CHANGING WITH THE RULES: COMPETITIVE BALANCE IN THE NFL

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Abstract

This article examines the impact of on-the-field rule changes on competitive balance in the NFL. This is done using the Herfindahl-Hirschman Index and other team statistics from 1970 through the 2016 regular season of the National Football League. Using a Two-Stage-Least-Squares regression this study's results do not support that on-the-field rule changes may impact competitive balance. This study's findings are companionless with respect to related literature.
KEYWORDS: (Competitive Balance, National Football League, Rule Changes, Herfindahl-Hirschman Index)
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Introduction

Competition can be a lifeline in business and a key descriptor for many markets. A big firm can capitalize on an unfair advantage to outperform the competitive landscape. An extreme example would be a monopoly, where there is no competition. Although competitive balance is a popular focus in economics it goes far beyond stereotypical business scenarios. Competitive balance within the world of sports provides several interesting talking points.

The National Football League (NFL) has received particular attention for being a very competitively balanced league. Quirk and Fort (1992) and Lee (2009) all point out the importance of parity in the NFL's revenues, concluding that parity is strongly correlated to attendance. That being said, most research in this area has focused on changes in the league's structure, for example the introduction of free agency and salary cap (Larsen, 2006). This leaves "on-the-field (OTF) rules" an undeveloped avenue for research. Even beyond the NFL there is little literature that looks at the effect of OTF rule changes, or changes that directly impact the flow of an individual game as opposed to overriding changes in the structure of the league. Leagues have committees who work tirelessly to make these decisions and these rules have major impacts on the way the game is played and perceived. I am questioning whether or not OTF rule changes affect competitive balance.

This paper looks into the unstudied area of OTF rule changes with respect to competitive balance in the NFL. I use a combination of the 1974 rule changes directed at action and tempo and the introduction of instant replay as the key variable. These rules were designed to open up more opportunities for the offense, making the game more

exciting for the fans, and allow for more careful officiating, leaving less of the game up to chance.

The rest of the paper will go as follows: a brief literature review covering the studies that shaped this paper, a section covering the theory of competitive balance, a look at the methodology and data for this study, and finally a review of the results.

Literature Review

Measuring competitive balance in professional sports is a common focus in recent literature. Previous research stems from Rottenberg's paper (1956) which introduces the Uncertainty of Outcome Hypothesis (UOH). UOH effectively sums up competitive balance as the idea that when two parties go into a situation, both parties have a fair chance at being victorious.

Before introducing the literature that helped inspire my study, I will try to contextualize the complexities of competitive balance as an economic tool. Part of why the literature regarding competitive balance in sports is so extensive is because of the many ways in which it can be measured. In Van Scyoc's paper (2015) on competitive balance he introduces both the "series" and "record" tests as ways of measuring competitive balance. He argues that in order to capture competitive balance most accurately both should be used simultaneously. Because of the NFL's schedule, the series test is not an option for this study. The record test on the other hand is a slight variation of the conventional way of measuring competitive balance by looking at teams' win/loss records and therefore better represents this study's methodology. Scyoc warns about misidentifying nontransitive imbalanced matchups for competitive balance. Lee (2009) warns that though many studies look at intraseasonal measures, it is important to note that not all intraseasonal measures are perfect. Lee points out that even if dispersion of winning percentage is the same between seasons, team rankings may not be the same, which will impact how competitive a league is. Despite being a controversial topic with regard to methodology, its significance in the field is indisputable.

Competitive balance is a tool used by the NFL to maintain popularity and avoid

collapse. Humphrey's paper (2002) reminds us that a lack of competitive balance may have contributed to the downfall of the All American Football Conference. That being said, there is little literature that supports the effects of OTF rule changes on competitive balance. In fact, many argue that rule changes are simply used to make the game more exciting with no consideration for, or intended impact on, competitive balance (Fort, 2007).

Previous literature has labeled sports leagues as good examples of business cartels; some go as far as to call them "textbook examples" (Fort and Quirk, 1995). In a business cartel a small number of firms, or franchises, work together in an oligopoly in order to limit competition and have more control over prices. Because the goal of the NFL is to maximize profits, as it is in any other league (Uyar, 2012), the NFL works in a similar manner. Over the lifetime of the NFL, rule changes have been made to enhance the game, at least for its fans. Fort (2007) identifies many rule changes enacted to increase offensive excitement, which favors the consumer demand. Fort argues these rules should influence competitive balance, but there is little literature to support this claim. Because the mission of the NFL is to please its fans, it is unlikely the League would pass a rule change that makes the game less exciting. This begs the question as to whether or not the rule changes made to increase consumer demand affect competitive balance. Although logic would say they do, there is no research to confirm this and thus we must dive into the literature revolving more closely around my research question.

