
Munich Personal RePEc Archive

Competitive Balance in the National Hockey League after Unrestricted Free Agency and the Salary Cap

Lee, Travis

New College of Florida

15 September 2020

Online at https://mpra.ub.uni-muenchen.de/108400/
MPRA Paper No. 108400, posted 25 Jun 2021 05:07 UTC

Competitive Balance in the National Hockey League after Unrestricted Free Agency and the Salary Cap

Travis Lee

New College of Florida

5800 Bayshore Road

Sarasota, FL 34234

(941) 487-4742

tlee@ncf.edu

Abstract

In the large literature on issues related to competitive balance, studies tend to find no significant effect of structural changes. However in the National Hockey League, the introduction of unrestricted free agency in 1995 and a hard salary cap in 2005 might reasonably be expected to affect competitiveness. The present note measures between-season competitive balance as the correlation between the current and prior years' winning percentages. The method is to regress winning percentage on lagged winning percentage and a set of controls. The finding is that competitive balance increased after unrestricted free agency and the salary cap were implemented.

Keywords: National Hockey League, competitive balance, collective bargaining, unrestricted free agency, salary cap

I certify that I have the right to deposit the contribution with MPR.

Competitive Balance in the National Hockey League

after Unrestricted Free Agency and the Salary Cap

Introduction

Restricted free agency in the National Hockey League (NHL) dates to 1972, but the league did not allow for unrestricted free agency until 1995. The salary cap was introduced for the 2005 season. Unrestricted free agency and the salary cap might reasonably be expected to have an impact on the competitive balance among teams. Since these changes occurred at different times, it is possible to empirically examine their separate effects. Free agency might be expected to have a deleterious effect on competitive balance; some argue it permits one or a few teams to accumulate the most talented players. However according to the Coase theorem, under certain circumstances, free agency should have no impact (see Kahn (2000), Rottenberg (1956), and Surdam (2006)). On the other hand, a hard salary cap is intended to improve competitive balance by preventing wealthier large market teams from recruiting all the top talent with higher salaries. Bowman, Lambrinos, and Ashman (2013) find that the hard salary cap in the NHL increased competitiveness. The present note finds evidence that unrestricted free agency and the salary cap are associated with an increase in competitive balance in the NHL.

Virtually every NHL player enters the league through the draft, through which teams obtain exclusive rights to sign players. Prior to free agency, the drafting team maintained exclusive rights throughout a player's career. NHL players enjoyed restricted free agency from 1972 when the league granted them certain limited rights; however they had to wait until the 1995 collective bargaining agreement (CBA) for unrestricted free agency. The provisions of the 1995 CBA granted experienced players far greater ability to negotiate with

other clubs. The 2005 CBA provided for a salary cap and floor constraining player payrolls. For the 2018-19 season, the cap was $79.5 million, and the floor is generally $16 million below the cap. Furthermore there are no exceptions to the cap so there is very little variance in teams' spending on player salaries. Because there are no exceptions, the cap is called "hard."

Competitive balance is thought to be important part of demand for sports entertainment, a large industry in which the NHL plays a prominent role.[1] Fans take a greater interest when the outcome of games is uncertain, what Neale (1964) called the League Standing Effect. This idea has been tested empirically. El-Hodiri and Quirk (1971) find predictability tends to reduce attendance. For further evidence, see Noll (1974); Knowles, Sherony, and Haupert (1992); and Levin and McDonald (2009). Furthermore competitive balance has been cited by the courts as a reason to permit collusive agreements in sports leagues. In fact in a 1984 decision, the Supreme Court held that National Collegiate Athletic Association (NCAA) limits on player mobility and compensation were essential for competitive balance (McKenzie and Sullivan 1987). Kahn (2007a) discusses these issues in collegiate sports.

Theoretical treatments suggest a payroll cap will improve competitive balance. In their widely acknowledged review, Fort and Quirk (1995) argue, assuming a reverse-order-of-finish draft and a cap that equalizes spending on talent across all teams and ignoring the role of coaches and general managers in a team's success, the long run equilibrium for a league would be equal winning percentages for all teams. Although this result is unlikely to obtain in a real league, it might be considered an undesirable outcome. Késenne (2000) reaches the same conclusion in a Fort-Quirk type model with markets for both average and top-level players.

However most theorists contend free agency does not have a strong impact on competitive balance. The standard argument describes a version of the Coase theorem in which players end up playing where their marginal revenue product is the highest:

> In professional sports, the logic of the Coase theorem implies that restraints on player pay do not affect competitive balance as long as teams can trade player contracts efficiently. [...] Most research on professional sports finds little effect of player free agency on competitive balance, supporting this reasoning (Kahn, 2007a).

Fort, Maxcy, and Diehl (2016) make a similar theoretical argument, starting with Rottenberg's invariance principle, and provide a thorough review of the empirical evidence. See also Fort and Quirk (1995) and Kahn (2000). Thus under a system allowing either free agency or cash sales of players, the end result is the same. Eckard (2001b) provides theoretical and empirical evidence that free agency in Major League Baseball (MLB) increased competitive balance. He argues there are diminishing marginal returns to fielding a top-quality team. Furthermore he provides evidence that, at least in MLB, top players were rarely traded before free agency, a conclusion also supported by Daly and Moore (1981) and Daly (1992).

Many empirical studies have investigated the effects of structural changes, such as changes in league rules, on competitive balance. Most measures of competitiveness are based on the dispersion of winning percentages within a given season or other intraseasonal measures. Using such measures, studies tend to find structural changes have no significant effect on competitive balance (see for example Quirk and Fort (1992), Šíma and Procházka (2014), and Addesa (2011)). However within-season measures neglect an important aspect of competitiveness. To see this, consider the example illustrated in Table 1.

In both leagues, the dispersion of winning percentages is the same in both years so within-season measures will rate competitive balance as the same in both leagues. However in League 2, the ordering of the teams changes from year 1 to 2. Thus one would think there is

greater competitive balance in League 2. The present note investigates the correlation of winning percentages for regular season games. It would also be possible to examine turnover in teams winning championships or reaching the playoffs.

Fort and Lee (2007) find no break points in the time series of their within-season measure of competitive balance related to changes in league rules, among other changes. Trandel and Maxcy (2011) develop a novel within-season measure of competitiveness which accounts for home field (or home ice) advantage. Feddersen and Maennig (2005) investigate trends in intraseasonal measures of competitive balance over many different professional sports leagues. They find competitiveness in the NHL is essentially the same for the seasons 1969-70 to 2003-04. Totty and Owens (2011) find no evidence that salary caps improve competitive balance (measured within season) in several sports leagues, including the NHL. Bowman, Lambrinos, and Ashman (2018) is an exception. They study the relationship between point spreads (within season) and competitive balance in the NHL and find it "increased rather substantially" from 2005 to 2015 (which is consistent with the results of the present note). They also use their measure to investigate competitive balance in the National Basketball Association (NBA) and NFL (2013). They find competitiveness has improved in the NBA over the past twenty years and remained about the same in the NFL. Larsen, Fenn, and Spenner (2006) are a second exception. They provide a detailed analysis of the effects of free agency and a hard payroll cap in the NFL using Gini coefficients and the Herfindahl-Hirschman Index (within-season measures). They find an increase in competitiveness after the institution of free agency and the payroll cap. Kim, Won, and Han (2017) is a final exception. They find some changes in league rules are associated with changes in their within-season measures of competitive balance, the standard deviation of winning percentages and Gini coefficient.

