



Sports Economics, Management and Policy
Series Editor: Dennis Coates

Bernd Frick *Editor*

Breaking the Ice

The Economics of Hockey

 Springer

Sports Economics, Management and Policy

Volume 16

Series Editor

Dennis Coates, Baltimore, USA

The aim of this series is to provide academics, students, sports business executives, and policy makers with information and analysis on the cutting edge of sports economics, sport management, and public policy on sporting issues.

Volumes in this series can focus on individual sports, issues that cut across sports, issues unique to professional sports, or topics in amateur sports. Each volume will provide rigorous analysis with the purpose of advancing understanding of the sport and the sport business, improving decision making within the sport business and regarding policy toward sports, or both. Volumes may include any or all of the following: theoretical modelling and analysis, empirical investigations, or description and interpretation of institutions, policies, regulations, and law.

More information about this series at <http://www.springer.com/series/8343>

Bernd Frick
Editor

Breaking the Ice

The Economics of Hockey

 Springer

Editor

Bernd Frick
Management Department
University of Paderborn
Paderborn, Germany

Department of Sport Economics and Sport
Management
Schloss Seeburg University
Seekirchen/Salzburg, Austria

ISSN 2191-298X ISSN 2191-2998 (electronic)
Sports Economics, Management and Policy
ISBN 978-3-319-67921-1 ISBN 978-3-319-67922-8 (eBook)
<https://doi.org/10.1007/978-3-319-67922-8>

Library of Congress Control Number: 2017958352

© Springer International Publishing AG 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

Part I Labor Relations and Player Behavior

From Strikes to Lockouts: Consequences of the Shift in the Balance of Power from the Players' Union to the Owners in the National Hockey League	3
Joel Maxcy	

Fighting as a Profit-Maximizing Strategy: The American Hockey League	17
Duane W. Rockerbie	

Part II Salary Determination and Player Careers

Returns to Handedness in Professional Hockey	41
Dennis Coates	

All-Star or Benchwarmer? Relative Age, Cohort Size and Career Success in the NHL	57
Alex Bryson, Rafael Gomez, and Tingting Zhang	

Part III Diversity and Discrimination

If You Can Play, You Get the Pay!? A Survey on Salary Discrimination in the NHL	95
Petra Nieken and Michael Stegh	

The Source of the Cultural or Language Diversity Effects in the National Hockey League	113
Kevin P. Mongeon and J. Michael Boyle	

Team-Level Referee Discrimination in the National Hockey League	131
Kevin Mongeon and Neil Longley	

Part IV Ticket Demand and Ticket Pricing

**The Effect of ‘Superstars’ on Attendance: NHL-Players
in the German and Czech Hockey League 151**
Christian Deutscher and Sandra Schneemann

**An Exploration of Dynamic Pricing in the National
Hockey League 177**
Rodney J. Paul and Andrew P. Weinbach

Index..... 199

Contributors

J. Michael Boyle Department of Operations & Information Systems, David Eccles School of Business, University of Utah, Salt Lake City, UT, USA

Alex Bryson Department of Social Science, University College London, London, UK

Dennis Coates Department of Economics, University of Maryland Baltimore County, Baltimore, MD, USA

Christian Deutscher Department of Sports Science, Bielefeld University, Bielefeld, Germany

Bernd Frick Management Department, University of Paderborn, Paderborn, Germany

Department of Sport Economics and Sport Management, Schloss Seeburg University, Seekirchen/Salzburg, Austria

Rafael Gomez Centre for Industrial Relations and Human Resources, University of Toronto, Toronto, ON, Canada

Joel Maxcy Center for Sport Management, Drexel University, Philadelphia, PA, USA

Kevin P. Mongeon Department of Sport Management, Brock University, St. Catharines, ON, Canada

Neil Longley Department of Sport Management, Isenberg School of Management, University of Massachusetts, Amherst, MA, USA

Petra Nieken Karlsruhe Institute of Technology, Institute of Management, Karlsruhe, Germany

Rodney J. Paul Falk College of Sport and Human Dynamics, Syracuse University, Syracuse, NY, USA

Duane W. Rickerbie Department of Economics, University of Lethbridge, Lethbridge, AL, Canada

Sandra Schneemann Department of Sports Science, Bielefeld University, Bielefeld, Germany

Michael Stegh Faculty of Economics and Management, University of Magdeburg, Magdeburg, Germany

Andrew P. Weinbach E. Craig Wall Sr. College of Business Administration, Coastal Carolina University, Conway, SC, USA

Tingting Zhang Centre for Industrial Relations and Human Resources, University of Toronto, Toronto, ON, Canada

Introduction

Why Hockey Economics?