Due to the lack of literature directly looking at OTF rule changes with respect to competitive balance in the NFL, a broader scope is used when analyzing similar studies. Kent (2013) studies the effects of rule changes on competitive balance in European

professional soccer leagues. Using goal differential as the dependent variable to analyze three different rule changes, Kent determines that all three variables do hold significance. Interestingly, Kent does not find that all rule changes improve competitive balance. Like Fort, Kent discusses how many of these changes seem to be made with a focus on the excitement of the consumer. Lee's paper (2009) studies competitive balance within the NFL with a focus on structural changes. Lee looks specifically at the 1993 Collective Bargaining Agreement and finds significant impact on competitive balance. Although the focus of Lee's paper is not OTF rule changes, Lee does argue that structural changes can be significant. Nevertheless, both of these articles helped to inspire my undertaking in analyzing OTF rule changes.

Acting as a continuation to Larsen's paper (2006), my study looks further into competitive balance in the NFL by modifying Larsen's methodology to analyze what effect, if any, OTF rule changes have on competitive balance. This study mimics Larsen's use of a deviation from the Herfindahl-Hirschman Index (HHI), dHHI, as a measure of competitive balance. DHHI is an alteration of the HHI and is explained in more depth in Larsen's paper. Mizak (2004) points out that all measures of competitive balance are subject to criticism, especially from Utt and Fort (2002), who warn readers about overstated competitive balance among other issues. Despite such dispute, Larsen (2006) and Depken (1999) find that the dHHI model performs better than standard deviation of winning percentages, and that is why this model is included in my study.

My study is most similar to Larsen's (2006), changing the focus from salary cap and free agency to a new variable based on OTF rule changes. I study what effect OTF rule changes designed to increase excitement have on competitive balance. This study

will be joining the few other pieces of literature that support OTF rule changes' effect on competitive balance. The focus is made relevant by the ever-changing rule book of the NFL, more specifically last year's rule change with regard to the distance of the extra-point attempt from the goal line. The study seeks to shed light on the impact such a rule change might have.

Theory

The AFL and NFL agreed to merge in 1966 and finalized the merger in 1970. The NFL has changed season by season, due to structural league changes and OTF rule changes. This section takes a more in-depth look at competitive balance before exploring OTF rule changes as a key variable. The rest of this section goes as follows: a quick overview of Larsen and Depken's use of dHHI, an introduction to the model and finally, variable definitions followed by an in-depth look at key variables.

dHHI for Competitive Balance

It is important to outline Larsen's (2006) methodology involving dHHI. Larsen closely follows Depken's (1999) paper just as this paper follows Larsen's. The HHI index is a common measure of market concentration. It is defined as:

$$\mathrm{HHI} = \sum_{i=1}^{N} \mathrm{MS}_i^2, \tag{1}$$

In this equation MS represents market share and N stands for the number of firms. In the NFL, market share is a team's win percentage by season. Thus Larsen's NFL centered definition of HHI is the following:

$$\mathrm{HHI} = \sum_{i=1}^{N} \left[\frac{2\mathrm{Wins}_i}{NG} \right]^2, \tag{2}$$

In this equation market share is replaced with two times the number of wins (2Wins) over the number of teams (N) by the number of games played by each team (G), all squared. According to Larsen, perfect parity in this equation is 1/N. In Depken's study on Major

League Baseball he is clear to point out the effect that expansion of a league can have on HHI. Larsen relays that HHI decreases as N increases, thus a control must be introduced. In order to account for this, dHHI becomes:

$$dHHI = HHI - \frac{1}{N}. \quad (3)$$

representing HHI's deviation from parity (Larsen, 2006).

Regression Model

The dependent variable used to measure competitive balance is dHHI. DHHI measures HHIs deviation from the ideal concentration of wins. The data used in this study spans from 1970 through the 2016 season, looking only at regular season play. Data for this study comes from RodsSportsBusinessData.com along with NFL.com for team stats and important dates. This study also uses Sportsattic.com for data regarding rule changes and dates. The following is the model used in this study:

dHHI = f(RULE, EXPAN, STRIKE73, STRIKE82, STRIKE87, PLAYERTALENT, SCHEDULE, PLAYOFF, RELOCATE, NEWSTAD)