Recently interseasonal, or between-season, measures have been developed, which are sensitive to these changes in rankings from year to year. Eckard (1998) gives a decomposition of the variance in teams' winning percentages over several years, which captures both between-season changes in relative team performance and within-season dispersion of winning percentages. He applies his measure to examine cartel behavior by the NCAA in college football and competitive balance in MLB (see Eckard (1998, 2001a, and 2001b)). Particularly interesting for present purposes, is his investigation of competitiveness in MLB before and after the advent of free agency. Although prior studies using conventional within-season measures do not detect an unambiguous effect, his between-season measure does.

Eckard's method, which is not applied to the 1995 and 2005 CBAs in the NHL, is more comprehensive in the sense that it incorporates both intraseasonal and interseasonal aspects. However it does not use regression analysis and thus offers no means to control for changes in other variables or to perform standardized significance testing.

Buzzacchi, Szymanski, and Valletti (2003) compare open and closed leagues in the United States and Europe using a measure of between-season competitive balance based on the probability of placing in the top k spots under perfectly balanced competition. In closed leagues, typical of the United States, a set group of teams competes each year. Open leagues, by contrast, feature a system of relegation whereby the worst-performing teams are demoted to a lesser league and replaced by a promoted newcomer. The authors find that closed leagues show higher between-season competitive balance and the standard deviation of winning percentage is typically lower in open leagues.

Humphreys (2002) develops a competitive balance ratio, which reflects variation in individual teams' winning percentage from year to year. He shows this measure outperforms

other measures of competitiveness in explaining changes in attendance over the past hundred years in MLB. Hadley, Cieka, and Krautmann (2005) estimate the transitional probabilities of teams appearing in the postseason from one year to the next in MLB. They detect a decline in competitive balance after the 1994 players' strike, which they call "deterioration."

Maxcy and Mondello (2006) investigate the effects of several institutional changes on competitive balance in various leagues. One of their methods involves regressing the Spearman rank correlation coefficient (SRCC) for consecutive seasons' rankings on dummy variables for institutional changes and other controls. The SRCC is an interseasonal measure, which reflects the degree of reordering in team rankings (see Daly and Moore (1981) and Maxcy (2002) for other uses of this measure in analyzing player mobility in MLB). The authors find the imposition of free agency and a hard salary cap had a positive effect on competitive balance in the NFL. They find no significant evidence of an effect on competitiveness using the conventional intraseasonal measure, the standard deviation of winning percentage.

Spalding (2014) investigates the effect of competitive balance on fan interest, and measures competitiveness using "inter-seasonal measures of qualification for and advancement in the playoffs." Büschemann and Deutscher (2011) find that the salary cap and revenue sharing elements of the NHL's 2005 CBA improved the financial competitiveness of the franchises. Jeglic (2005) argues that the 2005 CBA was essential to the financial viability of the league. Grant (2008) argues the 2005 CBA resulted in a redistribution of top-ranked talent, resulting in an enhancement of competitive balance. York and Miree (2018) use several measures of competitive balance to conclude that competitiveness in the NHL improved after the 2005 CBA. Fort (2006) offers an excellent overview of various measures of competitive balance (not including the measure used in the present note).

Model

There are many different measures of competitive balance. Evans (2014) lists 27 different measures. From one perspective, competitive balance is about turnover in team rankings. In a league with great competitiveness, dominant teams fall on hard times, winning fewer games, and weak teams grow stronger over time, winning more. Over a large number of seasons, every franchise can expect to finish sometimes near the top and sometimes near the bottom. A direct way to measure competitive balance, then, is to estimate the correlation of last year's winning percentage with this year's winning percentage for every team. The lower the correlation, the greater the competitive balance.

To motivate this method, consider the Pearson correlation between the current and the previous season's winning percentage for teams in the league over the period from the 1973-74 to the 2019-20 season (see Figure 1). The correlation is significant for every season except 1991-92, 2012-23, 2016-17, and 2017-18. The figure depicts a great deal of variation in the correlation coefficient. Even so by inspection there appears to be a downward trend over time, indicating an increase in competitive balance over this time period. Essentially there are three eras in the data:

1. Pre-unrestricted free agency from 1972-73 to 1994-95. This is the period of restricted free agency before the 1995 CBA.
2. Unrestricted free agency from 1995-96 to 2003-04.[2] This is the period of unrestricted free agency before the imposition of the salary cap.
3. Post-salary cap from 2005-06 to 2019-20. This is the period of the salary cap.

The correlation of lagged winning percentage with current winning percentage is 0.69 for the first period, 0.61 for the second, and 0.47 for the third. Although these results indicate an

increase in competitive balance from each era to the next, the differences are not significant by the Fisher r-to-z transformation. In fact, the correlation of current and previous season's winning percentage is itself a measure of interseasonal competitive balance. Figure 1 gives a preliminary indication that the 1995 and 2005 CBAs did have a positive effect on competitiveness, as the correlation declines between 1973-74 and 2019-20. Figures 2-4 illustrate the relationship between lagged and current winning percentage in each era.

The present strategy is to regress winning percentage in a given year on winning percentage from the previous year and a set of controls, including indicator variables for expansion teams and teams which have recently relocated (first two years as an expansion team or first three years in a new location). These definitions (two years for expansion teams and three years for relocations) were chosen because they gave the strongest effect on winning percentage in the regression. See Appendices A and B for details on expansions and relocations. Lee (2010) uses this model to investigate competitive balance in the NFL after the 1993 CBA. Yam (2015) adapts it in his study of competitiveness in the NBA after the 2011 CBA. Salaga and Fort (2017) investigate the time series of correlations of winning percentage with prior season winning percentage in the "Power 5" college football conferences. They find "very few structural break points" and conclude that competitive balance has remained stable over the histories of the conferences. Daly and Moore (1981) use correlations of winning percentage to examine turnover in rankings of the original eight MLB franchises. Butler (1995) uses the correlation of winning percentage to argue that "free agency, a more narrow distribution of market sizes, and a compression of baseball talent have all served to promote competitiveness." Balfour and Porter (1991) uses a similar method to argue that "liberalizing free agency will not destroy competitive balance" in MLB and the NFL. Richardson (2000) investigates competitive balance in the NHL

using correlations of winning percentage. The present note analyzes NHL data from 1972-73 to 2019-20 so it includes the imposition of a hard salary cap in 2005. The details of the present model (see Equation 1) differ from other correlational methods in the literature. Regression offers standard assessment of significance, and in addition, the effects of other variables can be controlled.