The National Hockey League (henceforth NHL) is the smallest and the least studied among the major team sports leagues in the US. This is surprising insofar as the annual revenues in the NHL are significantly higher than in four of the five well researched top divisions in European Football (only the Premier League generates more money). Moreover, one of the now seminal papers in sports economics specifically addressed hockey quite early already (Jones 1969), suggesting that the interest in that league has been rather low for decades.

This volume tries to close that research gap. It includes nine papers addressing some of the most important questions related to the economics of professional team sports leagues: labor relations and player behavior, salary determination and player careers, diversity and discrimination and, finally, ticket demand and ticket pricing.

Bernd Frick

Part I
Labor Relations and Player Behavior

From Strikes to Lockouts: Consequences of the Shift in the Balance of Power from the Players' Union to the Owners in the National Hockey League

Joel Maxcy

Abstract The development of a players' union in the National Hockey League lagged behind the organization of unions in the other American major team-sport leagues by a decade. Moreover, the union leadership was ineffectual until Bob Goodenow succeeded Alan Eagleson as the head of the NHLPA in 1992. Under Goodenow the players used strikes and the threat of strikes to leverage mobility rights including unrestricted free agency and salary arbitration, all of which substantially and steadily increased salaries and the players' share of revenue for more than ten years. In 1995 ownership locked out the players, a radical move at the time as it was the first owner-initiated work stoppage to cancel scheduled games. The lockout enabled owners to roll back some of the mobility concessions gained by the union. Yet, the league was unable to implement a desired salary cap and player salaries continued to grow. Nine years later a second lockout resulted in the cancellation of the entire 2004–2005 season. The outcome this time was very favorable to owners including a hard salary cap and a limit on individual player salaries. In this chapter the NHL eras before and after the salary cap are compared. Competitive balance and payroll dispersion across teams are examined empirically through means tests. The analysis indicates that the players' share of revenue is much lower under the salary cap and that payroll dispersion across clubs has diminished. The results also show a significant improvement over three different dimensions of competitive balance. Finally, it is anticipated that owners will continue to leverage their bargaining position and gain more concessions.

J. Maxcy (✉)

Center for Sport Management, Drexel University, Philadelphia, PA, USA

e-mail: jmax@drexel.edu

© Springer International Publishing AG 2017

B. Frick (ed.), *Breaking the Ice*, Sports Economics, Management and Policy 16,

https://doi.org/10.1007/978-3-319-67922-8_1

Introduction

The National Hockey League's (NHL) entire 2004–2005 schedule of games was canceled because of a bitter labor dispute between the club owners and the players' union. The players in the four major American team-sport leagues, which include Major League Baseball (MLB), the National Basketball Association (NBA), and the National Football League (NFL), all have organized as unionized work forces. Collective Bargaining Agreements (CBAs), the set of union-management negotiated policies regulating compensation, hours, and working conditions under American Labor Law (NLRB 1935) were in place for each league by 1970. Federal labor law governs negotiations, a process which may bring conflict leading to work stoppages. Strikes and lockouts are the stoppages initiated by the players' union and the owners, respectively. Such industrial actions are permissible by law. Work stoppages had cancelled games in each of the leagues on several occasions prior, including the 1994 MLB championship tournament (the World Series). Notwithstanding, a league's entire season's schedule had not before been voided.