Variables

Table 1: Variable Definitions

Variable	Definition	M	SD
dHHI	Deviation from ideal concentration of wins	00.008	00.003
RULE	(1974 action/tempo rule changes) + (introduction of instant replay)	01.298	00.623
EXPAN	Dummy Variable (1=expansion year)	00.064	00.247
STRIKE73	Dummy Variable (1=1973)	00.021	00.146
STRIKE82	Dummy Variable (1=1982)	00.021	00.146
STRIKE87	Dummy Variable (1=1987)	00.021	00.146
PLAYERTALENT (HHIPF & HHIPA)	Concentration of points scored for and points scored against.	00.071	00.006
SCHEDULE	Dummy Variable (1=1970-1977)	00.170	00.380
PLAYOFF	Change in number of playoff spots	10.723	01.638
RELOCATE	Change in team location in 5-year blocks	00.872	01.135
NEWSTAD	Reconstruction or new stadiums in 5-year blocks	04.447	03.406

RULE is a dummy variable created to represent OTF rule changes since 1970. It is a combination of the 1974 "sweeping" rule changes made to increase offensive excitement in the game and the introduction of instant replay, "The NFL's rules have continued to evolve since football's earliest days — always changing to protect the league's integrity and make the game fairer, safer and more entertaining," (operations.nfl.com/the-rules, 2016). Whether rules change to protect the league's integrity or to protect TV ratings, there is no literature testing their effect on competitive balance in the NFL. For that reason, RULE is this study's main focus. Appendix A goes into greater detail on the RULE variable and its origin. This paper hopes to broaden our

understanding of competitive balance by looking into the effect of such changes. The rest of this section breaks down other key variables.

FASAL is a dummy variable assigned to represent the introduction of Free agency and salary cap in 1993, the focus of Larsen's paper (2006). These variables hold values of 0 before their introduction date and values of 1 post-implementation. Free agency and salary cap affect a team's ability to acquire and retain talent, thus they should affect competitive balance.

Player talent is a more complex variable. We use Larsen's method of representing player talent through a combination of points scored and points allowed. These are represented by variables HHIPF and HHIPA. In Larsen's paper:

$$\text{PLAYER TALENT}_t = \text{HHIPF}_t + \text{HHIPA}_t. \quad (4)$$

HHIPF_t is defined as

$$\text{HHIPF}_t = \sum_{i=1}^{N}\left[\frac{\text{Points Scored}_i}{\text{Total Points Scored in the League}}\right]^2, \quad (5)$$

$$\text{HHIPA}_t = \sum_{i=1}^{N}\left[\frac{\text{Points Scored Against}_i}{\text{Total Points Scored in the League}}\right]^2, \quad (6)$$

Combining HHIPF and HHIPA identifies player talent and allows it to be controlled within the model. This allows my study to concentrate on rule changes.

NEWSTAD represents new stadium construction. This variable's effect on competitive balance is controlled by separating time spans from the data into five-year blocks. Each individual block sums up any new stadiums constructed within its five

years. New stadiums generate excitement for fans, leading to higher attendance rates. For this reason I expect to find this variable to have a significant impact on competitive balance.

PLAYOFF accounts for the changes in the number of playoff spots available. This number has changed thrice during the time period being analyzed. Because the number of playoff spots has increased each time (8, 10 and now 12), teams are statistically more likely to make the playoffs. When teams' playoff hopes dissolve their strategies change. For example, teams may start different players with the following year in mind, knowing the current season is a bust. This impacts the talent of the starting lineup, thus the number of playoff spots available should increase competitive balance as more teams have elongated seasons.

STRIKE73, STRIKE82 and STRIKE87 are all dummy variables, holding a value of one for the year of the strike they represent and a value of zero for all other years. Three major strikes have occurred in the NFL since 1970. Larsen (2006) finds significance in all three variables with mixed signs. He states that because of the unique nature of different strikes it is hard to estimate what effect they will have. Nonetheless, strike years are expected to be significant.

EXPAN, SCHEDULE and RELOCATE are three more variables of importance. Although Larsen did not find these variables significant, they should not be omitted from the model. Logically, expansion affects competitive balance because it should force the dispersion of talent. Larsen disagrees, pointing out that the NFL is structured in a way that protects the ability of established teams to hold onto their best players. This makes it hard for new teams to build competitive lineups. Scheduling is worth controlling because

unlike other leagues, NFL teams only meet a handful of the thirty-two total teams over the course of a season. Finally, relocation is controlled for the same reasons that new stadiums may impact competitive balance.

