
| ftd1 | Favored total defense | 347.1926294 | 67.89269907 |
| fsd1 | Favored scoring defense | 22.49543598 | 7.482748225 |
| fsched | Favored opponent’s winning percentage | 0.532153634 | 0.118489412 |
| uro1 | Underdog rushing offense | 144.0243921 | 51.46881055 |
| upo1 | Underdog passing offense | 211.0582049 | 54.86656342 |
| uto1 | Underdog total offense | 354.7805674 | 61.41161399 |
| uso1 | Underdog scoring offense | 24.23914443 | 6.953074058 |
| urd1 | Underdog rushing defense | 154.9033671 | 43.65709919 |
| uped1 | Underdog pass efficiency defense | 127.4525648 | 18.06079599 |
| utd1 | Underdog total defense | 373.9055699 | 64.79572458 |
| usd1 | Underdog scoring defense | 26.24521175 | 7.945179218 |
| usced | Underdog opponent’s winning percentage | 0.510413507 | 0.11724282 |
| frank | Favored rank | 7.831168831 | 11.12623527 |
| urank | Underdog rank | 3.961038961 | 9.449787058 |
| fnr | Favored not ranked | 0.532467532 | 0.500028232 |
| unr | Underdog not ranked | 0.813852814 | 0.390070623 |
| finj | Favored injuries | 4.489177489 | 2.812799119 |
| uinj | Underdog injuries | 4.372294372 | 2.895260508 |
| power5 | Member of power 5 conferences | 0.212121212 | 0.409697983 |
| AnyRivalry | Any rivalries between two teams | 0.155844156 | 0.363495173 |
| Home\_Rating | Jeff Sagarin home rating | 71.83099567 | 11.94332575 |
| Away\_Rating | Jeff Sagarin away rating | 71.93627706 | 11.77119391 |

Full model : Line=fro1+fpo1+fto1+tso1+frd1+fped1+ftd1+fsd1+fsched+uro1+upo1+uto1+uso1+urd1+uped1+utd1+usd1+usced+power5+AnyRivalry+frank+urank+fnr+unr+Home\_Rating+Away\_Rating+etp+finj+uinj

First the best prediction for the Vegas line needed to be forecasted, so the full model was used. Backwards selection using AIC and BIC was used to find the best variables for model selection. A summary of then used between the two to see which one had a better adjusted R2.

Below, are the results from using AIC backwards selection:

Step: AIC=697.28

line ~ fso1 + frd1 + fsd1 + fsched + uto1 + uso1 + urd1 + usd1 +

usced + frank + urank + fnr + unr + Home\_Rating + Away\_Rating +

etp

Df Sum of Sq RSS AIC

<none> 4079.6 697.28

- urd1 1 63.64 4143.3 698.86

- fsched 1 74.98 4154.6 699.49

- fsd1 1 94.31 4173.9 700.56

- etp 1 122.20 4201.8 702.10

- frank 1 122.57 4202.2 702.12

- fso1 1 135.98 4215.6 702.85

- uto1 1 142.02 4221.6 703.18

- urank 1 161.07 4240.7 704.22

- usd1 1 170.82 4250.4 704.75

- frd1 1 188.30 4267.9 705.70

- uso1 1 207.03 4286.6 706.71

- unr 1 279.22 4358.8 710.57

- usced 1 285.22 4364.8 710.89

- Home\_Rating 1 383.03 4462.6 716.01

- fnr 1 423.75 4503.4 718.11

- Away\_Rating 1 481.60 4561.2 721.06

Below, is the result from using BIC backwards selection:

Step: AIC=749.96

line ~ fso1 + frd1 + uto1 + uso1 + usd1 + usced + frank + urank +

fnr + unr + Home\_Rating + Away\_Rating

Df Sum of Sq RSS AIC

<none> 4370.9 749.96

- uto1 1 109.05 4479.9 750.21

- frank 1 180.65 4551.5 753.87

- uso1 1 184.32 4555.2 754.06

- urank 1 187.25 4558.1 754.21

- usced 1 294.05 4664.9 759.56

- frd1 1 306.72 4677.6 760.19

- unr 1 337.59 4708.5 761.71

- Away\_Rating 1 518.24 4889.1 770.40

- fnr 1 603.00 4973.9 774.37

- Home\_Rating 1 625.90 4996.8 775.43

- fso1 1 673.43 5044.3 777.62

- usd1 1 880.14 5251.0 786.90

**3 RESULTS AND DISCUSSION**

After deciding the best models from the two Information Criterions, their descriptive statistics were then examined.