The pivotal issue of contention was the owners' demand for a *salary cap*. NHL payrolls at that time, like MLB, but in contrast to the NBA and NFL, were not subject to any limits. The salary cap proposed by the owners, however, invoked strict bounds on both team payrolls and individual player salaries. This combination would make the NHL's salary rules the most restrictive of the American major leagues. For instance, the NBA had limited individual salaries since 1999, but its payroll restraint, in place since 1984, allows exceptions so as to be termed a *soft* payroll cap. The NFL meanwhile has employed a no-exception or *hard* payroll cap since 1994, but except for the contracts of first-year players (rookies), the policy does not directly limit individual players' salaries. Most importantly, the NHL owners' proposal greatly diminished the players' negotiation leverage and aimed to reduce their share of league revenue. The union was accordingly acrimonious to any mandated restriction on salaries and payrolls; the conflict over this issue motivated the work stoppage.¹

The National Hockey League Players' Association (NHLPA) was the last of the four unions to organize, and through most of its history lagged behind the other sports unions in terms of power and influence (Cruise and Griffiths 1991). However, with the appointment of Bob Goodenow as the NHLPA's Executive Director in 1992, the organization changed course. Goodenow invoked a considerably more aggressive approach to bargaining than his predecessor, Alan Eagleson. Following the MLB union's (MLBPA) tactic of instigating work stoppages at the point in the season of peak profitability for owners, Goodenow swiftly called a strike on the eve of the 1992 playoffs. The owners acquiesced before any missed games. The outcome was a modified CBA which loosened the rules for free-agent eligibility and

¹The NBA's *soft cap* refers to the policy that allows teams to exceed the predetermined payroll limit under several stipulated circumstances. Most common is when re-signing a player who is already on the club's current roster. The NFL *hard cap* allows no exceptions to the payroll limit, but can nevertheless be circumvented.

expanded opportunities for salary arbitration to settle contract disputes between ice hockey players and their teams (Dowbiggen 2007). The changes initiated a less restrictive, more fluid labor market, and represented a significant gain for players.

The NHL labor rules had quickly come to resemble MLB's, generally considered the most favorable to players in professional sports. Under Goodenow's leadership, from the 1992–1993 through 2003–2004 seasons, the average NHL player's salary rose from \$276,000 to \$1.8 million (Dater 2012). All advancement aside, a mild restraint of free agent and salary arbitration eligibility and the implementation of a strict salary cap for first-year players followed from a new CBA negotiated after an owners' lockout that cancelled about one-third of the scheduled 1994–1995 contests. The 1994–1995 lockout is of consequence, not as much for the rather modest rollback of union gains, but for changing the dynamics of labor relations in the NHL and American professional sports.

The 2003–2004 championship season was the last one before the expiration of the CBA, which began with the lockout settlement in 1995. Negotiations for a new agreement were attempted on several occasions over that season (Kahane 2006), but proved futile given the club owners' demand for payroll limits and Goodenow's unyielding resistance to a restricted labor market. Typical of sports labor disputes, leveling the playing field and improving competitive balance was stated as the primary goal. However, owners' objectives were also to reverse the flow of income and increase their share of the total generated revenues.

The owners, as they had done in 1994, timed the lockout so as to inflict the highest cost on players, just as preseason training camps were scheduled to open in September 2004 (Stoudohar 2005). There was little compromise from either side until early February when the union accepted as inevitable a payroll cap; however, the two sides differed substantially on the dollar value of the cap's upper bound. The NHLPA offered \$49 million per team per year and the owners countered at \$42.5 million, a \$6.5 million gap. Summed across all 30 NHL teams, the difference between the two sides' positions totaled \$195 million (Stoudohar 2005). Unable to compromise and with insufficient time to complete a schedule, NHL Commissioner Gary Bettman announced on February 16, 2005 that the season was cancelled (Kahane 2006).

Cracks in the union's solidarity were revealed the following summer as owners indicated the resolve to continue the lockout into a second season. Various players, under the pressure of losing a second year of hockey income, urged the union to concede, and accompanied by Goodenow's forced resignation, the NHLPA did just that (Dowbiggen 2007). The conditions of a new CBA, to extend through 2011–2012, were announced in July 2005. The union accepted a hard payroll cap at \$39 million per team for the 2006–2007 season, with annual adjustments to fix the cap so that the players' share was a maximum of 54% of league revenue. Moreover, any individual player's salary was capped at 20% of his team's total payroll, amounting to an annual limit of \$7.8 million in 2005–2006 (Stoudohar 2005). Kahane (2006) provides a detailed table of the resultant CBA. The approved payroll bound was not only 25% less than the union's bid in February, it was also 10% below the owner's tender. The deteriorating negotiating leverage of the union as the lockout persisted was clearly revealed.