This analysis uses data on the number of regular season wins, losses, and ties for each team in the league for seasons from 1972-73 to 2019-20 (available from hockey-reference.com). Winning percentage is computed as the number of wins, plus one half the number of ties, divided by the number of games.[3] One observation consists of a team's record during any of these seasons. The sample begins in 1972-73 because in that year the NHL granted players limited rights as restricted free agents. Including data before the 1972-73 season would bias the results in favor of finding a positive effect of the 1995 and 2005 CBAs on competitive balance. The regression focuses on the relationship between current and previous years' winning percentages. There is no data for 2004-05 because the entire season was cancelled due to the owners' lockout. As a result, the lagged winning percentage for 2005-06 is the 2003-04 record.

The equation to estimate takes the form of Equation 1:

$$\text{WinPct}_{it} = \alpha_0 1_{\text{1973-74 to 1994-95}} + \alpha_1 1_{\text{1995-96 to 2004-05}} + \alpha_2 1_{\text{2005-06 to 2019-20}}$$

$$+ \beta_0 1_{\text{1973-74 to 1994-95}} \text{WinPct}_{it-1} + \beta_1 1_{\text{1995-96 to 2004-05}} \text{WinPct}_{it-1} + \beta_2 1_{\text{2005-06 to 2019-20}} \text{WinPct}_{it-1}$$

$$+ \gamma X_{it} + U_{it} \text{ where } U_{it} = U_{it-1} + \rho\ \varepsilon_{it}$$

where i and t index the team and year respectively. The indicator variable $1_{\text{1973-74 to 1994-95}}$ is one for the seasons 1973-74 to 1994-95 and zero otherwise. Similarly for $1_{\text{1995-96 to 2004-05}}$ and $1_{\text{2005-06 to 2019-20}}$. X is a set of control variables, including indicator variables for expansion teams and teams which have recently relocated. The Vegas Golden Knights reached the Stanley Cup Finals in

their first year of operation, but their success as an expansion team is exceptional. Regressing winning percentage on dummy variables for expansion teams in their first two seasons and for teams in their first three years in a new location found these indicator variables to be significant with p-values of $2 \bullet 10^{-16}$ and 0.0148 respectively. These variables had coefficients of -0.1557 and -0.0492 respectively, indicating expansion and relocated teams have lower winning percentages. Regressing winning percentage on lagged winning percentage and indicator variables for expansion teams and relocations showed only the expansion team variable was significant (with p-value 0.0032 and coefficient -0.0584). Interactions between lagged winning percentage and the expansion and relocation indicators were not significant. The expansion team variable was included in the final model, but the relocation variable was dropped. *X* includes year-specific dummy variables for seasons between 1973-74 and 2019-20 in the following cases:

- Expansion years: The NHL expanded in 1972-73, 1974-75, 1979-80, 1991-92, 1992-93, 1993-94, 1998-99, 1999-2000, 2000-01, and 2017-18 (see Appendix A for details). Kahn (2007b) explores many of the issues relating league expansion and competitive balance, as well as consumer welfare.
- Strikes or lockouts: The league experienced lockout-shortened seasons in 1994-95 (48 games), 2004-05 (no games), and 2012-13 (48 games).

Regressing winning percentage on lagged winning percentage and these dummy variables showed that indicators for individual expansion years were not significant (except for 1974 which had a p-value and coefficient of 0.0381 and 0.0441 respectively). The indicator for all the expansion years together was significant with p-value of 0.0473 and coefficient 0.0124. None of the indicators for lockout seasons were significant whether taken individually or together. None of the interactions between any of these dummy variables and lagged winning percentage was

significant. As a result, the indicator for all the expansion years together was maintained in the final model, while the others were dropped. The error term U_{it} is assumed to exhibit autocorrelation at the team level with parameter ρ. The errors ε_{it} are independent and normally distributed.

Results

Table 2 gives the results from a Prais-Winsten AR(1) regression, which allows for autocorrelation in the error term U_{it} in Equation 1. The best fit for the autocorrelation parameter is $\rho = -0.2812$, indicating negative autocorrelation. This outcome suggests a season of high winning percentage (based on the winning percentage from the previous year) tends to be followed by a year of low winning percentage (based on the winning percentage from the previous year) and vice versa.

The original data gives a Durbin-Watson statistic of 2.1421, which is close to 2. In fact, the Durbin-Watson statistic of the transformed data is 1.8849, which is approximately as far from 2 as the original. This reduction is a result of the best fit ρ being negative. Taken together, these outcomes suggest the use of ordinary least squares (OLS) regression, the results of which are also given in Table 2.

The expansion team indicator variable was dropped from the Prais-Winsten regression because it was not significant. There are separate constants and lagged winning percentage parameters for each of the three eras in the data. The constants are permitted to change to allow variation in the coefficients on lagged winning percentage. The constants and lagged winning percentage variables are significant in both regressions. In both regressions, the p-values for the constants and lagged winning percentage terms are on the order of 10^{-16}, except for the 1995-96

to 2004-05 constant (on the order of 10^{-10} and 10^{-15} for the Prais-Winsten and OLS regressions respectively). R^2 is quite high for both regressions at 98.50% and 97.50% respectively. The indicator for expansions teams in their first or second season is significant at the 5% level in the OLS results (it is not significant in the Prais-Winsten regression). The coefficient suggests expansion teams experienced a 0.0510 decrease in their winning percentage as compared to non-expansion teams. The indicator for expansion years is significant at the 5% level in the Prais-Winsten regression (it is not significant in the OLS results with a p-value of 0.0669). The results are robust to a number of changes in the specification given in Equation 1, such as the inclusion of additional lags of winning percentage and polynomial trends in lagged winning percentage.

In both regressions, the coefficient on lagged winning percentage is lower for the change from each era to the next. This suggests the 1995 and 2005 CBAs had the effect of increasing competitive balance. The difference between the coefficients on the lagged winning percentage terms in the first and second eras is not significant with p-values of 0.47 and 0.31 in the Prais-Winsten and OLS regressions respectively. Likewise the difference between the lagged winning percentage coefficients between the second and third eras is not significant with p-values of 0.11 and 0.31. However the difference between the first and third eras is significant in both regressions. The p-values for the difference between the coefficients on lagged winning percentage in the first and third eras are 0.0045 and 0.0005 respectively in the Prais-Winsten and OLS regressions. These results suggest the combined effects of the 1995 and 2005 CBAs are associated with a significant increase in competitive balance in the league.

The economic significance of these results is the implication that the provisions of the 1995 and 2005 CBAs regarding team payrolls and free agency are associated with an increase in competitive balance in the league. In opposing players' union demands for free agency, leagues

typically argue free agency would have an adverse impact on competitive balance. These results show that, in combination with payroll limits of the 2005 CBA, free agency is associated with the opposite effect. York and Miree (2018) also reach the conclusion that the 2005 CBA increased competitive balance in the NHL. Lee (2010) reaches similar conclusions for the NFL's 1993 CBA, which included free agency and a hard salary cap.