Estimation and Results

An instrumental-variables approach is used to estimate this model. As mentioned in Larsen's paper, the introduction of free agency and salary cap to the NFL may influence the concentration of player talent across teams. Larsen explains that these regulations will disallow for teams to "hoard the best players in the league," (Larsen, 2006). A more equal distribution of player talent should lead to a more equal distribution of wins in the league. The instrumental-variables approach is used to account for the potential endogeneity between player talent and the error term. I mimic Larsen's methodology in using the number of free agents who change teams in a given year as an instrument for PLAYERTALENT. Data for this instrumental variable came from http://www.foxsports.com/nfl/transactions, complete with all but three seasons since the introduction of free agency in 1993.

In order to directly compare this study to Larsen's paper, I analyze results that come from the most similar model possible. This study has a longer span of data and the introduction of a new variable, thus a direct comparison is worth investigating. The results of this regression are shown in Table 2.

Table 2

2SLS Dependent Variable (dHHI)	
Explanatory Variable	Coefficient/T-stat
RULE	0.0017/(2.02)*
FASAL	-0.006/(-7.099)*
PLAYERTALENT	0.054/(2.477)*
EXPAN	-4.00E-05/(-0.049)
RELOCATE	0.0004/(1.121)
STRIKE73	0.0010/(1.630)
STRIKE82	0.0014/(5.359)*
STRIKE87	-0.0013/(-3.814)*
SCHEDULE	0.0040/(3.837)*
NEWSTAD	1.45E-05/(0.185)
PLAYOFF	0.0003/(1.667)
Durban-Watson stat	2.31
R2	.89

*Significant at the 5% level. Standard Errors adjusted for Heteroscedasticity

Unfortunately, the previous regression had a Jarqu-Bera (JB) stat of 13.76 which is greater than the critical value of 5.99. This means that there is an issue with the normality of the distribution of errors in this model. In order to fix this I transform dHHI. By logging the dependent variable, the equation gains normality with a JB of 1.23, which is below the critical value. When interpreting the results of a regression with a logged dependent variable the coefficients represent a percent change as opposed to a unit change. The final regression has a R squared of .81. A Durban-Watson statistic of 2.12 is greater than the critical value of 2. This means that serial correlation is not a concern. This should all be considered when interpreting the results of the final regression, which is shown in Table 3 below.

Table 3

2SLS Dependent Variable (logdHHI)	
Explanatory Variable	Coefficient/T-stat
RULE	0.0192/(0.164)
FASAL	-1.401/(-8.149)*
PLAYERTALENT	-69.3571 /(-18.538)*
EXPAN	-0.1466/(-0.747)
RELOCATE	0.0759/(1.719)
STRIKE73	0.1601/(1.630)
STRIKE82	0.2530 /(5.736)*
STRIKE87	-0.2310/(-4.449)*
SCHEDULE	0.6792/(4.062)*
NEWSTAD	0.0159/(0.900)
PLAYOFF	0.0318/(1.084)
Durban-Watson stat	2.12
R2	.81

*Significant at the 5% level. Standard Errors adjusted for Heteroscedasticity

The variable RULE is not significant. This implies that OTF rule changes do not affect competitive balance in the NFL. Because RULE is only composed of two rule types, action/tempo and the introduction of instant replay, I can't jump to the conclusion that no OTF rule changes affect competitive balance. In fact, in generating the final rule variable, certain iterations in different regressions found RULE to be significant. More discussion on this variable, its origin and its variations can be found in Appendix A.

These results do coincide with Larsen's findings for the variable FASAL. FASAL is negative and significant at the 5% significance level. This implies that competitive balance increases with the introduction of free agency and a salary cap. This makes sense as both of these changes forced a more level dispersion of star players across the league.

PLAYERTALENT was positive and significant at the 5% significance level before transforming the dependent variable. After logging dHHI PLAYERTALENT is

even more significant, but is now negative. This means that as player talent is more concentrated, the league becomes more competitively balanced. I predicted that if a team hogs a high concentration of the most talented players, they will most likely win more games due to such an unfair talent advantage, thus hurting competitive balance. This result contradicts my prediction and Larsen's (2006) findings.

STRIKE73 is insignificant, STRIKE82 is positive and significant and STRIKE87 is negative and significant, both 82 and 87 at the 5% significance level. This helps to confirm that, as Larsen pointed out, different strikes have different effects. Further research might study the impact of strikes across different leagues.

SCHEDULE is the last significant variable. It is positive and significant at the 5% significance level. This means that the increase in the number of games per season in 1978 has decreased competitive balance.

EXPAN, RELOCATE, NEWSTAD and PLAYOFF are all insignificant, meaning that the addition of teams to the league, the relocation of existing teams, the construction of new stadiums and the increase in the number of playoff spots do not have a significant effect on competitive balance. This is inconsistent with Larsen's (2006) findings, in which the construction of new stadiums and the increase in playoff spots are found to decrease competitive balance.