The NHL's success with lockouts appears to have influenced at least the NBA and NFL owners to adopt similar strategies. Both leagues at once faced expiring CBAs in 2011 and locked out the players. The NBA had already used the method to their benefit in 1998. The NFL resorted to a lockout for the first time after 18 years of labor peace. The NFL owners actually accelerated the CBA expiration so as to take earlier advantage of the lockout opportunity. (The NFL followed up with a lockout of their referees in 2012.) In each case, the owners made considerable gains and reduced the players' share of revenue from about 60% to less than 50%.

The NHL likewise exercised its third lockout in 2012, cancelling 34 games for each team before terms of a new CBA were reached in December. The new CBA made no substantial changes in either salary or payroll cap policy. However the players' percentage share was reduced from 54% to 48% (Brehm and Allen 2013). Bob Goodenow's warning regarding a payroll cap during negotiation in 2004 appears to have come to pass. He surmised at the time that once a cap is imposed, the owner's enthusiasm to adjust the players' share down will not cease (Dowbiggen 2007).

The NHL's experience in the aftermath of the lockout brings about two areas for consideration. First, the imposition of the hard salary cap facilitates an empirical examination of the effect of the policy on talent distribution and competitive balance. The NHL's cap represents a significant change as the league moved to a highly restrained market from a talent distribution that was the outcome of a relatively free labor market. Salary cap effects on sports leagues have been heretofore difficult to distinguish empirically. The NBA's soft cap is not truly a payroll limit. The NFL invoked their salary cap system and at once loosened free agent rules; the changes modified what was already a highly restricted labor market. Second, the NHL's success from the lockout strategy was a resounding success from the owners' perspective and this did not go unnoticed by the other American leagues. The lockout strategy has become the standard choice of actions by owners in the other American sports when engaging in collective bargaining negotiations.

This chapter proceeds as follows. The next section reviews the literature regarding salary caps and their effect on talent distribution and compensation patterns in team-sport leagues. That section is followed by empirical tests measuring several dimensions of competitive balance in the NHL before and after the imposition of the salary cap, including an account of those results. The chapter concludes with a broader discussion of the outcomes, including the advancement of the lockout strategy.

Literature Review

Transformations in labor policies, both hypothetical and existent, have long motivated analyses by sports economists. Simon Rottenberg's (1956) seminal work established one primary tenet of sports economics; that the assignment of property rights to players' labor service does not alter the distribution of players (talent)

across clubs in a team-sport league –the *invariance principle*. Rottenberg wrote specifically about the MLB reserve clause, which contractually authorized to owners the property rights to the players' labor service. Free agency conversely shifts those property rights to the player.

The invariance principle has been interpreted by some to broadly suggest that all changes in labor policies that reallocate the distribution of income between owners and players will not alter competitive balance in a sports league. Analysis of labor policy shifts, in particular the institution of free agency in American sports and the corresponding elimination of, or restrictions on transfer payments in European football, predominate the sports economics literature. Fort and Maxcy (2003) discuss the significant body of literature that considered the effects of league policy changes on competitive balance to that point. Fort (2006) follows with a comprehensive review of the literature on competitive balance in American team-sport leagues.

Rottenberg's work applied invariance only to MLB's reserve clause, but the presumption remains that it extends to other policies and events that manipulate sports labor markets. Even when a policy may theoretically improve balance, economists researching this area frequently suggest that it is overwhelmingly labor market control and profits that motivate the rule changes (e.g. Quirk 1997). The argument for improved balance is simply a smokescreen and incidental to the true objective.

Empirical tests are mixed and vary across both the policy change examined and the measure of competitive balance employed. Fort et al. (2016) provide a thorough and critical review of the economic research that addresses the effects of all types policy changes by team-sport sport leagues on competitive balance. A sample of those papers is discussed here. Papers by Spitzer and Hoffman (1980), Cymrot (1983), and Besanko and Simon (1985) each find empirical evidence from the early years of MLB free agency that support the invariance principle. There are several studies that reject invariance including Hylan et al. (1996), Marburger (2002), and Maxcy (2002). Nevertheless, Fort and Lee (2007) employ a time series analysis of the most common measure of balance—the ratio of the actual to ideal standard deviations of win percent (RSD)—and find no structural changes coincidental with drafts, free agency, salary caps, or most labor disputes in the NBA, NHL, or NFL.² Other researchers disagree on the theoretical generalization beyond a strict transfer of property rights. For example, Késenne (2000a) argues that invariance does not hold for alternate revenue sharing schemes.