Although coaching salaries are not included here, coaching performance is likely to affect team performance. Kahn (1993) investigates these effects in MLB. In the NHL, teams seeking a competitive edge might be constrained in hiring player talent by the salary cap. Such teams might be more likely to increase spending on coaches. Thus coaching salaries could be considered endogenous. If indeed constrained teams tend to spend more on coaches, this bias works against finding a positive effect of the 1995 and 2005 CBAs on competitive balance.

Returning to Equation 1, note that ideally lagged winning percentages would be treated as endogenous variables. This method requires the use of instruments correlated with the endogenous predictors but not correlated with the error. In the case of NHL winning percentage, several candidates come to mind:

- Team revenues: In general, there is some reason to believe winning and revenue are positively correlated; however, as observed in Forbes (2019), revenue seems more closely correlated with market size than winning percentage. For example, in 2019 the most valuable franchise in the league was the New York Rangers who had lost more games than they won during the prior two seasons (Forbes 2019).
- Television ratings: Although a case can be made for using television ratings, this information is proprietary and unavailable for the purposes of academic research.

- Arena attendance: Attendance figures are available for each team and season in the sample at the Internet Hockey Database (www.hockeydb.com/nhl-attendance). Arena attendance is positively correlated with winning percentage at the level of the individual franchise, but the relationship is somewhat weak. Peters (2011) found a small correlation which was only significant for one of the seasons studied. In fact, the relationship between attendance and winning percentage may be nonlinear. Coates and Humphreys (2011) find "asymmetric" relationships between attendance, uncertainty of outcome, and team quality in the NHL. Claxton (2014) investigates the determinants of attendance at NCAA Division II football games other than winning percentage. Scelles, Durand, Bonnal, Goyeau, and Andreff (2013) compares the effects of competitive balance and competitive intensity on attendance in French football Ligue 1.

It is not difficult to see that appropriate instruments are difficult to find. Arguably attendance is the strongest candidate. Figure 5 is a plot of winning percentage versus attendance. The correlation between the variables is 0.36. Table 3 gives the results of a regression of winning percentage on attendance. Using lagged attendance (and lagged attendance squared) as an instrument for lagged winning percentage, the Durbin-Wu-Hausman test finds significant evidence that the lagged winning percentage predictors are endogenous. This outcome suggests an instrumental variables regression. The model is Equation 1 with lagged winning percentage instrumented by lagged attendance and lagged attendance squared. The results of a two-stage least squares regression are given in Table 4. The coefficient on lagged winning percentage still decreases from one era to the next, which indicates an increase in competitive balance. However the differences between the coefficients on the lagged winning percentage from the first to the second, the second to the third, and the first to the third eras are not significant.

Having the data for both winning percentage and attendance, it is also possible to briefly investigate the relationship between attendance and winning percentage. Attendance is often considered a measure of fan and viewer interest. As mentioned above, the relationship may be nonlinear. The results of fitting an OLS regression of attendance on winning percentage is given in Table 5. The influence of winning percentage and squared winning percentage are significant, with the latter coefficient negative. There does appear to be a quadratic relationship (see Figure 5) where attendance drops off at the low and high ends of winning percentage.

Conclusion

Although there is a large literature on issues related to competitive balance in sports, studies tend to find no significant effect of structural changes, such as changes in league rules. With the 1995 and 2005 CBAs, which included unrestricted free agency and a hard salary cap respectively, the NHL instituted changes which, the present analysis suggests, were associated with an increase in competitive balance. This note adds to the recent literature on between-season measures of competitiveness, which do respond to changes in league rules.

References

Addesa, F. A. (2011). Competitive balance in the Italian basketball championship. *Rivista di Diritto ed Economia dello Sport*, 7(1).

Adgate, B. (2019). Hockey's big pay day is coming. Forbes. Retrieved from https://www.forbes.com/sites/bradadgate/2019/01/15/hockeys-big-pay-day-is-coming/#600de0844e44

Balfour, A., & Porter, P. K. (1991). The reserve clause in professional sports: Legality and effect on competitive balance. *Labor Law Journal*, 42(1), 8-18.

Bowman, R. A., Lambrinos, J., & Ashman, T. (2013). Competitive balance in the eyes of the sports fan: Prospective measures using point spreads in the NFL and NBA. *Journal of Sports Economics*, 14(5), 498-520.

Bowman, R. A., Lambrinos, J., & Ashman, T. (2018). Prospective measures of competitive balance application to money lines in the national hockey league. *Applied Economics*, 50(46), 4925-4936.

Büschemann, A., & Deutscher, C. (2011). Did the 2005 collective bargaining agreement really improve team efficiency in the NHL. *International Journal of Sport Finance*, 6(4), 298-306.

Butler, M. R. (1995). Competitive balance in Major League Baseball. *The American Economist*, 39(2), 46-52.

Buzzacchi, L., Szymanski, S., & Valletti, T. (2003). Equality of opportunity and equality of outcome: Open leagues, closed leagues, and competitive balance. *Journal of Industry, Competition and Trade*, 3, 167-186.

Claxton, L. J. (2014). Factors that Motivate Attendance At NCAA Division II Football Games: A Multiple Case Study. Northcentral University.

Coates, D., & Humphreys, B. R. (2012). Game Attendance and Outcome Uncertainty in the National Hockey League. *Journal of Sports Economics, 13(4), 364-377.*

Daly, G. (1992). Diamonds are forever: The business of baseball. In M. Sommers Paul (Ed.), *The Baseball Player's Labor Market Revisited* (pp. 11-28). Washington, DC: Brookings Institution.

Daly, G., & Moore, W. (1981). Externalities, property rights, and the allocation of resources in Major League Baseball. *Economic Inquiry*, 19, 77-95.

Eckard, W. (1998). The NCAA cartel and competitive balance in college football. *Review of Industrial Organization*, 13, 347-369.

Eckard, W. (2001a). Baseball's blue ribbon economic report: Solutions in search of a problem. *Journal of Sports Economics*, 2, 213-227.

Eckard, W. (2001b). Free agency, competitive balance, and diminishing returns to pennant contention. *Economic Inquiry*, 39, 430-443.

El-Hodiri, M., & Quirk, J. (1971). The economic theory of a professional sports league. *Journal of Political Economy*, 79, 1302-1319.

Evans, R. (2014). A review of measures of competitive balance in the "analysis of competitive balance" literature. Working Paper. Birkbeck, University of London, London, UK.

Feddersen, A., & Maennig, W. (2005). Trends in competitive balance: Is there evidence for growing imbalance in professional sport leagues?. *Hamburg Contemporary Economic Discussion Paper*, (01).

Forbes. (2011). Forbes Releases 21st Annual NHL Team Valuations [Press release]. Retrieved from https://www.forbes.com/sites/forbespr/2019/12/11/forbes-releases-21st-annual-nhl-team-valuations/#7c65f3125d83

Fort, R. (2006). Competitive balance in North American professional sports. *Handbook of sports economics research*, 190-206.

Fort, R., & Lee, Y. H. (2007). Structural change, competitive balance, and the rest of the major leagues. *Economic Inquiry*, 45(3), 519-532.

Fort, R., Maxcy, J., & Diehl, M. (2016). Uncertainty by regulation: Rottenberg′ s invariance principle. *Research in Economics*, 70(3), 454-467.