These results are far from identical to Larsen's, the most surprising difference being that PLAYERTALENT is negatively significant. There are two overriding concerns surrounding this model. The first is a small sample size of 47 observations. This could be solved by using a different dependent variable, for example one that values every game as an observation rather than breaking the data down by season. There is

plenty of literature debating the use of intraseasonal versus interseasonal measures of competitive balance, or both, as seen in Eckard's (1998) paper on competitive balance in college football. The second issue surrounding this model is the large number of dummy variables. It is rule of thumb in econometrics to always have one less dummy variable than you do categorical. Further research should correct for this.

Conclusion

This study examines the impact of rule changes on competitive balance in the NFL using purposeful increases in action and tempo in 1974 and the introduction of instant replay in 1999 as the investigated rule changes. This study is based on the methodology of Larsen (2006), using dHHI as a measure for competitive balance from 1970 through 2016.

I find evidence that these rule changes do not impact competitive balance in the NFL. This study does confirm some findings from Larsen's paper, most importantly that the introduction of free agency and a salary cap increase competitive balance. The lack of similarity between my findings and those of Larsen is concerning. I hope this paper is a starting point for further investigation of the impact of OTF rule changes on competitive balance, both in the NFL and in other leagues.

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Appendix A

The RULE variable

Determining the specifications of the variable "RULE" was a challenging process. First I identified rule changes since 1970. This data came from sportsattic.com. I weeded out non-OTF rule changes and then divided the remaining rule changes into 9 original sections based on the effects the rule changes would have (Uniform, Scoring, Field/logistic regulation, Instant replay, Action tempo, Timing, Player safety and Player behavior).

I put these 9 sections into 5 groups based on similarities. These 5 groups were then grouped into 3 overriding categories, action/tempo, player safety and instant replay, as seen below:

Table A1

Category	Rule Title	Rule Description	Year
Action/ Tempo	RULETEMPO	Sweeping rule changes were adopted to add action and tempo to the games. (Ex: overtime added, kickoffs moved, goal posts moved, restrictions on blocking, cutting and return possibilities were added etc.)	1974
	RULESCORING	Introduction of the 2pt conversion	1994
	RULEQBCOM	QBs can receive communication from the bench	1995
Safety	RULEPLAYERSAFETY	4 rule changes emphasized player safety (2 rules about blocking, one about hazardous equipment and one about blowing plays dead promptly)	1979
	RULEQBSAFETYhth	(Helmet-to-helmet contact by the defender to be flagged as personal fouls and subject to fines. Done to protect offense, particularly the QB) + (Emphasis on helmet-to-helmet contact with QB after change in possession)	1996 + 2002
	RULEQBSAFTEYemphasized	Emphasis on protecting the passer	2001
Instant replay	RULEINSTANTR	Instant replay with a challenge system	1999

Ideally, I wanted the rule variable to act as a representation of rule changes in general. By involving rules from the three categories mentioned above I can ensure that the variable took on a broad representation. Unfortunately it was more complicated than throwing all of these remaining rule variables into one. Although RULE1 is a combination of all variables in table 1, finding a rule variable compatible to the model was a process of trial and error.

When composing different rule variables two main factors were considered. First, I organized the rule variables from above by their likelihood to affect competitive balance based on my intuition, rather than statistical correlation. This is necessary as a starting

point in this process. The list is shown in table A2:

Table A2

Rank (1=most likely)	OTF Rule
1	RULEtempo
2	RULEinstantr
3	RULEscoring
4	RULEqbsafetyhth
5	RULEplayersafety
6	RULEqbcom
7	RULEqbsafetyemphasized

That being said, it would be wrong to base all of the following rule variable iterations off of this table. For that reason, a second consideration was kept in mind.