Generally the evaluation of competitive balance in the NHL has been included with works that encompass all four American major leagues (e.g., Sanderson and Siegfried 2003, Schmidt and Berri 2003). Very little work has considered the NHL in isolation. Jones and Walsh (1987) find that rival league competition in the 1970s from the World Hockey Association (WHA) mirrored free agency outcomes and significantly increased players' salaries. Richardson (2000) evaluates the invariance principle with respect to free agency in the NHL and finds a gradual, though cyclical improvement in RSD. Yet, he cannot ascertain that changes in free agency are

²This followed Lee and Fort (2005) who found the same lack of structural change applied to MLB.

responsible. To this point there is no known research that has isolated salary cap effects in the NHL.

Mandated limits (salary caps) on club payrolls and/or individual player's compensation have become commonplace at all levels of American sport leagues. Major League Soccer (MLS), the Women's National Basketball Association (WNBA), and the Arena Football League are among those team-sport leagues that enforce a hard salary cap. Bounds on payroll have been implemented in three of the four major professional leagues, and in several lower-level leagues. Salary caps, at least by conventional wisdom, are at once considered the solution to (small market) teams' financial troubles and the panacea to competitive imbalance. Although some adherents to invariance may include cap policy with the group of rules that do not alter the distribution of talent, there is theoretical support for the effectiveness of salary caps in the moderation of competitive balance.

Quirk and Fort (1995) and Rascher (1997) consider payroll cap effects as modifications within broader theoretical models of sport leagues. Both papers weigh the circumstances under which a cap is expected to improve competitive balance. Késenne's (2000b) model shows that in addition to improving balance, salary caps will level (improve) the salary distribution within and across teams. Notwithstanding, there has been scant empirical examination as to the effect of these policies on sports labor markets.

Larson et al. (2006) employ Gini Coefficients to measure allocation outcomes and find some evidence that the NFL's salary cap is consistent with improved balance. However, they find that unrestricted free agent rights are also responsible, and both policies were instituted at once with the league's 1994 CBA. Lee (2010) found that with the 1994 CBA, the NFL's combination of labor policy changes, including the payroll cap, improved inter-seasonal balance. Booth (2005), using the familiar RSD method, finds that imposition of a salary cap in 1986 improved competitive balance in the Australian Rules Football League. However, as with NFL free agency, another policy was implemented concurrently. In this case a player draft was imposed the same year as the payroll cap. Again, it was not possible to distinguish the changes in competitive balance as consequences of one policy, the other, or a combination of the two.

Quirk (1997) maintained that a theoretically effective cap differs considerably from those caps that have been implemented in practice. He alludes to the NBA cap outcomes, which are shown to neither improve balance nor restrain payrolls, as the incongruence between the implemented soft cap policy and a true hard cap. Maxcy (2011) conversely evaluates MLB's luxury tax on team payrolls—a restraint similar to a soft cap—and finds the policy to be mildly effective at inhibiting the flow of the most productive players toward the highest revenue generating clubs. At any rate, the effect of salary and payroll restraints on sports labor market outcomes remains unclear. Perhaps, despite the current prevalence of these restraints, an opportune setting in which to study their effects, and the corresponding data necessary to support a proper empirical examination, has not before been present.

The NHL case provides a clear shift of policy and the cap is strict, enforced, and not entangled with other policy tools. The empirical examination assesses several dimensions of competitive balance and analyzes changes in the distribution of salaries across teams and players.

Empirical Analyses

Two simple propositions with respect to the effect of the NHL's payroll cap are tested:

Proposition 1: The dispersion of annual payroll values across teams will be less under a payroll cap system.

Proposition 2: Imposition of a payroll cap will level the distribution of talent across teams and improve competitive balance.

The effect of the salary cap is tested by comparing the periods before and after implementation of the salary restrictions following the lockout in 2005. The initial period of comparison is defined by the *Goodenow era*, encompassing eleven seasons starting in 1992–1993. Although the removal of mobility restrictions had gradually loosened NHL labor markets prior, this period marks the apex of free labor market conditions for NHL players. Basic testing of mean values is used to compare the before-cap (1992–1993 – 2003–2004) and after-cap (2005–2006 – 2013–2014) periods. Changes in salary dispersion across teams and measures of three alternate dimensions of competitive balance are examined. Data were collected from Rod Fort's (2014) sport business database and HockeyReference.com (2014).