Results from backwards selection using AIC:

lm(formula = **line ~ urd1 + fsched + fsd1 + etp + frank + fso1 +**

**uto1 + urank + usd1 + frd1 + uso1 + unr + usced + Home\_Rating +**

**fnr + Away\_Rating**, data = ncaaf)

Residuals:

Min 1Q Median 3Q Max

-10.8464 -2.5981 -0.1613 2.8572 14.2336

Coefficients:

**Estimate Std. Error t value Pr(>|t|)**

(Intercept) 11.074231 5.970049 1.855 0.064977 .

urd1 0.018328 0.010031 1.827 **0.069083** .

fsched 6.191479 3.121999 1.983 0.048626 \*

fsd1 -0.175779 0.079031 -2.224 0.027181 \*

etp 0.199526 0.078807 2.532 0.012065 \*

frank -0.118088 0.046572 -2.536 0.011939 \*

fso1 0.190763 0.071426 2.671 0.008149 \*\*

uto1 -0.025673 0.009406 -2.729 0.006873 \*\*

urank 0.199889 0.068769 2.907 0.004037 \*\*

usd1 0.214073 0.071515 2.993 0.003083 \*\*

frd1 -0.033057 0.010518 -3.143 0.001910 \*\*

uso1 -0.308263 0.093542 -3.295 0.001150 \*\*

unr 6.930608 1.810925 3.827 0.000170 \*\*\*

usced -10.863795 2.808620 -3.868 0.000146 \*\*\*

Home\_Rating 0.195647 0.043648 4.482 1.20e-05 \*\*\*

fnr -6.548678 1.388999 -4.715 4.36e-06 \*\*\*

Away\_Rating -0.203135 0.040415 -5.026 1.06e-06 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

**Residual standard error: 4.366 on 214 degrees of freedom**

(6 observations deleted due to missingness)

Multiple R-squared: 0.6827, **Adjusted R-squared: 0.6589**

F-statistic: 28.77 on 16 and 214 DF, p-value: < 2.2e-16

The only variable that is statistically insignificant is fsched and the adjusted R2 for this model is 65.89%. I then compared this to the summary from the model selection using BIC, which is below:

lm(formula = **line ~ uto1 + frank + uso1 + urank + usced + frd1 +**

**unr + Away\_Rating + fnr + Home\_Rating + fso1 + usd1**, data = ncaaf)

Residuals:

Min 1Q Median 3Q Max

-12.5622 -2.7814 -0.2685 2.6450 14.9647

Coefficients:

**Estimate Std. Error t value Pr(>|t|)**

(Intercept) 13.049444 5.840453 2.234 0.026477 \*

uto1 -0.022126 0.009488 -2.332 0.020607 \*

frank -0.139645 0.046523 -3.002 0.002998 \*\*

uso1 -0.272290 0.089806 -3.032 0.002724 \*\*

urank 0.214003 0.070028 3.056 0.002523 \*\*

usced -11.021457 2.877975 -3.830 0.000168 \*\*\*

frd1 -0.034460 0.008811 -3.911 0.000123 \*\*\*

unr 7.556512 1.841545 4.103 5.75e-05 \*\*\*

Away\_Rating -0.193766 0.038113 -5.084 7.95e-07 \*\*\*

fnr -7.438328 1.356359 -5.484 1.15e-07 \*\*\*

Home\_Rating 0.223351 0.039975 5.587 6.84e-08 \*\*\*

fso1 0.266841 0.046043 5.795 2.37e-08 \*\*\*

usd1 0.356038 0.053738 6.625 2.67e-10 \*\*\*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

**Residual standard error: 4.478 on 218 degrees of freedom**

(6 observations deleted due to missingness)