The second consideration was each individual rule's correlation to the dependent variable, dHHI. This is shown below in table A3:

Table A3

```
. corr dHHI RULEQBCOM RULESCORING RULEQBSAFETYhth RULEINSTANTR RULEQBSAFETYemphasized RULEPLAYERSAFTEY RULETEMPO
(obs=47)

             |     dHHI RULEQB~M RULESC~G RULEQB~h RULEIN~R RULEQB~d RULEPL~Y RULETE~O
-------------+------------------------------------------------------------------------
        dHHI |   1.0000
   RULEQBCOM |  -0.8698   1.0000
 RULESCORING |  -0.8532   0.9583   1.0000
RULEQBSAFE~h |  -0.8390   0.9580   0.9180   1.0000
RULEINSTANTR |  -0.7215   0.8398   0.8048   0.8766   1.0000
RULEQBSAFE~d |  -0.6833   0.7658   0.7339   0.7994   0.9119   1.0000
RULEPLAYER~Y |  -0.6435   0.4565   0.4764   0.4374   0.3834   0.3496   1.0000
   RULETEMPO |  -0.3557   0.2861   0.2986   0.2741   0.2403   0.2191   0.6267   1.0000
```

Most surprising is the lack of correlation between RULETEMPO and dHHI considering I expected RULETEMPO to have the greatest impact in table 2. The variation between

these lists is a key point. Although it may seem that table 3 should be the obvious focus (being based in statistics rather than personal opinion), I am careful not to weigh the importance of one form of measurement more than the other. Because these are all dummy variables I have to remain skeptical as to whether it is the rule change that is correlating with dHHI, or something else that happened in or around the same year.

Table A4 holds examples of some of the different rule variables I experimented with. They are broken down as RULE1, RULE2 and so on through RULE7. More detail on these rules can be found in Appendices B and C.

Table A4 **Italics represent the rule variable used in the study*

Rule#	**Rules involved**	**Reasoning**
RULE1	All rules of the final 3 categories	This broad combination of rules ensures the full effects of OTF rule changes are captured
RULE2	All rules from Action/Tempo category	These OTF rule changes were made to open up offensive opportunities, making the game more exciting. Offense-based teams should have advantage, affecting competitive balance.
RULE3	All rules from safety category	A safer game may be less exciting, which could decrease competitive balance.
RULE4	All rules from instant replay category	The ability to reconsider calls can change the turnout of a game. This could impact competitive balance as it leaves less room for officiating errors.
RULE5	RULEscoring+RULEqbsafety+RULEqbcom	These are the top three rules with respect to their correlation with dHHI, the measure of competitive balance.
RULE6	*RULEtempo+RULEinstantr*	*I felt these two rules would have the most effect on game turnout as seen in Table A2, and thus may impact competitive balance.*
RULE7	RULEqbsafetyhth	Protecting the "most important player" on the field affects the greater game, thus it could impact competitive balance.

Appendix B
RULE2 & 7

RULE2 and RULE7 were the most promising of the six rules from Appendix A not featured in the study itself. The model that these iterations of the rule variable were run with is consistent with the model from the rest of the study. All iterations encountered heteroscedasticity, non-normality and other various issues. The rest of this appendix will break down the extent of the investigation put into the models holding RULE2 and RULE7.

RULE2

As mentioned in Appendix A, RULE2 consists of all the rule changes in the action/tempo category. The regression is shown in Table B1.

Table B1: Instrumental-Variable Estimation Results (dHHI)

2SLS Dependent Variable (dHHI)	
Explanatory Variable	Coefficient/T-stat
C	-0.0331/(-1.667)
RULE2	0.0033/(2.018)*
FASAL	-0.0082/(-2.848)*
PLAYERTALENT	0.4665 /(1.776)
EXPAN	-0.0005/(-1.046)
RELOCATE	-0.0002/(-0.834)
STRIKE73	0.0011/(0.939)
STRIKE82	0.0006 /(1.210)
STRIKE87	-0.0004/(-0.832)
SCHEDULE	0.0028/(2.189)*
NEWSTAD	-1.27E-05/(-0.160)
PLAYOFF	0.0005/(5.311)*
Durban-Watson stat	2.087
R2	.9

*Significant at the 5% level. Standard Errors adjusted for Heteroscedasticity

The variable RULE2 is positive and significant at the 5% significance level. This implies that certain OTF rule changes may actually decrease competitive balance in the NFL. Because RULE2 is composed of only action/tempo rule changes I can't jump to any conclusions about OTF rule changes in general. That being said, this variable being significant begs for more research to be done in this area of focus. The reason RULE may decrease competitive balance is because rule changes made to increase action and tempo favor offense-driven teams.

These results do coincide with Larsen's findings for the variable FASAL. FASAL is negative and significant at the 5% significance level. This implies that competitive balance increased with the introduction of free agency and a salary cap. This makes sense as both of these changes forced a more level dispersion of star players across the league.

PLAYERTALENT is not significant. This is surprising. It denies the logic that as player talent is more concentrated, the league becomes less competitively balanced. If a team hogs a high concentration of the most talented players, they will most likely win more games due to such an unfair talent advantage, or so one may think. These results counter player talent having an effect on competitive balance and disagree with this study's result section.