The analysis of salary dispersion across teams checks Késenne's (2000b) theory and the first proposition, that a salary cap equalizes team payrolls. Though the correlation between team payroll and winning is far from perfect (e.g. Hall et al. 2002), a closer distribution of payrolls theoretically reflects a more even distribution of talent across a league. Table 1 presents the average club payroll and standard deviation for each year of the two periods for which data is available.³ Correctly accounting for dispersion requires calculation of the coefficient of variation (COV = standard deviation ÷ mean). A comparison of the before and after means shows that the cap is clearly consistent with payroll dispersion. Average team payrolls increased substantially over the 20 year period from \$8.25 million in 1992–1993 to more than \$62 million for 2013–2014, and average payrolls in the post cap period are nearly double the pre cap years. Notwithstanding, the comparison of payroll dispersion, as measured by the COV, shows that payrolls were much more concentrated in the years following the imposition of the cap. The COV is more than double in the earlier era (0.355–0.149) and the t-test shows this to be a highly significant result (p-value = 0.000). The results leave little doubt that the payroll cap accomplished

³NHL payroll data is not available for the 1997–1998 season.

Table 1 NHL payroll dispersion: pre and post salary cap

Period of analysis	Season	Average payroll	Standard deviation	Coefficient of variation
	1992–1993	\$8,275,648	\$4,514,633	0.546
	1993–1994	\$12,950,000	\$3,702,327	0.286
	1994–1995	\$15,967,500	\$4,302,599	0.269
	1995–1996	\$19,769,666	\$4,944,225	0.250
	1998–1999	\$28,552,225	\$9,587,472	0.336
	1999–2000	\$30,529,312	\$11,640,445	0.381
	2000–2001	\$33,375,943	\$11,657,873	0.349
	2001–2002	\$38,011,852	\$14,162,670	0.373
	2002–2003	\$41,939,715	\$16,876,630	0.402
	2003–2004	\$44,400,490	\$15,898,399	0.358
	2005–2006	\$34,657,712	\$6,247,900	0.180
	2006–2007	\$40,211,713	\$4,699,260	0.117
	2007–2008	\$44,388,537	\$7,601,233	0.171
	2008–2009	\$51,387,176	\$8,104,458	0.158
	2009–2010	\$51,750,270	\$7,948,647	0.154
	2010–2011	\$54,173,190	\$11,046,770	0.204
	2011–2012	\$56,657,728	\$9,777,196	0.173
	2012–2013	\$60,699,742	\$6,311,335	0.104
	2013–2014	\$62,200,365	\$4,956,297	0.080
Full period	1992–2014	\$38,415,725	\$8,630,546	0.257
Pre cap	1992–2004	\$27,377,235	\$9,728,727	0.355
Post cap	2005–2014	\$50,680,715	\$7,410,344	0.149
Difference		\$23,303,480 ^a	\$2,318,383	0.206 ^a

^aSignificant at 0.01

^bSignificant at 0.05

^cSignificant at 0.1

the goal of smoothing club payrolls. However additional tests are needed to confirm that competitive balance also improved.

Fort (2006) summarizes other researchers and offers three dimensions of outcome uncertainty that can be used to measure competitive balance. These are game uncertainty, end of season uncertainty, and seasonal discontinuity. Numerous statistical measures have been employed to assess the various aspects of competitive balance. The three chosen here attempt to capture each of the three aforementioned dimensions. RSD, the most used measure of balance, explains the variation in talent distribution over the course of each full season. Arguably it captures end of season uncertainty as the more closely grouped the teams are, the less certain end-of-season outcomes are, for instance which teams will qualify for the playoffs. Table 2 shows the absolute standard deviations of win percent and the RSD results over the course of both the pre and post cap eras. RSD shows a much tighter and statistically significant distribution of talent in the post cap years (1.602 post cap compared to 1.832 pre cap, p -value = 0.035).