Fort, R., & Quirk, J. (1995). Cross-subsidization, incentives, and outcomes in professional team sports leagues. *Journal of Economic Literature*, 33, 1265-1299.

Grant, M. (2008). Competitive Balance in the National Hockey League After the Salary Cap (Doctoral dissertation, Colorado College.).

Hadley, L., Cieka, J., & Krautmann, A. (2005). Competitive balance in the aftermath of the 1994 players' strike. *Journal of Sports Economics*, 6, 379-389.

Humphreys, B. (2002). Alternative measures of competitive balance in sports leagues. *Journal of Sports Economics*, 3, 133-148.

Jeglic, A. A. (2005). Can the New Collective Bargaining Agreement Save the NHL. *Entertainment & Sports Lawyer*, 23, 1.

Kahn, L. (1993). Managerial quality, team success, and individual player performance in Major League Baseball. *Industrial and Labor Relations Review*, 46, 531-547.

Kahn, L. M. (2000). The sports business as a labor market laboratory. *Journal of Economic Perspectives*, *14*(3), 75-94.

Kahn, L. (2007a). Cartel behavior and amateurism in college sports. *Journal of Economic Perspectives*, 21, 209-226.

Kahn, L. (2007b). Sports league expansion and consumer welfare. *Journal of Sports Economics*, 8, 115-138.

Késenne, S. (2000). Impact of salary caps in professional team sports. *Scottish Journal of Political Economy*, 47, 422-430.

Kim, M. S., Won, D., & Han, J. W. (2017). Structural changes and competitive balance in the Korean professional baseball league. *International Journal of Applied Sports Sciences*, 29(2), 195-208.

Knowles, G., Sherony, K., & Haupert, M. (1992). The demand for major league baseball: A test of the uncertainty of outcome hypothesis. *American Economist*, 36, 72-89.

Larsen, A., Fenn, A., & Spenner, E. (2006). The impact of free agency and the salary cap on competitive balance in the National Football League. *Journal of Sports Economics*, 7, 374-390.

Lee, T. (2010). Competitive balance in the national football league after the 1993 collective bargaining agreement. *Journal of Sports Economics*, 11(1), 77-88.

Levin, M. A., & McDonald, R. E. (2009). The value of competition: competitive balance as a predictor of attendance in spectator sports. *International Journal of Sports Marketing & Sponsorship*, *11*(1).

Maxcy, J. (2002). Rethinking restrictions on player mobility in Major League Baseball. *Contemporary Economic Policy*, 20, 145-159.

Maxcy, J., & Mondello, M. (2006). The impact of free agency on competitive balance in North American professional team sports leagues. *Journal of Sport Management*, 20, 345-365.

McKenzie, R., & Sullivan, T. (1987). Does the NCAA exploit college athletes? An economics and legal reinterpretation. *Antitrust Bulletin*, 32, 373-399.

Neale, W. (1964). The peculiar economics of professional sports. *Quarterly Journal of Economics*, 78, 1-14.

Noll, R. (1974). Government and the sport business. In G. Noll Roger (Ed.), *Attendance and price setting* (pp. 115-158). Washington, DC: Brookings Institution.

Peters, D. (2011). Winning percentage and attendance in the NHL. *Sport Management Undergraduate*. Paper 23.

Quirk, J., & Fort, R. (1992). *Pay dirt: The business of professional team sports*. Princeton, New Jersey (NJ): Princeton University Press.

Richardson, D. H. (2000). Pay, performance, and competitive balance in the National Hockey League. *Eastern Economic Journal*, 26(4), 393-417.

Rottenberg, S. (1956). The baseball players' labor market. *Journal of political economy*, 64(3), 242-258.

Salaga, S., & Fort, R. (2017). Structural change in competitive balance in big-time college football. *Review of Industrial Organization*, 50(1), 27-41.

Scelles, N., Durand, C., Bonnal, L., Goyeau, D., & Andreff, W. (2013). Competitive balance versus competitive intensity before a match: Is one of these two concepts more relevant in explaining attendance? The case of the French football Ligue 1 over the period 2008–2011. *Applied Economics*, 45(29), 4184-4192.

Šíma, J., & Procházka, J. (2014). Competitive Balance in the Austrian, Czech, Hungarian and Ukrainian Soccer Leagues. *Acta Universitatis Carolinae Kinanthropologica*, 50(1), 83-92.

Spalding, R. L. (2014). Fan Response to League Playoff Structure and Consecutive Season Competitive Balance in Professional Sports. *Doctoral Dissertations*. 142

Surdam, D. G. (2006). The Coase theorem and player movement in major league baseball. *Journal of Sports Economics*, 7(2), 201-221.

Totty, E. S., & Owens, M. F. (2011). Salary caps and competitive balance in professional sports leagues. *Journal for Economic Educators*, 11(2), 45-56.

Trandel, G. A., & Maxcy, J. G. (2011). Adjusting winning-percentage standard deviations and a measure of competitive balance for home advantage. *Journal of Quantitative Analysis in Sports*, 7(1).

Yam, N. (2015). The New Landscape of the NBA: The 2011 Collective Bargaining Agreement's Impact on Competitive Balance and Players' Salaries (Undergraduate thesis, Duke University).

York, K. M., & Miree, C. E. (2018). Averting a tragedy of the commons: Revenue sharing and competitive balance in the NHL. *Sport, Business and Management: An International Journal*.

Footnotes

1. According to Adgate (2019), for the 2017-18 season, NHL revenue was $4.86 billion, doubling the total from the 2006-07 season. The NHL was aided by a record high $559.5 million in sponsorship deals. The average NHL franchise in 2018 was valued at $630 million, a 6% increase from the previous year.
2. The 2004-05 season is missing since the entire season was cancelled due to the owner's lockout and the inability of the NHL and the National Hockey League Players Association to agree on the provisions of a new CBA. The 2003-04 record is used as the previous year's winning percentage for 2005-06.
3. Beginning with the season 2005-06 when a game could not end in a tie, the formula for winning percentage becomes the number of wins divided by the number of games.

Tables

Table 1. End-Of-Year Standings in Two Hypothetical Leagues

League 1				League 2			
Year 1		Year 2		Year 1		Year 2	
Team 1	0.75	Team 1	0.75	Team 1	0.75	Team 2	0.75
Team 2	0.5	Team 2	0.5	Team 2	0.5	Team 3	0.5
Team 3	0.25	Team 3	0.25	Team 3	0.25	Team 1	0.25

Table 2. Regression Results Estimating Equation 1.