STRIKE73, STRIKE82, and STRIKE87 are all insignificant. This does not help to confirm Larsen's findings or his argument that different strikes have different effects.

PLAYOFF and SCHEDULE are the last significant variables, both positive and significant at the 5% significance level. This means that the increase in the number of playoff spots over the history of the NFL has decreased competitive balance, contrary to what I expected

EXPAN, RELOCATE and NEWSTAD are all insignificant, meaning that the addition of teams to the league, the relocation of existing teams and the construction of new stadiums do not have a significant effect on competitive balance. This is inconsistent with Larsen's findings, in which the construction of new stadiums was found to decrease competitive balance.

These results are far from identical to Larsen's, the most surprising difference being that PLAYERTALENT is not significant. Again, the two overriding concerns from the results section apply to this this model. The small sample size of 47 observations and the large number of dummy variables. I do not use this regression in this study for those two reasons and because although I find RULE2 to be significant in this regression, I do not feel the model is as strong with RULE2 as it is with RULE6. Part of this is certainly influenced by such drastic differences between this regressions results and those of Larsen's (2006).

RULE7

RULE7 is a dummy variable created to represent OTF rule changes since 1970. It takes on a value of 1 starting in 1996, the year helmet-to-helmet contact against the offense was deemed a penalty. This rule was put in place to protect the offense, particularly the Quarterback. RULE7 introduces QB safety as the key variable because the quarterback is arguably the most important player on the field (NFL.com). Protecting the QB has had a major impact on officiating and it can also be argued that by protecting the "most valuable position" on the team, all teams are able to count on that player having the opportunity to make plays. This model also suffers from heteroscedasticity and non-normality. After correcting for these I am left with the following results:

Table B2

2SLS Dependent Variable (logdHHI)	
Explanatory Variable	Coefficient/T-stat
RULE7	-0.5943 / (-2.7402)*
FA/SAL	-0.9089 / (-4.32)*
PLAYERTALENT	-71.4483 / (-21.49)*
EXPAN	-0.3690 / (-1.81)
RELOCATE	0.0426 / (1.12)
STRIKE73	0.1159 / (1.07)
STRIKE82	0.2295 / (5.47)*
STRIKE87	-0.2032 / (-4.48)*
SCHEDULE	0.6710 / (4.52)*
NEWSTAD	0.0283 / (2.00)**
PLAYOFF	0.0504 / (2.02)*

*Significant at the 5% level **Significant at the 10% level

The rule change variable (RULEQBSAFETYHTH) was negative and significant at the 5% significance level. This means that when normality is restored the rule change increases competitive balance in the league. Because transforming the dependent variable improves the overall model I can trust this regression's results.

FA/SAL and PLAYERTALENT are both negative and significant at the 5% significance level. This is again consistent with Larsen's findings and shows that player talent and its distribution both impact competitive balance.

STRIKE73 is insignificant, STRIKE82 is positive and significant and STRIKE87 is negative and significant as seen in the results of this study. This helps to confirm that as Larsen pointed out, different strikes have different effects. Further research might study the impact of strikes across different leagues.

SCHEDULE, NEWSTAD and PLAYOFF are all positive and significant. SCHEDULE and PLAYOFF are significant at the 5% significance level while

NEWSTAD is at the 10% significance level.

EXPAN and RELOCATE were both insignificant. This implies that neither the introduction of new teams nor the relocation of existing teams has a significant impact on competitive balance in the NFL.

These results are nearly identical to Larsen's, the only difference being his estimation showed STRIKE73 to be significant. Again, the two overriding concerns from the results section apply to this this model. The small sample size of 47 observations and the large number of dummy variables. I do not use this regression in the study because of the same reoccurring concern. I fear that because RULE7 is a dummy variable, its significance may be unrelated to the rule change itself.

Appendix C

RULE1,3,4 and 5

The rule variations 1, 3, 4 and 5 are not as promising as those mentioned in Appendix B. Below are the final regressions involving these four variations after fixing for heteroscedasticity. These variations also suffered from non-normality along with various other problems. They are included to emphasize the trial and error required to accurately perform this study, not as focal points to the findings.