Table 2 NHL standard deviation of win percent: pre and post salary cap

Period of analysis	Season	SDWP	ISD	RSD
	1992–1993	0.145	0.055	2.660
	1993–1994	0.102	0.055	1.875
	1994–1995	0.111	0.072	1.541
	1995–1996	0.116	0.055	2.092
	1996–1997	0.078	0.055	1.411
	1997–1998	0.096	0.055	1.742
	1998–1999	0.097	0.055	1.752
	1999–2000	0.104	0.055	1.880
	2000–2001	0.108	0.055	1.950
	2001–2002	0.092	0.055	1.658
	2002–2003	0.093	0.055	1.693
	2003–2004	0.095	0.055	1.729
	2004–2005	NA	NA	NA
	2005–2006	0.109	0.055	1.979
	2006–2007	0.102	0.055	1.852
	2007–2008	0.066	0.055	1.193
	2008–2009	0.088	0.055	1.586
	2009–2010	0.085	0.055	1.543
	2010–2011	0.085	0.055	1.532
	2011–2012	0.080	0.055	1.449
	2012–2013	0.109	0.072	1.510
	2013–2014	0.097	0.055	1.768
Full period	1992–2014	0.098	0.057	1.733
Pre cap	1992–2004	0.103	0.057	1.832
Post cap	2005–2014	0.091	0.057	1.602
Difference		0.012 ^a	−0.001 ^b	0.230 ^b

^aSignificant at 0.1

^bSignificant at 0.05

^cSignificant at 0.01

Game uncertainty is evaluated by examining goal differential across teams over the course of each season. HockeyReference.com (2014) reports total goals scored and allowed each season for all NHL teams. Goal differential (GD) is the calculated difference between the two and may take either a positive or negative value. Two work stoppage seasons (1994–1994 and 2012–2013) had only 48 games, thus GD was adjusted to a per-game average. The standard deviation of goal differential (SDGD), both absolute and adjusted across teams in the league, was calculated for each season and the computed values are shown in Table 3. Once again a clear improvement in competitive balance in the post cap era is apparent. The SDGD per game dropped from 0.61 to 0.48 (p-value = 0.002). In addition to tighter groupings of teams in the standings, the SDGD comparison indicates that scoring differential was on average much closer following implementation the cap.

Table 3 NHL standard deviation of goal differential: pre and post salary cap

Period of analysis	Year	SDGD	Games	SDGD/games
	1992–1993	78.35	82	0.933
	1993–1994	54.02	82	0.643
	1994–1995	31.58	48	0.658
	1995–1996	58.38	82	0.712
	1996–1997	38.32	82	0.467
	1997–1998	44.26	82	0.540
	1998–1999	42.98	82	0.524
	1999–2000	50.22	82	0.612
	2000–2001	48.79	82	0.595
	2001–2002	42.36	82	0.517
	2002–2003	43.59	82	0.532
	2003–2004	45.75	82	0.558
	2004–2005	NA	82	NA
	2005–2006	46.71	82	0.570
	2006–2007	46.10	82	0.562
	2007–2008	28.33	82	0.345
	2008–2009	36.99	82	0.451
	2009–2010	35.55	82	0.434
	2010–2011	37.13	82	0.453
	2011–2012	25.26	82	0.308
	2012–2013	24.09	48	0.502
	2013–2014	40.76	82	0.497
Full period	1992–2014	42.834	78.909	0.543
Pre cap	1992–2004	48.218	79.167	0.608
Post cap	2005–2014	35.657	78.222	0.458
Difference		12.561 ^a	0.944	0.150 ^a

^aSignificant at 0.01^bSignificant at 0.05^cSignificant at 0.1

The Spearman's Rank Correlation Coefficient (SRCC) is used to evaluate seasonal discontinuity. This method, which measures the correlation of each team's rank in the league standings over two consecutive seasons, is standard practice in the sports economics literature. For example, Daly and Moore (1981) and Maxcy (2002) have used this method to evaluate the seasonal discontinuity dimension of competitive balance in American team sport leagues. A league where a club can quickly move from last to first is thought to exhibit good balance, while little year-over-year change of the order of finish reflects poor balance; the SRCC captures this. SRCC coefficient values range from $R_s = -1$ to $R_s = +1$ with -1 representing a perfect reordering of league standings and thus the best possible balance. A value of $+1$ indicates exactly the same order of finish and thus higher coefficient values indicate worse balance.