	Prais-Winsten AR(1)	OLS
1973-74 to 1994-95 constant	0.1181972***	0.182287***
	(0.0135223)	(0.017026)
1995-96 to 2004-05 constant	0.1329215***	0.209038***
	(0.0221016)	(0.026577)
2005-06 to 2019-20 constant	0.1779455***	0.270886***
	(0.0180708)	(0.021183)
1973-74 to 1994-95 lagged win percentage	0.7679805***	0.642471***
	(0.026201)	(0.032759)
1995-96 to 2004-05 lagged win percentage	0.731306***	0.580868***
	(0.043265)	(0.051916)
2005-06 to 2019-20 lagged win percentage	0.6419915***	0.456391***
	(0.035648)	(0.041662)
Expansion year indicator	0.0120669*	-0.011816.
	(0.0056782)	(0.006443)
Expansion team indicator	-	-0.050953*
		(0.019974)
Durbin-Watson (original)	2.142148	-
Durbin-Watson (transformed)	1.884985	-
Autocorrelation parameter	-0.2812	-
Observations	1139	1139
R^2	0.9850	0.975

Note: Standard errors are given in parentheses.

***p < .001, **p < .01, *p < .05, .p < .10

Table 3. Results of Regressing Winning Percentage on Attendance.

	OLS
Constant	0.0828694
	(0.0529702)
Attendance (in thousands)	0.0426028***
	(0.0070607)
Attendance squared	-0.0009869***
	(0.0002323)
Expansion team (in first two years)	-0.1224076***
	(0.0161539)
Observations	1170
R^2	0.1979

Note: Standard errors are given in parentheses.

***p < .001, **p < .01, *p < .05, .p < .10

Table 4. Instrumental Variables Regression Results.

	Two-stage least squares regression
1973-74 to 1994-95 constant	0.1048326**
	(0.0341507)
1995-96 to 2004-05 constant	0.119291.
	(0.0654045)
2005-06 to 2019-20 constant	0.1891685**
	(0.0691499)
1973-74 to 1994-95 lagged win percentage	0.7984046***
	(0.0677988)
1995-96 to 2004-05 lagged win percentage	0.7664136***
	(0.1303827)
2005-06 to 2019-20 lagged win percentage	0.6211687***
	(0.1380778)
Observations	1145

Note: Standard errors are given in parentheses.

***p < .001, **p < .01, *p < .05, .p < .10

Table 5. Regression of Attendance (in thousands) on Winning Percentage.

	OLS
Constant	5.511***
	(1.148)
Winning percentage	33.234***
	(4.725)
Winning percentage squared	-23.475***
	(4.781)
Observations	1170
R^2	0.1608

Note: Standard errors are given in parentheses.

***p < .001, **p < .01, *p < .05, .p < .10

Figures

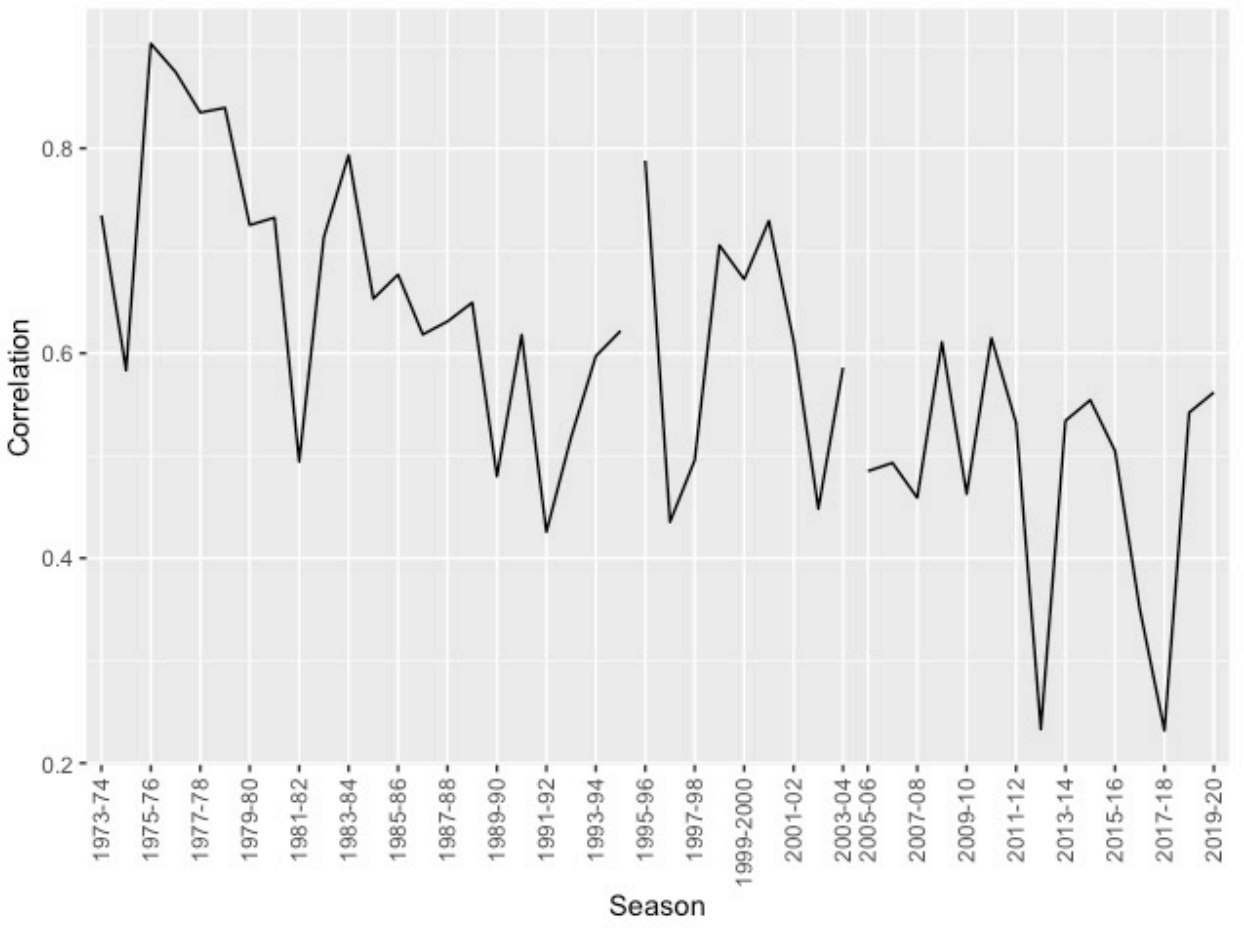

Figure 1. Correlation of NHL Team Winning Percentage with Previous Year's Winning Percentage (1973-74 to 2019-20)[2]. The three different eras are illustrated by breaks in the line on the graph.