Multiple R-squared: 0.66, **Adjusted R-squared: 0.6413**

F-statistic: 35.26 on 12 and 218 DF, p-value: < 2.2e-16

Between the two the AIC model produced a better adjusted R2 so that was the model that was chosen. Then all of the significant predictors were discarded and the ones that didn’t make the original cut for the model were then added back in. Summaries were then running multiple times, with each predictor that was useful being thrown out, until no predictors were useful. The subsequent steps are below:

lm(formula = **line ~ fped1 + utd1 + power5 + AnyRivalry + finj +**

**uinj**, data = ncaaf)

Residuals:

Min 1Q Median 3Q Max

-12.709 -4.933 -1.372 3.535 27.034

Coefficients:

**Estimate Std. Error t value Pr(>|t|)**

(Intercept) 7.12969 4.24944 1.678 0.094782 .

fped1 -0.08744 0.02672 -3.272 0.001235 \*\*

utd1 0.02960 0.00784 3.776 0.000205 \*\*\*

power5 0.85598 1.30931 0.654 **0.513931**

AnyRivalry 0.59686 1.30348 0.458 **0.647469**

finj -0.03552 0.18154 -0.196 **0.845034**

uinj 0.40087 0.16414 2.442 0.015367 \*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

**Residual standard error: 7.159 on 224 degrees of freedom**

(6 observations deleted due to missingness)

Multiple R-squared: 0.1069, **Adjusted R-squared: 0.08293**

F-statistic: 4.467 on 6 and 224 DF, p-value: 0.0002715

Again,

lm(formula = **line ~ power5 + AnyRivalry + finj**, data = ncaaf)

Residuals:

Min 1Q Median 3Q Max

-9.379 -6.071 -2.440 3.968 26.121

Coefficients:

**Estimate Std. Error t value Pr(>|t|)**

(Intercept) 9.74665 0.96329 10.118 <2e-16 \*\*\*

power5 0.70057 1.30488 0.537 **0.592**

AnyRivalry 0.08917 1.36477 0.065 **0.948**

finj -0.06125 0.19010 -0.322  **0.748**

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

**Residual standard error: 7.52 on 227 degrees of freedom**

(6 observations deleted due to missingness)

Multiple R-squared: 0.001362, **Adjusted R-squared: -0.01184**

F-statistic: 0.1032 on 3 and 227 DF, p-value: 0.9581

This was the final model of the predictors that do adjust the Vegas line.

Line = power5 + AnyRivalry + finj

Lastly, the variance inflation factor was calculated for the final model.

power5 AnyRivalry finj

1.162334 1.000867 1.162852

There is no multicollinearity as the numbers are all pretty low, and well below the acceptable cutoff of 5.

Since power5, any rivalry, and favored team injuries, were the most significant in not affecting the movement of the Vegas line, their mean and standard deviation were examined. The mean of all teams in the dataset having any rivalry was 0.156 and the standard deviation was 0.363. This suggests that most teams of the dataset, doesn’t have a rivalry against each other. The favored team having an injury has a mean of 4.489, with a standard deviation of 2.813. This suggests that the teams have an average of 5 people being injured during the season, as half a person cannot be injured. Being a power 5 conference member has a mean of 0.212 and a standard deviation of 0.41. This shows that less than a quarter of the teams are not a member of the top 5 conferences.

**4 CONCLUSIONS**

The purpose of this investigation was to determine what Vegas does factor in, when they are determining their line, for each college football game. Since the lines are not static and they shift according to new information, what doesn’t cause it to adjust was important. My results show that though Vegas does take into account a lot of different criteria for its line (according to Witte and Mirabile) there are aspects that they don’t give much thought. These are those teams that are not a member of the top 5 dominant (currently) conferences (SEC, ACC, PAC-12, Big Ten, and Big-12). The team that is favored to win, doesn’t have any injuries. Neither the team that is favored, nor the underdog, are rivals of each other. If one looks at a game with these 3 factors, as soon as the line is made, it has a better chance of being more static, when it is again looked at on the day of the game. Essentially these are the games that should be bet upon, and one can wait until the last minute to bet, and the line will be similar to when it was first created.

As for future work, a more current and thus relevant dataset would be ideal. More observations are needed, since 232 is not a lot. A more in depth look at why these factors are not taken into account, is also needed. More years should also be incorporated. Then a comparison between the teams that play against the same teams, each year, can be formed.