RULE1

Table C1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.053966	0.024984	-2.159983	0.0384
PLAYERTALENT	0.794077	0.336109	2.362557	0.0244
FASAL	-0.005743	0.002050	-2.801403	0.0086
EXPAN	0.001382	0.001230	1.124247	0.2693
RELOCATE	0.000227	0.000238	0.954525	0.3470
STRIKE73	-0.000489	0.000992	-0.492899	0.6254
STRIKE82	0.000557	0.000447	1.246759	0.2215
STRIKE87	-0.000794	0.000370	-2.144066	0.0397
SCHEDULE	0.001364	0.001287	1.059864	0.2971
NEWSTAD	-8.80E-05	0.000109	-0.805857	0.4263
PLAYOFF	0.000130	0.000210	0.617742	0.5411
RULETEMPO+RULESCORING+RULEINS...	0.001675	0.000698	2.398956	0.0224

R-squared	0.924778	Mean dependent var	0.007610
Adjusted R-squared	0.898921	S.D. dependent var	0.003241
S.E. of regression	0.001030	Sum squared resid	3.40E-05
F-statistic	35.76452	Durbin-Watson stat	1.712408
Prob(F-statistic)	0.000000	Second-Stage SSR	3.40E-05
J-statistic	0.006169	Instrument rank	13
Prob(J-statistic)	0.937396		

RULE3

Table C2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PLAYERTALENT	0.059248	0.020858	2.840553	0.0077
FASAL	-0.005656	0.001113	-5.082171	0.0000
EXPAN	-0.000189	0.000977	-0.193039	0.8481
RELOCATE	7.59E-05	0.000208	0.364460	0.7178
STRIKE73	3.95E-05	0.001007	0.039218	0.9690
STRIKE82	0.001193	0.000246	4.842453	0.0000
STRIKE87	-0.001020	0.000348	-2.932834	0.0061
SCHEDULE	0.003311	0.001018	3.253226	0.0026
NEWSTAD	7.60E-05	7.55E-05	1.007201	0.3212
PLAYOFF	0.000451	0.000178	2.540828	0.0159
RULEPLAYERSAFTEY+RULEQBSAFETY...	0.000185	0.000523	0.353757	0.7258

R-squared	0.890435	Mean dependent var	0.007610
Adjusted R-squared	0.857233	S.D. dependent var	0.003241
S.E. of regression	0.001225	Sum squared resid	4.95E-05
Durbin-Watson stat	1.712161	Second-Stage SSR	4.95E-05
J-statistic	2.662210	Instrument rank	13
Prob(J-statistic)	0.264185		

RULE4

Table C3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PLAYERTALENT	0.066328	0.021677	3.059762	0.0044
FASAL	-0.006030	0.000862	-6.991890	0.0000
EXPAN	5.80E-05	0.000909	0.063819	0.9495
RELOCATE	0.000248	0.000195	1.274098	0.2115
STRIKE73	3.02E-05	0.001000	0.030233	0.9761
STRIKE82	0.001354	0.000235	5.771912	0.0000
STRIKE87	-0.001166	0.000298	-3.906325	0.0004
SCHEDULE	0.003172	0.001033	3.070144	0.0043
NEWSTAD	4.81E-05	7.55E-05	0.636196	0.5290
PLAYOFF	0.000404	0.000161	2.510184	0.0171
RULEINSTANTR	0.001174	0.000636	1.845096	0.0740

R-squared	0.895391	Mean dependent var	0.007610
Adjusted R-squared	0.863691	S.D. dependent var	0.003241
S.E. of regression	0.001197	Sum squared resid	4.72E-05
Durbin-Watson stat	1.799725	Second-Stage SSR	4.72E-05
J-statistic	3.173539	Instrument rank	13
Prob(J-statistic)	0.204586		

RULE5

Table C4

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PLAYERTALENT	0.053379	0.019527	2.733597	0.0100
FASAL	-0.002636	0.003693	-0.713804	0.4804
EXPAN	-0.000660	0.001206	-0.547381	0.5878
RELOCATE	-1.83E-05	0.000193	-0.095070	0.9248
STRIKE73	-8.93E-06	0.001029	-0.008671	0.9931
STRIKE82	0.001138	0.000263	4.332490	0.0001
STRIKE87	-0.000916	0.000287	-3.188005	0.0031
SCHEDULE	0.003237	0.001068	3.031096	0.0047
NEWSTAD	9.75E-05	7.14E-05	1.365444	0.1813
PLAYOFF	0.000517	0.000141	3.665756	0.0009
RULESCORING+RULEQBCOM+RULEQB...	-0.000990	0.001243	-0.796143	0.4316

R-squared	0.891379	Mean dependent var	0.007610
Adjusted R-squared	0.858463	S.D. dependent var	0.003241
S.E. of regression	0.001219	Sum squared resid	4.91E-05
Durbin-Watson stat	1.643514	Second-Stage SSR	4.91E-05
J-statistic	2.632047	Instrument rank	13
Prob(J-statistic)	0.268200		