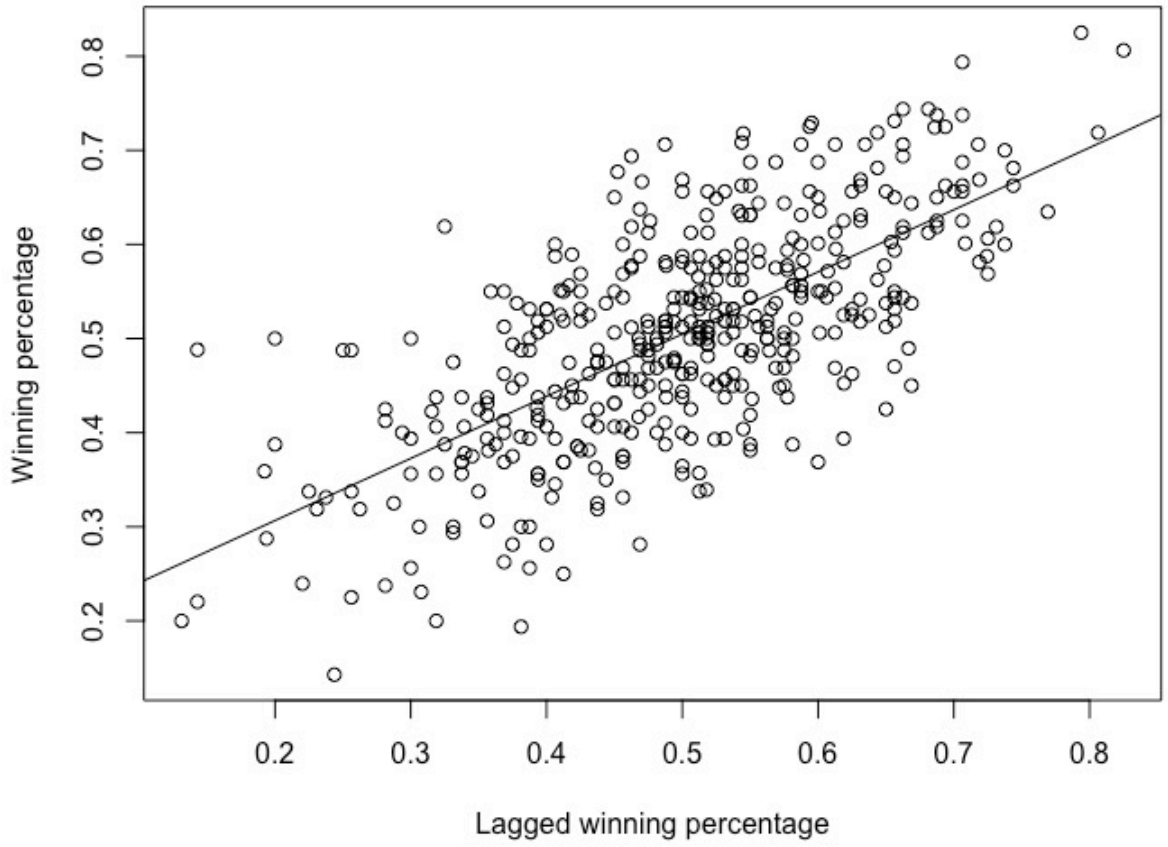

Figure 2. For the first era 1973-74 to 1994-95, a scatterplot of lagged winning percentage against current winning percentage.

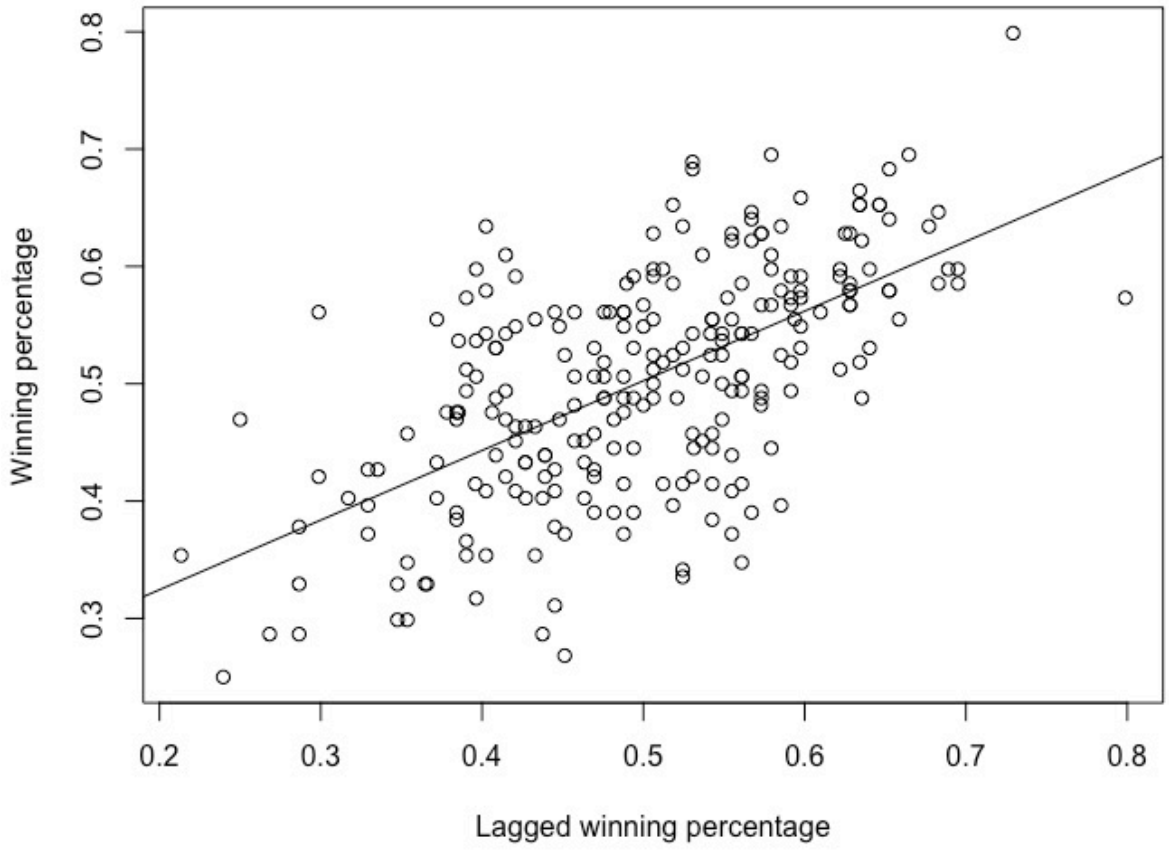

Figure 3. For the second era 1995-96 to 2004-05, a scatterplot of lagged winning percentage against current winning percentage.

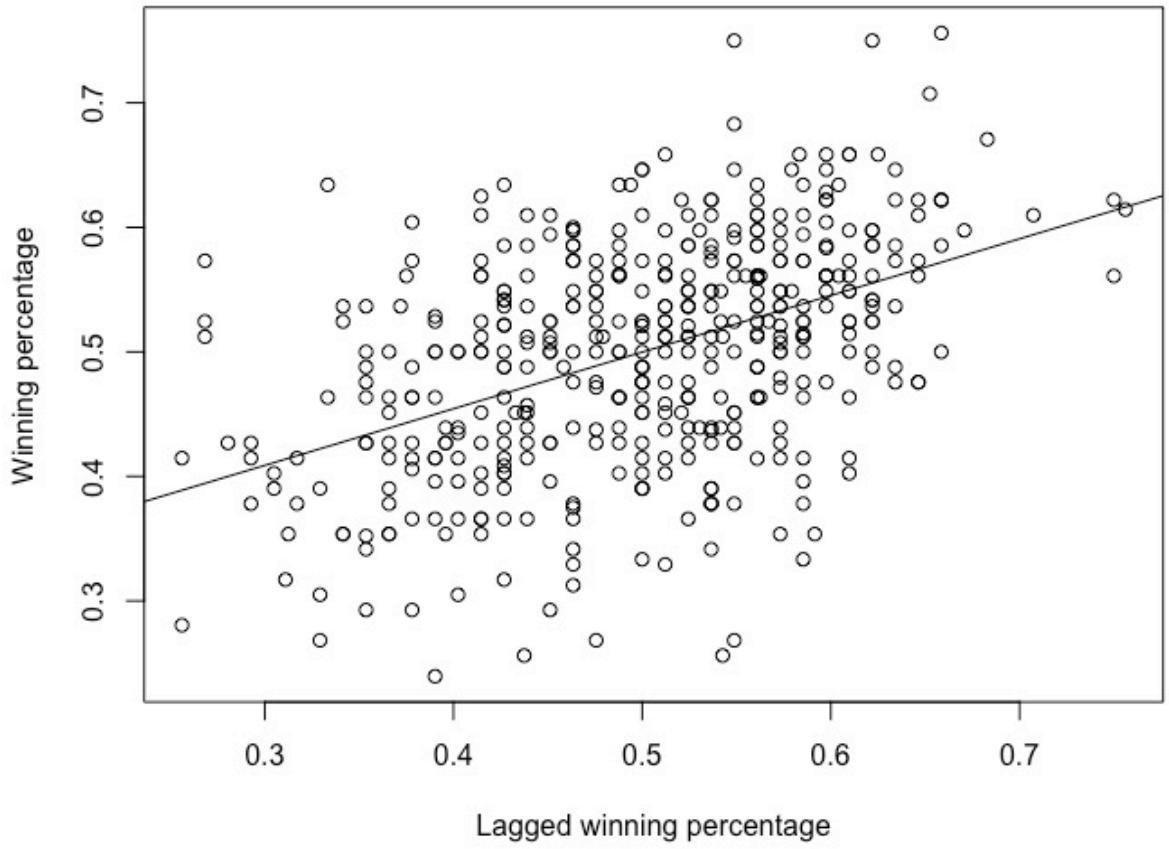

Figure 4. For the third era 2005-06 to 2019-20, a scatterplot of lagged winning percentage against current winning percentage.

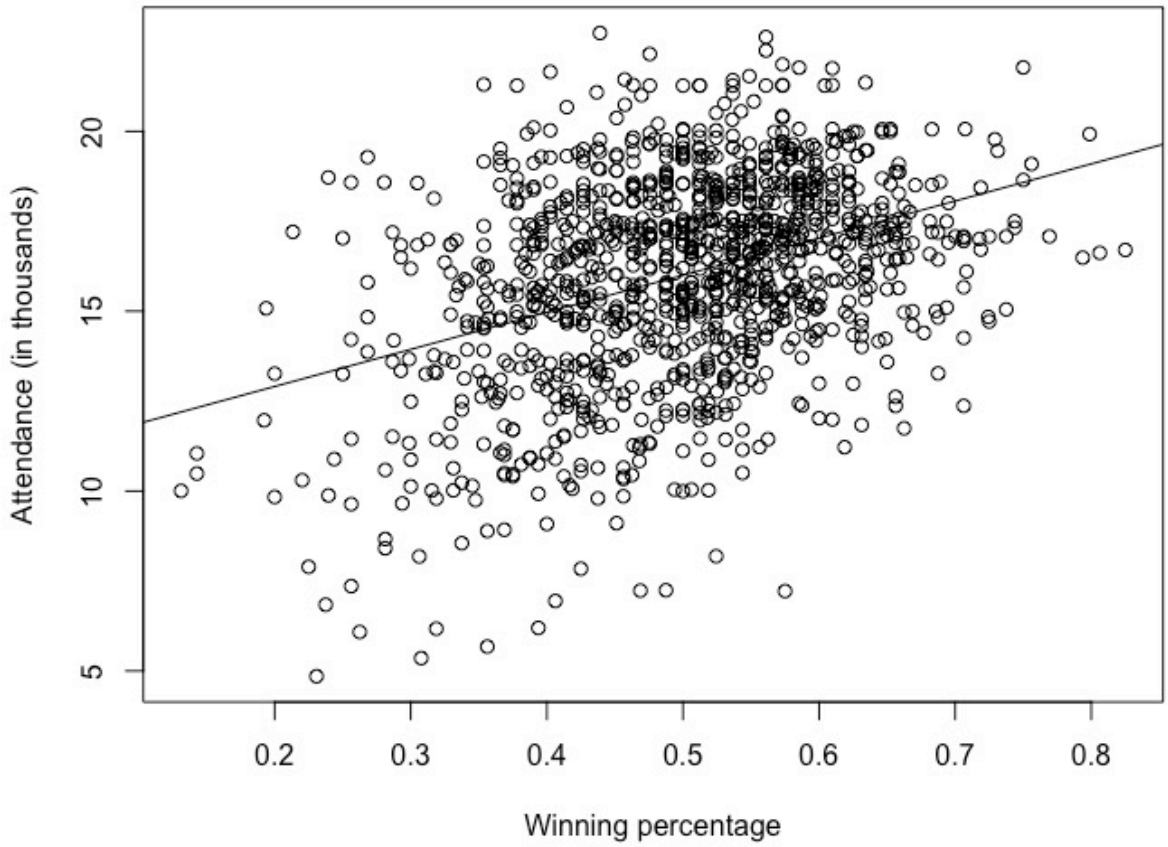

Figure 5. A scatterplot of winning percentage against attendance.

Appendices

Appendix A. Expansion Teams from 1972-73 to 2019-20

1972-73 Atlanta Flames and New York Islanders

1974-75 Kansas City Scouts and Washington Capitals

1979-80 Edmonton Oilers, Hartford Whalers, Quebec Nordiques, and Winnipeg Jets

1991-92 San Jose Sharks

1992-93 Ottawa Senators and Tampa Bay Lightning

1993-94 Florida Panthers and Mighty Ducks of Anaheim

1998-99 Nashville Predators

1999-2000 Atlanta Thrashers

2000-01 Columbus Blue Jackets and Minnesota Wild

2017-18 Vegas Golden Knights

Appendix B. Team Relocations from 1972-73 to 2019-20

1976-77 The California Golden Seals relocated to become the Cleveland Barons, and the Kansas City Scouts moved to become the Colorado Rockies.

1978-79 The Cleveland Barons merged with the Minnesota North Stars (since the North Stars continued in Minnesota, this merger is not coded as a relocation).

1980-81 The Atlanta Flames relocated to Calgary.

1982-83 The Colorado Rockies moved to become the New Jersey Devils.

1993-94 The Minnesota North Stars relocated to become the Dallas Stars.

1995-96 The Quebec Nordiques relocated to become the Colorado Avalanche.

1996-97 The Winnipeg Jets relocated to become the Phoenix Coyotes.

1997-98 The Hartford Whalers relocated to become the Carolina Hurricanes.

2011-12 The Atlanta Thrashers relocated and became the Winnipeg Jets.